Industry and Innovation

ISSN: 1366-2716 (Print) 1469-8390 (Online) Journal homepage: https://www.tandfonline.com/loi/ciai20

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To cite this article: Nuria González Álvarez & Anderson Argothy (2019) Research, development and growth in state-owned enterprises: empirical evidence from Ecuador, Industry and Innovation, 26:2, 158-175, DOI: 10.1080/13662716.2018.1493982

To link to this article: https://doi.org/10.1080/13662716.2018.1493982

Published online: 26 Jul 2018.

INDUSTRY AND INNOVATION
2019, VOL. 26, NO. 2, 158–175
https://doi.org/10.1080/13662716.2018.1493982

Routledge
Taylor & Francis Group

ARTICLE

Research, development and growth in state-owned enterprises: empirical evidence from Ecuador

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ABSTRACT

Investment in R&D is essential for the survival and growth of organizations. Recent literature has focused on the study of effects of R&D on the growth of private companies. However, there is no research studying the effects of R&D on the growth of Latin American public companies. This paper estimates, using an endogenous growth model, the effect of investments in R&D on sales growth in public enterprises of Ecuador. Data corresponding to a sample of 86 public companies have been taken from the Survey of Activities of Science and Technology (ACTI) of Ecuador for the period 2012 to 2014. These data are estimated by OLS. The results show that there is a statistically significant positive relation between investment in research and development and the growth of sales in public companies.

KEYWORDS

State owned enterprises; innovation; growth; sales; public innovation

JEL

L32; O32; O54

1. Introduction

Economic and business growth is one of the main topics of study in business literature (García and Romero 2012; Geroski 2005; King and Levine 1993; Morbey and Reithner 1990), as well as in economic development literature (Abramovitz 1956, 1994; Kuznets 1973). Social studies of science have analysed the nature of scientific research and its fruitful effects for innovation and employment and the economic growth of nations (Coccia 2017). The explanations for the growth of organizations and countries are varied, focusing on the importance of research, development and innovation (Schumpeter 1947; Brenner and Rushton 1989; Morbey and Reithner 1990; García and Romero 2012), technical change (Solow 1957; Dosi et al. 1988), technology (Damanpour 1987; Freeman 1989; Arduini et al. 2010) and employment (Vivarelli 2014).

Despite the importance of innovation for survival and growth in organizations (Schumpeter 1947), within the knowledge economy (David and Foray 2002; Mohamed 2011), few studies have focused on the study of R&D in state-owned enterprises (SOE). Most research on SOEs have focused on efficiency and privatization issues (Vining and Boardman 1992; Omran 2004; Goldeng, Grünfeld, and Benito 2008), structure and concentration (Choi, Park, and Hong 2012), contribution by SOE R&D to industry (Hu and Jefferson 2004), the role of Foreign Direct Investment to R&D in SOE

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(Girma, Gong, and Görg 2009), the role of EPE in R&D&I (Tõnurist 2015). In Ecuador, there are no previous studies on the impact of R&D on the growth of state-owned enterprises.

In recent years, interest in SOEs has emerged as an important economic agent, being considered as instruments of economic policy in strategic sectors (Bernier 2014), thus focusing on R&D investments (Florio 2014a; Bernier 2014) and contributing to economic development (SENPLADES 2013). In the case of Latin America, the R&D study of SOEs is relevant because the business community consists mainly of SMEs with difficulties accessing financing, and private R&D activities are concentrated in a few companies (Botella and Suárez 2012). R&D is scarce at the private level, public R&D being important as a strategy to improve industrial productivity and national competitiveness (IBD 2010).

In this sense, the objective of this work is to contribute to the analysis on the variables that influence the growth of SOEs, focusing on the effect of the investment in R&D on the growth of sales in the SOE from Ecuador. To meet this aim, based on the literature review, a model is proposed that allows measuring the impact of R&D on the growth of state-owned enterprises in Ecuador. Once the model is estimated, recommendations will be made on the results obtained. This research contributes to the existing literature, as it is the first time that the impact of R&D investments on the growth of state-owned enterprises in Ecuador is analysed. Previous work has analysed the impact of R&D on the growth of income in private companies (Brenner and Rushton 1989; García and Romero 2012); however, this work differs from those cited. Firstly, this work chose state-owned enterprises in Ecuador. In addition, in the proposed model, the variable of Investment in fixed capital is included, which had not been considered in previous literature.

The work is structured as follows: section 2 contains a review of the previous literature related to this research. Section 3 presents a description of the data and methodology used. Section 4 shows the results and their analysis. Finally, section 5 contains some conclusions and recommendations.

