Journal of the Knowledge Economy (2024) 15:9538–9555
https://doi.org/10.1007/s13132-023-01466-8

Does the Location in Science and Technology Parks Foster the Employment Growth of Firms?

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Received: 24 January 2023 / Accepted: 6 August 2023 / Published online: 19 August 2023

Abstract

One of the main objectives of science and technology parks (STPs) is to contribute to regional development through the creation of skilled jobs in the territory where they are located. However, despite the expansion of these infrastructures over the last decades and the governmental support they receive, there is very little empirical evidence on how these infrastructures affect the employment growth of the firms located there. The aim of this paper is to examine whether the location in STPs has positive effects on employment growth at the firm level. We analysed a sample of 553 Portuguese firms located on STPs and a control group of the same size of comparable firms located outside STPs, applying a dynamic panel data model methodology. The empirical evidence does not allow to prove that location in STPs has positive effects on employment growth, which raises the need to rethink the policies supporting these parks.

Keywords Science and technology parks · Employment growth · Location effects · Regional development · Dynamic panel data

JEL Classification M13 · O30 · R11

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Introduction

The topic of science and technology parks (STPs) is becoming increasingly relevant. In Europe, the first parks were born in the late 1960s and early 1970s; it was not until the 2000s that they began to expand significantly (IASP, 2016). In Portugal, the country under study, these infrastructures born from 1991 onwards but, following the international trend, most of the existing parks were born in the 2000s (representing 57.6% of parks born between 1991 and 2015). One of the factors that had a decisive influence on this boom was the adoption of public policies that encouraged the creation of STPs, with the aim of promoting the growth of skilled employment and added value in the regions where they were located (European Commission EC, 2013).

According to the International Association of International Science Parks and Areas of Innovation (IASP), the aim of the science and technology parks is to increase the wealth of communities by promoting the culture of innovation and the competitiveness of associated firms and knowledge-based institutions (IASP, 2016). Bellavista and Sanz (2009) highlight eight defining elements of STPs: (i) management is carried out by a specialised team whose main task is to create links and knowledge transfer between the actors involved; (ii) there is a link with universities; (iii) firms have access to value-added services — such as access to venture capital funds, consultancy in intellectual property, or access to international networks; (iv) there are quality facilities adapted to the needs of the firms; (v) instruments are provided to attract innovation-based firms, promote specialised entrepreneurship, and attract highly qualified professionals; (vi) STPs should be business attractive areas, promoting links between start-ups and established firms so that both have an incentive to locate there; (vii) provide networks to enhance the exchange between stakeholders; and (viii) influence the territory, disseminating their positive effects beyond the borders of the parks. Overall, the location of firms in STPs should facilitate the introduction of resources that push growth economies, i.e. economies available at the firm level that enable profitable growth (Penrose, 1959).

Although the number of STPs has grown significantly in the last decades and they are now well-established infrastructures in many countries, the scientific literature on parks is still in a phase of expansion (Albahari et al., 2022; Hobbs et al., 2017; Lecluyse et al., 2019). In particular, there is still very little work on the effects of parks on the economic performance of the firms located there, whether measured through profitability, productivity, sales growth, or employment growth (Albahari et al., 2022).

This study focuses on the effects of STPs on firms' employment growth, one of the most overlooked topics in the PCT literature. The employment growth of firms located in STPs is relevant for several reasons. In general, firm growth serves as a proxy of performance, as it reflects market acceptance of the business (Zhou & Wit, 2009). Employment growth implies an increase in the resources available within the firm, facilitating the exploitation of potential economies of scale and the future growth; that is, growth is a dynamic and cumulative process (Penrose, 1959). Theoretically, the access to the resources and skills provided by

the parks should promote employment growth (Löfsten & Lindelöf, 2001, 2002). In fact, employment growth is seen as a benchmark of STPs and business incubators (Stokan et al., 2015), where one of the motivations for the creation of new ventures is the self-employment of innovative and highly skilled founders (Colombo & Delmastro, 2002). Crucially, employment growth is one of the main policy objectives justifying governments' financial support for STPs, as attracting well-paid and well-trained employees to a geographical area is one of the positive externalities that parks have on the region where they are located (Colombo & Delmastro, 2002; EC, 2013; Ferguson & Olofsson, 2004; Spithoven & Knockaert, 2011; Stokan et al., 2015).