2. Theoretical framework

2.1. *State-owned companies*

Our definition of SOE falls within the OECD definition (2016), which is based on entities' corporate forms, commercial orientation and degree of state ownership and control. In this paper, we assume that an SOE is any corporate entity recognised by national law as an enterprise, and in which the state exercises ownership (OECD 2016, 18).

The definition currently proposed by the OECD for State-Owned Enterprises, does not consider only those where the state is the ultimate beneficiary, the owner of majority of company's shares, as public enterprises. It also includes those where the State, by institutional or legal arrangements, has strong control over the organization and directs it to the convenience of state interests, even if it is not the major owner (OECD 2016).

Traditional definitions consider SOEs as economic organizations with the following characteristics: a) owned or co-owned by the national or local government; b) internalize a public mission among their objectives; c) have partial or total budgetary autonomy; d) show discretion in management; e) are committed to business activities; F) privatization could be possible, but for various reasons is not an option (Short 1984; Florio 2014a). According to Short (1984) the factors that contribute to the development of SOEs are: i) socialist policies; ii) political and historical factors; iii) pursuit of socio-economic objectives; iv) structural factors.

In this context, SOE can be an instrument to correct market failures, particularly in countries with regulatory weaknesses or where the private sector is insufficient (Kowalski et al. 2013). In the case of Latin American research, the Inter-American Development Bank (IDB) highlights the poor capacity of the private sector to generate and assimilate research and development results, making the public sector the main R&D generator (IBD 2010).

The public sector is generally seen as inappropriate to innovation, full of rules and adverse to risk (Bernier 2014). Traditionally it has been argued that public sector institutions are monopolies with no pressures to compete and innovate (Borins 2002). On the other hand, the lack of control of the owners, in this case the citizens, does not allow an exit from the investment, so that SOEs may not have incentives to increase their performance to obtain rewards of innovation (Tõnurist 2015). With these considerations usually presenting a negative image of SOEs, literature traditionally tends to ignore innovation as an objective or minimizes its role within the SOE; it is not taken into consideration how SOEs affect other organizations in achieving objectives of R&D or innovation (Tõnurist 2015). This negative image served to strengthen the privatization processes of SOEs during the 1990s (Bezes et al. 2012; Hood 1995; Omran 2004), as well as the disappearance of R&D units within the SOE and public Research Institutes (Acha and Balazs 1999).

Recently, several SOEs have been created or strengthened as industrial policy instruments in strategic sectors, supporting high levels of R&D investment (Bernier 2014; Florio 2014a), fostering rising industries where the private sector would not take the risk (Kowalski et al. 2013; Chang 2002). Even more so after the crisis of 2008 (Florio 2014b; Tõnurist 2015), these are constituted for different reasons, but mainly for the achievement of large national objectives linked to development in strategic sectors and social benefit (Tõnurist 2015; SENPLADES 2013).

This concept is not new, it was used in Latin America in the 70's through the application of an Import Substitution Model (Prebisch 1950). It highlights the role of the State as an active element in industrial policy to eliminate asymmetries created by international trade and the international division of labour, thus seeking the development of the Region (Prebisch 1950). It is based on the logic that market failures and the supply of certain goods can be addressed through public regulation (Koppell 2007; Prebisch 1963), a mechanism also used by Asian economies during their development phase (Hu and Jefferson 2004; Tõnurist 2015; Choi, Park, and Hong 2012); in the Chinese case maintaining control over strategic industries, building them and directing capital for investment (Chan and Rosenbloom 2009). In western SOEs, it is related to the maintenance of a vital industry, to secure property rights, non-commercial value and income from these industries (MacAvoy et al. 1989).

Despite the resurgence of SOEs as important elements for development objectives of several countries (Chang 2007), the strength of SOE research has focused on privatization and its results (Bezes et al. 2012; Omran 2004; Hood 1995; Pollitt 2003), economic reforms in state enterprises (Li 1997), type of ownership, competence and enterprise efficiency (Vining and Boardman 1992; Bartel and Harrison 2005), commercial effects (Kowalski et al. 2013). However, there are few papers focused on R&D of SOEs.

2.2. *R&D in public enterprises*

There is a common assumption between managers and directors of both state-owned enterprises and private companies. R&D and innovation activities play an important role in technical change and in the performance of technological innovation (Hoskisson et al. 2002; Choi, Park, and Hong 2012), supporting economic growth and development (Solow 1957; Aghion, David, and Foray 2009; Schumpeter 1947, 1934). Investment in R&D is a key factor in generating innovation (Gopalakrishnan and Damanpour 1997; Hoskisson et al. 2002), it improves the productivity of firms, industries and supports economic growth in countries (Terleckyj 1980; Schumpeter 1934, 1947; Morbey and Reithner 1990).

R&D has become an important factor in the innovation process of state-owned and private enterprises. For this reason, developed and developing countries are making efforts to generate indicators for measuring R&D efforts (OECD 2002). However, the generation of indicators of R&D results (output) is more complicated (Acha and Balazs 1999). A good alternative for the measuring R&D and its impact is through annual expenditure on R&D activities (OECD 2002; Acha and Balazs 1999).

Previous work has focused on measuring the contribution of R&D to economic or productivity growth, through production functions; that is to say, to include R&D expenditure as a production factor similar to land, labour, capital and others, this approach can be seen in (Griliches 1979; Terleckyj 1980; Griliches and Mairesse 1984). This kind of analysis has been used at different levels: firms (Griliches and Mairesse 1984), industries (Terleckyj 1980; García and Romero 2012), and countries (Solow 1957; Griliches 1979).

According to Griliches (1979), two approaches have been traditionally used to measure the contribution of R&D investment to economic growth: i) historical case studies; ii) econometric estimation of the production function including the R&D variable. The second method seeks to abandon the details of specific events and focus on the total result or the total productivity of factors as a function of investment in R&D and other variables (Griliches 1979). Thus, the entire increase in productivity is related to R&D expenditures and an attempt is made to estimate statistically the part of productivity growth that can be attributed to R&D. This is a valid and available method for measuring the contribution of R&D. It has been used in several papers such as (Griliches 1979; Hu and Jefferson 2004; Terleckyj, 1980).

Regarding R&D measurement in state-owned enterprises, previous empirical work has focused on the effects of foreign direct investment on R&D (Girma, Gong, and Holger 2009), structure and concentration and their effect on R&D (Choi, Park, and Hong 2012), the role of SOEs in R&D policies (Tõnurist 2015), returns of R&D in the industry (Hu and Jefferson 2004), R&D expenditures and productivity (Hu 2001), reforms ownership and innovation (Jefferson and Inderjit 1999), the effect of

motivation on innovation (Grönblom and Willner 2014), entrepreneurship in SOEs (Bernier 2014). Some of these papers on SOEs are based on those of Griliches (1979); Griliches and Mairesse (1984); Terleckyj (1980). Additionally the papers of Hu (2001); Hu and Jefferson (2004) use a revenue function to measure the impact of R&D on organizations. However, in this context there is a lack of papers analysing State-Owned Enterprises in Latin America. Thus, this research contributes to the existing literature, because it is the first time the impact is analysed of R&D investments on the growth of state-owned enterprises in Ecuador and additionally it includes the variable Investment in Fixed Capital, which has not been considered in previous papers.

Given the difficulty of measuring the effects of R&D, a third stream of work measures R&D and its contribution to growth in sales in private companies (Morbey and Reithner 1990; Brenner and Rushton 1989; Watanabe and Asgari 2003; García and Romero 2012; Aghion et al. 2012; Amat and Perramon 2011).

2.3. *Growth and R&D*

According to Oliveira and Fortunato (2006), the growth of a company can be deterministic or stochastic. The deterministic approach assumes that the difference in growth of organizations depends on the industry or characteristics of the company; in contrast, stochastic growth predicts growth rates independently, the growth is random and independent of size and past growth history (Oliveira and Fortunato 2006; Sutton 1997). This postulate is known as Gibrat's Law (Sutton 1997) and has been analysed by (Oliveira and Fortunato 2006; Langebaek 2008; Geroski 1999).

Growth is one of the most important topics studied in business literature (García and Romero 2012). It is a multidimensional phenomenon, which depends on the distinctive variables we use to measure it and the appropriateness of these measures relative to specific theories (Frédéric Delmar, Davidsson, and Gartner 2003). There are different alternatives for measuring the impact of R&D on organizations, which has led to a debate about which kind of indicators are most suitable for capturing growth (García & Romero, 2012). On the one hand, the use of multiple indicators is proposed (Frederic Delmar 1997), other authors consider that it is better to use a single indicator (Weinzimmer, Nystrom, and Freeman 1998). According to García & Romero (2012), the most common indicators in the literature are: market value, number of employees, sales and income, value of production or value added. However, there is a consensus on the use of sales as an appropriate indicator, this is demonstrated by previous studies (Brenner and Rushton 1989; Morbey and Reithner 1990; Watanabe and Asgari 2003; Coad 2007; García and Romero 2012).