However, as already anticipated, empirical studies on STPs have not devoted much attention to the relationship between these infrastructures and firms' employment growth (Hobbs et al., 2017) which is surprising considering that promoting employment is one of the main policy objectives justifying government support for these parks (Amirahmadi & Saff, 1993; EC, 2013). Table 1 summarises the existing literature on this topic. Beyond the scarcity of empirical studies, it is worth noting the divergence in their results. Whilst some of them find a positive effect of location in STPs on the employment growth of firms (Colombo & Delmastro, 2002; Díez-Vial & Fernández-Olmos, 2017a; Lindelöf & Löfsten, 2002; Löfsten & Lindelöf, 2001, 2002, 2003; Stokan et al., 2015), others find no statistical evidence to support this conclusion (Díez-Vial & Fernández-Olmos, 2017b; Ferguson & Olofsson, 2004; Monck et al., 1988; Westhead & Storey, 1994).

The authors who find a positive effect of STPs on firm employment growth refer to the resources and the networking capacities enabled in the parks. Thus, the sharing of equipment, services, human capital, and knowledge spillovers would enhance the growth of the companies (Díez-Vial & Fernández-Olmos, 2017a). Stokan et al. (2015), focused on business incubators, emphasise that the networking and services received by companies in these locations allows firm managers to have more time available, whilst at the same time it can reduce costs, leaving more resources available to devote to other aspects of the business.

On the other hand, the authors who find no positive effects of STPs on employment growth provide different explanations for this fact. In this sense, Díez-Vial and Fernández Olmos (2017b) find a significant effect of location in STPs on employment growth only in the case of high-tech firms and during recession periods, finding no significant effect for other types of firms and periods. Thus, the resources provided by the parks would not make a significant difference to the growth of firms in times of economic growth, as firms could access similar growth-enhancing resources outside the parks. Another complementary explanation is provided by Ferguson and Olofsson (2004), who suggest that the cooperation with universities could reduce the need for early growth of the firms. Insofar as firms can benefit from external human resources to develop their activity, i.e. scientific and technical personnel from universities or provided by the parks themselves, they have less need to increase their number of employees. The study by Arauzo-Carod et al. (2018) find an overall negative effect of location in STPs on firm employment growth, but a positive effect for high-growth firms, concluding that the parks have different types of impact depending on the characteristics of the companies located there.

Table 1 Summary of empirical literature on STPs and firm employment growth

Authors	Sample	Country	Period	Method	Dependent variable	Result
Monck et al. (1988)	284 technology-based firms, 183 of which are located on STPs	United Kingdom	1986	Difference of means	Employment	()
Westhead and Storey (1994)	142 technology-based firms, 71 of which are located on STPs	United Kingdom	1986–1992	Difference of means	Employment growth	()
Löfsten and Lindelöf (2001)	263 technology-based firms, 163 of which are located on STPs	Sweden	1994–1996	Regression analysis	Employment growth	+
Löfsten and Lindelöf (2002)	273 technology-based firms, 134 of which are located on STPs	Sweden	1996–1998	Regression analysis	Employment growth	+
Lindelöf and Löfsten (2002)	134 on-park new technology-based firms, 139 off-park firms	Sweden	1996–1998	Mean comparisons	Employment growth	+
Löfsten and Lindelöf (2003)	134 on-park new technology-based firms, 139 off-park firms	Sweden	1996–1998	Mean comparisons, Pearson correlation	Employment growth	+
Colombo and Delmastro (2002)	90 technology-based firms, of which 45 are incubated on STPs and the rest are incubated outside these parks	Italy	2000	TOBIT	Employment growth	+
Ferguson and Olofsson (2004)	66 technology-based firms, 30 of which are located on STPs	Sweden	1991–2000	Difference of means (Mann–Whitney test)	Employment growth	()
Stokan et al. (2015)	589 firms, 294 of which in incubators	USA	2009	Regression analysis (OLS)	Employment growth	+
Díez-Vial and Fernández-Olmos (2017a)	438 on-park firms, 11,156 off-park firms	Spain	2007–2012	Random effects panel Random effect TOBIT	Employment growth	+
Díez-Vial and Fernández-Olmos (2017b)	359 on-park firms, 9541 off-park firms	Spain	2007–2012	Generalised method of moments	Employment growth	()
Arauzo-Carod et al. (2018)	170 on-park firms, 7189 off-park firms	Catalonia (Spain)	2006–2013	OLS; fixed effect quantile regressions	Employment growth	-