In the knowledge-based society, it is expected that the creation of knowledge in an organization will influence sales, income and employment generation, in level public and private companies. Therefore, it is expected that there is a positive relationship between R&D investments and organization growth (García and Romero 2012). Several studies confirm the existence of positive impact of R&D and organization growth (Brenner and Rushton 1989; Morbey and Reithner 1990; Geroski 2005), while other authors do not find significant results in these two variables (Bottazzi et al. 2001). Previous literature also shows that the relationship between these two variables, depends on the country, industry and time period (Morbey and Reithner 1990; Brynjolfsson and Yang 1996).

As explained in this literature review, there are several papers that analyse the impact of R&D on the growth of private companies. However, no work has been found focused on identifying the effect of R&D on the growth of State-owned Enterprises within Latin American countries, despite the fact that several studies in general emphasize the importance of R&D (Girma, Gong, and Holger 2009; Florio 2014a; Luke, Verreynne, and Kearing 2010). In this sense there is a gap in the previous literature, which is why the following hypothesis is proposed:

H1: R&D investment in public companies has a positive effect on the growth of sales in the SOE from Ecuador.

3. Methodology

Data for this study were taken from database of National Survey of Activities of Science, Technology and Innovation of Ecuador (ACTI),[1] conducted by National Institute of Statistics and Census (INEC) and the National Ministry of Higher Education Science Technology and Innovation (SENESCYT) with updated information up to 2014. It has a sample of 6275 organizations, divided into 6189 (98.6%) private companies and 86 (1.4%) public companies. We decided to focus our study on a developing country, Ecuador, since we have found some recent literature that studies innovation in developing countries (Archibugi and Coco 2004; Vivarelli 2014; Crespi et al. 2016; Aboal and Tacsir, 2017; Balsmeier 2017; among others).

This research has been conducted with the sample of public companies (86 institutions) and analysed in the period 2012–2014. The sample of public companies corresponds to 34% of the total public companies in Ecuador. According to National Secretariat of State Planning, overall there are 250 SOEs corresponding to the Executive Function, Decentralized Autonomous Governments and Universities (SENPLADES 2013). The sample includes manufacturing and service companies; no institution has been left out because of the small size of sample.

Because the study of R&D and innovation in SOEs is a relatively new field of work, several previous papers have been prepared with small samples. For example: 31 US institutions (Borins 2012), 51 projects from 16 companies (Vanagunas and Webb 1994), 81 survey in the United Kingdom, Denmark, Finland and Estonia (Pärna and Nick 2007), 97 Australian public offices (APSC 2011), 120 managers of public institutions in the United Kingdom (Walker 2006) and 125 UK institutions (Dunleavy and Margetts 2006).

Once the database was obtained, an analysis of information collected in ACTI survey was carried out to order and debug the information. Additionally, new variables were created. Taking as a point of departure the work of Rao and Arkin (2003), Coad (2007), Schimke and Brenner (2011) y García and Romero (2012) which use stochastic vision in the growth of organizations. The following equation is proposed:

$$Growth_{i,t} = \alpha + \beta_1 RD_{it-1} + \beta_2 Growth_{it-1} + \beta_4 ICF_{it-1} + \beta_3 Size + sect + ubic + \varepsilon_{it} \quad (1)$$

In equation (1) the dependent variable $Growth_{it}$ corresponds to business growth, as measured by the logarithm of the difference in sales (Coad 2007; García and Romero

[1]The database can be downloaded at http://www.ecuadorencifras.gob.ec/ciencia-tecnologia-e-innovacion/.

2012). As we mentioned above, different indicators for quantifying growth have been found in previous research. However, there is a general consensus that sales are one of the most appropriate indicators for this purpose (Hoy, McDougall, and Dsouza 1992; Ardishvili et al. 1998; García and Romero 2012)

The variable RD_{it-1} corresponding to intensity in R&D for period t-1 and it was calculated as total R&D divided by total sales of the company in the specific period; this indicator is used in papers by Morbey & Reither (1990), Coad (2007); Watanabe and Asgari (2003); García and Romero (2012).

Variable $Growth_{it-1}$ is used to control autocorrelation and endogeneity or any other dependence on growth in SOE, its value corresponds to lag of growth t-1.