In a systematic review of the literature, Albahari et al. (2022) explored the causes of the heterogeneity of empirical results yielded by studies on STPs and the economic performance of firms. These authors find that the researches using relatively small sample sizes are less likely to find statistically significant results confirming positive effects of park location on firm economic performance, including employment growth. Statistical significance depends on the relationship between the estimated coefficient and the estimated standard deviation for that coefficient, which would lead to small samples underestimating the effect of the independent variable (location in PCT) on the dependent variable (performance). In other words, the different sample sizes could be a determining factor in explaining the heterogeneity of results yielded by previous studies. In addition, the same authors also highlight for the risk of bias in the selection of control samples (i.e. companies located outside STPs). Park managers follow criteria of growth potential and business viability when selecting candidate firms to locate there, which in itself could lead to a higher growth of in-STP firms than off-STP firms, but not because of a park effect, but because of the previous characteristics of each firm.

The scarcity of published research and the divergence of their results make it necessary to further explore the effects of location in STPs on firm's employment growth, which is the aim of this paper. In particular, we contribute to the existing literature by using a large sample of 553 firms located in STPs, thus avoiding a potential underestimation of park effects that could result from the use of a small sample. In this regard, it is noteworthy that of the 38 studies analysed by Albahari et al. (2022) on STPs and economic performance, only one fifth use samples consisting of more than 500 firms. Additionally, we used Propensity Score Matching (PSM) to match the sample of firms in STPs with the control sample, avoiding potential bias problems. Besides, the empirical analysis is conducted with recourse to the generalised method of moments (GMM) in dynamic panel data. As we develop in the next section, this methodology is particularly suited to the empirical study of firm growth and allows to control for individual firm characteristics that could influence employment growth. Furthermore, this work takes Portugal as a case study, a country that has not yet been analysed, and considers an extended period (2006–2014), updating the insights on this topic.

Considering the existing literature, this study aims to answer the following research question (RQ1): Does location in science and technology parks foster the employment growth of firms?

Materials and Methods

Sample and Data

As already anticipated, this study relies on a sample of Portuguese firms located on STPs during the period 2006–2014 and a control sample of firms located off these parks. The firms' data were retrieved from SABI database of Bureau van Dijk and Informa. This database contains general information and annual accounts for thousands of Portuguese firms (Bureau van Dijk, 2022).

In their literature review, Albahari et al. (2022) concluded that there is no relationship between the countries used as case studies and the likelihood of finding effects of STPs on firm performance. Thus, the use of Portugal as a case study is not because this country has any particular characteristics; on the contrary, the results obtained for Portugal should be similar to those that would be obtained using any other developed country.

The choice of the period 2006–2014 is based on two criteria. First, it is a period in which there are already a significant number of parks and companies located in them. This ensures that the sample has a large number of observations and, therefore, that the results are robust. In Portugal, the first STP was established in 1991 but, as in other countries, most of the existing parks were founded after 2000. Second, it is a fairly long period of 9 years. In addition to ensuring a high number of observations, it also prevents the macroeconomic conjuncture of any particular year from distorting the overall results.

To construct the sample of firms located in STPs, the existing STPs in Portugal were identified, using the register of TECPARQUES (Portuguese Association of Science and Technology Parks—*Associação Portuguesa de Parques de Ciência e Tecnologia*), the association that represents the STPs in the country, identifying 26 parks. The postcodes of these STPs were used to identify in SABI the firms located there. To limit the sample to firms with the legal form of commercial corporations, non-corporate entities, or firms whose corporate purpose was not of a commercial or industrial nature, were not considered. The search was limited to firms created in 1991 or later, the born year of the first STP in Portugal. In addition, firms with an Economic Activity Code (CAE, for its Portuguese acronym) for catering and similar activities were excluded. After this process, the sample of firms located in STPs included 591 entities.

To construct a control sample of the same size and similar characteristics as the main sample, we applied the Propensity Score Matching (PSM) method. In a first step, we collected data from SABI for those firms that met the following conditions: (i) having an economic activity code (CAE 3rd version) equal to at least one of the firms in the main sample, (ii) having a date of incorporation equal to or later than 1991, (iii) be located in at least one of the regions in which the firms in the main sample are located, and (iv) not being one of the firms located in STPs. For the sake of consistency, only firms with the legal form of commercial corporations and not having a catering activity code were considered. In addition, to ensure data quality, only observations with a positive sales figure and with positive values for both assets and equity were considered. At the end of this step, the control sample consisted of 137,915 firms not located on STPs.

To select those firms located outside STP with the most similar characteristics to those located on STPs, we applied the Propensity Score Matching (Caliendo & Kopeinig, 2008; Rosenbaum & Rubin, 1983). To integrate the PSM, the independent variables age, sector of economic activity, and region were used, following previous studies on STPs and firm performance (e.g. Lamperti et al., 2017; Liberati et al., 2016; Löfsten & Lindelöf, 2002). The age was calculated as the difference between the year of incorporation of each company and 2015. The qualitative variable sector of economic activity refers to the economic activity

code (CAE Rev. 3) in which each firm is registered. The qualitative variable region refers to the Portuguese region each firm is located.

Based on the estimated propensity scores, each STP firm was matched to its closest non-STP neighbour (nearest-neighbour method) without replacement. To check whether the participation model had been adequately specified to balance the characteristics of the treatment and the control groups, we compared the estimated propensity scores across firms located on and off STPs before and after matching (Figs. 1 and 2). As can be observed, the matching performed well given that the overlapping of distribution improves from before matching to after matching. Then, the common support region was established by comparing minimum and maximum propensity scores. The model did not find a support region for 38 of the firms located on STPs, so they were removed from the sample. Thus, both the sample of firms on STPs and the control sample of firms off STPs eventually included 553 firms each. Finally, we tested whether the samples of firms on and off STPs were significantly different in the mean values of the matching variables prior to matching and post-matching. The virtual absence of statistically significant differences between samples after matching indicated that the process yielded good results.

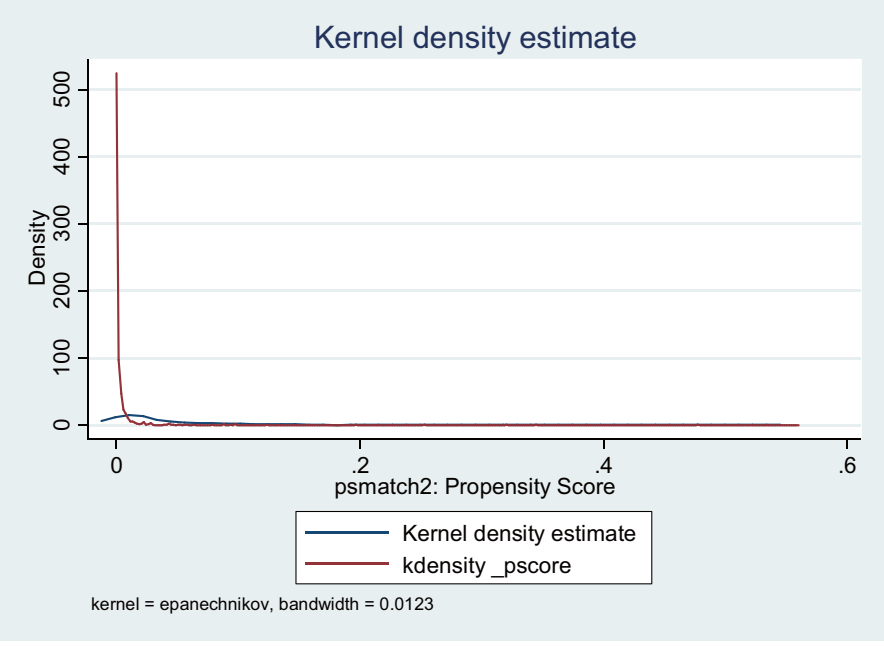

Fig. 1 Distribution of the propensity scores before the matching process

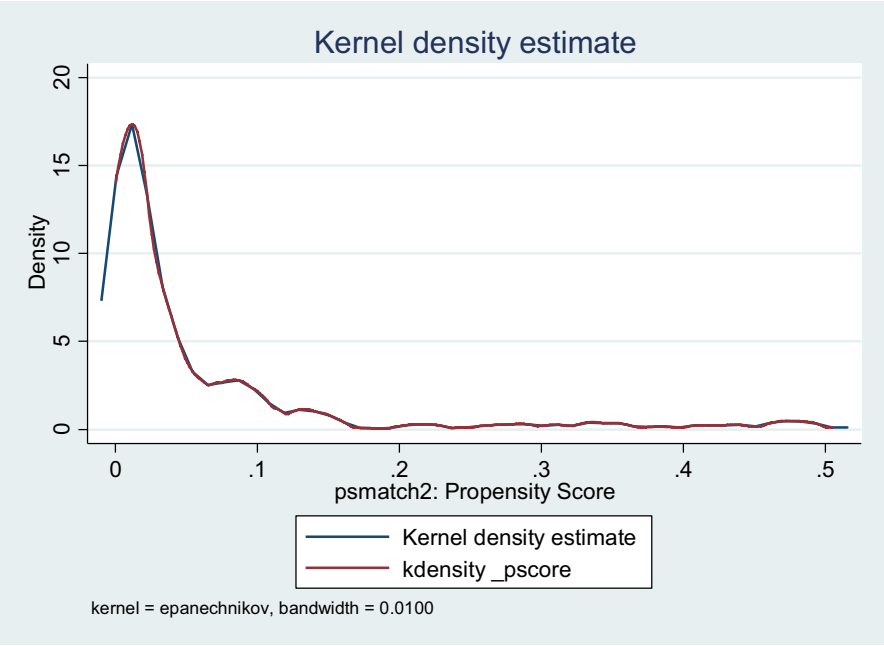

Fig. 2 Distribution of the propensity scores after the matching process

Definition of Variables

The dependent variable is employment growth, measured as the growth rate of the natural logarithm of employment (number of employees) between 1 year and the next:

$$GEMP_{i,t} = \ln\left(EMP_{i,t}\right) - \ln\left(EMP_{i,t-1}\right) = \ln\left(\frac{EMP_{i,t}}{EMP_{i,t-1}}\right)$$

Location in STPs is the key variable of interest. It is measured as a dummy variable (*PARK*) that takes the value 1 if the firm is located on a STP and 0 otherwise.

Considering the literature on STPs, employment growth can be explained by other variables related to firm characteristics, namely (i) age (Lamperti et al., 2017; Löfsten & Lindelöf, 2002); (ii) sector of economic activity — in particular, being or not in a high-technology sector (Liberati et al., 2016; Löfsten & Lindelöf, 2001, 2002); and (iii) firm size, which can be measured in terms of sales or number of employees (Lamperti et al., 2017). The definition of these variables and the expected effect on employment growth according to the literature are displayed in Table 2.

Table 3 presents the descriptive statistics of the independent variables related to firm characteristics, referring to the sample of firms located in STPs.

Additionally, we conducted a *t*-test for difference in means comparing the main sample and the control sample (Table 4). There is no statistical evidence to reject the null hypothesis of equality of means between firms located in STPs and firms

Table 2 Definition of variables and expected result

Group	Variable	Measure	Expected result
Age	***LNAGE***	Natural logarithm of the number of years since the creation of the firm	(+)
	LNIDADEQUAD	Squared natural logarithm of the number of years since the creation of the firm	(−)
Sector of economic activity	***HIGHTECH***	Dummy variable that takes the value of 1 if the firm develops an activity in any high-tech sector and 0 otherwise.*	()
Size	***LNSALES***	Natural logarithm of net turnover	(+)

*The classification of sectors was carried out in accordance with the established by the National Institute of Statistics (INE) and Eurostat for this purpose (Eurostat, 2020; Instituto Nacional de Estatística, 2012)

Table 3 Descriptive statistics of the independent variables for firms located in STPs

Variable	No. of observations	Mean	Standard deviation	Minimum	Maximum
AGE (years)	2643	5.740	4.405	1	24
HIGHTECH	2643	0.428	0.495	0	1
SALES (thousands of euros)	2260	606.801	2451.535	0.010	50,977.990

not located in STPs for the variables *AGE* and *HIGHTECH*. On the other hand, the *t*-test shows that there is statistical evidence to reject the null hypothesis of equality of means for the variable *SALES*; that is, there are statistically significant differences in the turnover between firms located in STPs and those in the control sample.

Model Specification

As anticipated, to answer the research question posed, we applied a dynamic panel data methodology. Several theoretical and methodological aspects motivated this choice. First, panel data allows to control for individual heterogeneity, that is, the firm's unobservable effects that could influence the employment growth and are individually related with each of the firms (a_i). Thus, the error term in the model is divided into three elements: the unobserved firm-specific effect mentioned above (a_i), a time component to capture the effect of macroeconomic factors on employment growth (λ_t), and the random disturbance ($\square_{it}$). In this way, the risk of obtaining biased results was reduced (Baltagi, 2008).

On the other hand, economic literature highlights the need for an autoregressive (AR) framework in the empirical study of firm growth since it was theoretically proposed by Gibrat's (1931) Law of Proportionate Effect. In this sense, panel data methodology makes it possible to capture the dynamic nature of employment growth.

Finally, endogeneity attributable to the reverse causality problem may arise, since the employment growth may explain some of the independent variables. Given that the GMM system is an instrumental variable estimator, it enables the endogeneity of all time-varying explanatory variables to be considered (Pindado et al., 2014).

Table 4 Results of the t-test for the independent variables

Variable	Parks (1)		No parks (0)		*t*	*p value*
	Mean	**Standard deviation**	**Mean**	**Standard deviation**		
AGE (years)	5.740	4.405	5.59	4.33	− 1.272	0.204
HIGHTECH	0.428	0.495	0.42	0.49	− 0.521	0.602
SALES (thousands of euros)	606.80	2451.54	278.56	614.74	− 6.376***	0.000

***$p < 0.01$

Table 5 Descriptive statistics for the dependent variable

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
EMP (no. of employees)	2248	8.138	22.82	1.000	312.000
GEMPBLN	1708	0.207	0.70	−0.929	8.000
GEMP	1708	0.087	0.43	−2.639	2.197

The model specification is as follows:

$$GEMP_{i,t} = \beta_1 GEMP_{i,t-1} + \beta_2 PARK_i + \beta_3 LNAGE_{i,t} + \beta_4 LNAGESQUA_{i,t} + \beta_5 LNSALES_{i,t} + \beta_6 HIGHTECH_i + \alpha_i + \lambda_t + \varepsilon_{it}$$

The dependent variable itself is included as an explanatory variable with a lag of one period ($GEMP_{i,t-1}$). The variable $PARK_i$, which is the main independent variable and indicates whether the firm is located in a STP or not, is accompanied by a set of other control variables related to the firm characteristics defined in the previous subsection.

For the analysis, the generalised method of moments was used, applying the *system GMM* estimator through the user written command *xtabond2* for Stata (Roodman, 2009). We checked for the potential misspecification of the models. Thus, the absence of correlation between the instruments and the error term was verified with the Hansen *J* statistic for overidentifying restrictions. Additionally, we used the m^2 statistic (Arellano & Bond, 1991) to test for the lack of second-order serial correlation in the first-difference residual.

Results

Univariate Analysis

Table 5 displays the descriptive statistics for the variable number of employees (*EMP*), as well as for the employment growth rate both before (*GEMPBLN*) and after (*GEMP*) the log transformation. The average number of employees of firms

Table 6 Evolution of mean and median values of EMP and GEMPBLN variables over the analysis period

Year	*EMP*		*GEMPBLN*	
	Mean	**Median**	**Mean**	**Median**
2006	8.308	3.500		
2007	7.927	3.000	28.7%	0.0%
2008	7.966	3.000	26.6%	0.0%
2009	8.154	3.000	24.8%	0.0%
2010	8.764	3.500	28.1%	0.0%
2011	8.882	3.000	19.2%	0.0%
2012	8.545	3.000	17.7%	0.0%
2013	7.324	3.000	12.8%	0.0%
2014	7.720	3.000	17.5%	0.0%

Table 7 Results of the t-test for the dependent variable

Variable	Parks (1)		No parks (0)		*t*	*p value*
	Mean	**Standard deviation**	**Mean**	**Standard deviation**		
EMP	8.138	22.819	5.087	13.663	−5.419***	0.000
GEMPBLN	0.207	0.696	0.186	0.714	−0.860	0.390
GEMP	0.087	0.428	0.071	0.414	−1.070	0.285

***$p < 0.01$

located in STPs is around 8 people (8.138), with an average annual increase over the period of 20.7% (*GEMPBLN*).

Table 6 presents the mean and median values for the number of employees over the analysis period. The average number of employees remains at around 8 people throughout the entire series. Despite this general trend, the growth rates of the number of employees are clearly high, ranging from 12.8 to 28.7%. However, these average values should be interpreted with caution: given the small number of employees, growth rates are very sensitive to small variations. The median value of the *GEMPBLN* variable, which remains at zero throughout the whole period, shows that a significant number of the firms in the sample have no changes in the number of employees.

The *t*-test for difference in means (Table 7) shows that firms located in STPs have, on average, a significantly higher employment volume (*EMP*) than firms in the control sample, with statistical evidence to reject the null hypothesis of equality of means between the two subsamples. However, it cannot be concluded from the *t*-test that there is a difference in means for the variables referring to employment growth, both before (*GEMPBLN*) and after (*GEMP*) the logarithmic transformation.

As can be seen in the correlation matrix (Table 8), the dependent variable *GEMP* is negatively and significantly correlated with firm age (*LNAGE*) and with age squared (*LNAGESQUA*); that is, employment growth is lower in older firms. On the other hand, the *GEMP* variable is positively and significantly correlated with the size variable, measured in turnover (*LNSALES*); that is, employment growth is higher in bigger firmzs.

Table 8 Correlation matrix for the global sample

	GEMP	*LNAGE*	*LNAGESQUA*	*LNSALES*
GEMP	1			
LNAGE	−0.1843*	1		
LNAGESQUA	−0.1704*	0.9511*	1	
LNSALES	0.0924*	0.3916*	0.3622*	1

Pearson correlation coefficients between the dependent variable and the continuous independent variables included in the empirical analysis

*$p < 0.1$

Multivariate Analysis

Table 9 displays the estimates of the dynamic panel data model on employment growth (*GEMP*). The model includes the lagged dependent variable (*L.GEMP*), the main explanatory variable (*PARK*), the control variables related to the characteristics of the firm (*LNAGE*, *LNAGESQUA*, *LNSALES*, and *HIGHTECH*), and the dummy variables controlling for the time effect (*YR*A*). As mentioned, we checked for potential misspecification of the models. Whereas, the AR(2) statistic (Arellano & Bond, 1991) shows the lack of second-order serial correlation in the first-difference residuals, the non-significant values of the Hansen *J* statistic indicate that the instruments we use are valid in all of the models.

Table 9 Estimation results of the effect of location in STPs on firm employment growth: GMM estimations

Variable	*GEMP*
L.GEMP	−0.196 (0.122)
PARK	−0.003 (0.002)
LNAGE	−0.479** (0.166)
LNAGESQUA	0.064 (0.037)
LNSALES	0.146*** (0.034)
HIGHTECH	0.005* (0.002)
YR2009A	0.025 (0.032)
YR2010A	−0.025 (0.030)
YR2011A	0.01 (0.027)
YR2012A	−0.007 (0.026)
YR2013A	0.014 (0.024)
_CONS	−0.038 (0.144)
Years	Yes
No. of observations	2411
Unique firms	628
Instruments	72
Degrees of freedom	11
F test	6.47
F *p*-val	0
AR(1) test	−2.66
AR(1) *p*-val	0.008
AR(2) test	−1.12
AR(2) *p*-val	0.263
J Hansen test	70.4
J Hansen *p*-val	0.169

The corrected standard errors (Windmeijer, 2005) are presented in brackets

*$p<0.1$; **$p<0.05$; ***$p<0.01$

According to the results of the model presented in Table 9, no statistically significant effect of the main independent variable (*PARK*) on the dependent variable (*GEMP*) is found; that is, empirical evidence does not allow us to conclude that location in STC has a positive effect on firms' employment growth.

The results also indicate that the age (*LNAGE*) has a negative and significant effect on employment growth. On the other hand, the variables *HIGHTECH* and *LNSALES*, indicating, respectively, belonging to a high-tech sector and firm size measured in sales, have a positive and significant effect on employment growth. No statistically significant effect is found for the lagged dependent variable (*L.GEMP*) and for the logarithm of the age squared (*LNAGESQUA*).

Discussion and Conclusion

The initial aim of this work was to analyse the potential effects of STPs on employment growth of the firms located there, attempting to fill the existing gap on this topic. To do so, we analysed a sample of 553 firms located in STPs and a control sample of the same size and similar characteristics. To select the control sample, we used the PSM method, avoiding bias problems. We applied a dynamic panel data methodology, estimating a model with employment growth as the dependent variable and location in STPs as the key explanatory variable, controlling for those individual firm characteristics that are likely to influence firm growth.

Returning to the research question of this study, i.e., whether the location in STPs fosters the employment growth of firms, the estimated model results indicate that there is no statistically significant effect. In other words, it cannot be proven that there is a difference in employment growth between firms located in STPs and comparable firms located elsewhere. This means that, in general, locating in a STP will not lead to higher employment growth for firms. These results from Portuguese firms are consistent with those of the studies by Monck et al. (1988) and Westhead and Storey (1994) for the UK, Ferguson and Olofsson (2004) for Sweden, and Díez-Viel and Fernández Olmos (2017b) for Spain. On the other hand, the results of this study do not confirm the findings of Colombo and Delmastro (2002), Díez-Vial and Fernández-Olmos (2017a), Lindelöf and Löfsten (2002), Löfsten and Lindelöf (2001, 2002, 2003), and Stokan et al. (2015), who found a positive impact of the location in STPs on the employment growth of firms.

Regarding the control variables, the data point to the existence of a negative and significant relationship between age and employment growth; that is, employment grows more in those firms that are younger. This result is in line with the conclusions of Löfsten and Lindelöf (2002), Squicciarini (2008), and Lamperti et al. (2017). On the other hand, firm size measured in terms of sales is positively related to employment growth, as expected from the resource-based theory of Penrose (1959). Thus, larger firms are able to raise more resources which, when invested, lead to higher growth. This positive relationship between firm size and firm growth can be also founded in the study by Colombo and Delmastro (2002) on start-ups incubated in STPs. In addition, the model reveals the existence of a

positive effect of belonging to a high-tech sector on employment growth of firms, which is consistent with Monck et al. (1988).

In their literature review, Albahari et al. (2022) found that the studies analysing large samples were more prompt to find an statistically significant impact of location in STPs on the economic performance of firms, including employment growth. Of the 38 studies analysed by these authors, only one fifth used samples of more than 500 firms. However, the present study used a sample of 553 firms, and still did not find a significant effect of the location in STPs on employment growth. Some studies suggest that, although parks do not have an effect on the growth of firms in general, they may have positive effects for certain types of firms, for instance high-growth firms (Arauzo-Carod et al., 2018).

Science and technology parks are seen as an instrument for regional economic development and employment creation, which justifies public sector financial support for the parks, but the absence of empirical evidence to support that the location in STPs fosters firm employment could call into question the role of these infrastructures and the public direct or indirect support they receive (Amirahmadi & Saff, 1993). The mere fact that a firm locates in a STP does not guarantee that it will increase its number of employees more than if it were located elsewhere. It is therefore mandatory to further explore the effects of STPs on the different types of firms, identifying those firms more likely to benefit from being located in parks. This would allow public managers to be more restrictive in the selection of firms that are supported, i.e., those that are allowed to locate in STPs, better targeting efforts and thus achieving greater impact on regional development. By the same token, is also necessary to further investigate if some STPs are more likely than others to stimulate the employment growth of firms. STPs can be very different from each other; they can have different characteristics and, in fact, have different missions or objectives (Berbegal-Mirabent et al., 2020), so not all parks may have the same effects on employment growth. These insights would allow governments to improve the design of policies supporting STPs, incentivising those features of the parks most associated with employment growth if this is the policy objective.

Limitations and Future Research

Some limitations related to the use of employment as an indicator must be pointed out. Ferguson and Olofsson (2004) highlight the fact that some of the funding entities for firms located in STPs provide human resources to be used by these same firms, but whose payment and registration for employment purposes are in other organisations, such as universities or research centres. Delmar et al. (2003) emphasise the bias that employment growth may incorporate as a proxy of firm growth, since it is affected by labour productivity, the increasing substitution of employees by machines, the degree of firm integration, or management decisions associated with subcontracting processes. These situations can justify that the turnover and the assets of firms increase, without being accompanied by increases in employment levels. In fact, these situations may result in firms actually growing whilst simultaneously decreasing the number of

employees (Spithoven & Knockaert, 2011). One future line of research to enlarge the knowledge on firm growth could be related to the relationships between employment growth, sales growth, asset growth, and productivity.

The scarcity of studies on STPs and employment growth mean that this is not yet an exhausted object of study. The fact that no differences in employment growth are found between firms located in and outside the parks calls for attention to be directed towards other factors. In particular, as we anticipated, future research must explore whether firms with specific characteristics could benefit from their location in a park. In addition, it would be interesting to explore possible differences in employment growth between firms located in the different STPs and, if any, to look for the factors associated with the success or failure of firms in each particular park (such as the type of link with the university or characteristics of the region, for instance).

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature.

Data Availability The dataset associated to this research is available to readers upon reasonable request.

Declarations

Competing Interests The authors declare no competing interests.

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