Variable ICF_{it-1} is the logarithm of Fixed Investment Capital in public enterprises, its value corresponds to the lag t-1, this lagged variable has been used in order to avoid autocorrelation, endogeneity and eliminate any existing dependency. It has included the variable ICF_{it-1} as an additional element to analyse its effect on sales growth in SOEs. Previous studies demonstrate that economic growth could not be understood without the investment in fixed capital (Blomstrom, Lipsey, and Zejan 1993), but this variable has almost always been analysed in macroeconomic terms to explain the growth of countries through Gross Capital Formation (Kuznets 1973; Abramovitz 1956).

$Size_{it-1}$ corresponds to the size of the company, measured by logarithm of number of workers; likewise, to avoid problems of autocorrelation and endogeneity, we include the lagged variable for period t-1.

In addition, the following control variables have been included:

- Variables *Sect* and *Ubic*: the first one refers to the enterprise economic sector, while the second one refers to the province where the SOE is located.

With information of variables and database in general, some basic statistical data were collected prior to the presentation and analysis of the general model. The model has been estimated using Ordinary Least Squares (OLS), taking into account the main statistics for validity and confidence of the model. The model cannot be estimated using panel data techniques because the period of time is too short. The main results are presented below.

4. Results

As mentioned in the previous section, we first present some informative statistical data about the situation of SOEs that make up the sample used for the model. Table 1 shows information about the number of companies analysed by economic sector.

In Table 1, there are 86 companies per year, the total data for analysis is 258 enterprises. Industrial sectors are classified according to the schematic structure of the International Standard Industrial Classification (ISIC) Revision 4 (INEC 2012). The highest amount of SOEs corresponds to Electricity, gas, steam and air-conditioning supply (34); followed by water and sewage (10), third, manufacturing industry (12). Despite the existence of firms by sector, the number of companies per sector is small, which is why a study of the impact of sectorial R&D has not been carried out. However,

Table 1. Public companies by sector.

Schematic structure	Industry	2012	2013	2014	Total
A	Agriculture, forestry and fishing.	1	1	1	3
B	Exploitation of mines and quarries.	9	9	9	27
C	Manufacturing industry.	12	12	12	36
D	Electricity, gas, steam and air-conditioning supply.	34	34	34	102
E	Water, sewage, waste management and remediation activities.	10	10	10	30
F	Construction.	1	1	1	3
G	Wholesale and retail trade, repair of motor vehicles and motorcycles.	10	10	10	30
H	Transportation and Storage.	1	1	1	3
I	Accommodation and food service activities.	3	3	3	9
J	Information and communication.	4	4	4	12
K	Financial and insurance activities.	1	1	1	3
	Total	86	86	86	258

for informative purposes, in Table 2 we can see the variables used for the model with a division at the sectorial level.

In Table 2 we used the logarithm of the variables Sales, Investment in R&D and Investment in Fixed Capital, in order to reduce magnitudes. The first part corresponds to general values for all companies that are part of the database, so the average intensity of R&D is (0.068) which could be translated as, on average, the SOEs allocate the 6.8% of total sales to investment in Research and Development. In terms of sectors, the highest sales sector corresponds to Accommodation and food service activities (18,513), followed by Manufacturing Industries (17,313) and Wholesale and Retail Trade, Vehicle, Automotive and Motorcycle Repair (16,521).

If we analyse the sectors with highest investment in R&D, we can highlight: Activities of accommodation and food service (12,021), followed by Transportation and storage (9,982) and Mining and Quarrying (6,871). The last one has great importance for the country since the extraction and sale of oil is the activity that generates more income for the country.

In terms of R&D Intensity, the sector with the highest value is Electricity, gas, steam and air-conditioning supply (0.131), followed by Accommodation and food (0.053) and then Manufacturing (0.052). There is a marked difference in the intensity of R&D among the different economic sectors; the high value of sector *(D)* can be the result of large state investments in recent years to launch new hydroelectric and photovoltaic plants.

Table 3 presents the results of four estimated models as well as some contrast statistics

Model 0 has been estimated without taking control variables into account. A control variable *(Location)* is included in Model 1. Model 2 includes the second control variable *(Sector)*. Finally Model 3 is estimated using all variables. If statistics are analysed it is seen that four models have been estimated for a sample of $N = 84$ public enterprises. If estimated models are statistically significant $(p < 0.05)$ according to the results of F test, we can say that the models are valid. Collinearity analysis was performed using the statistical Variance Inflation Factors *(VIF)*, the results show no collinearity being independent and dependent variables.

When the coefficient of determination is analysed (R^2) in the model, the results indicate that models are virtually identical, each explained *(0.18)* of sales. Although the explanatory value of the models is low, its value is related with previous work using data from private companies (Coad 2007; García and Romero 2012). Based on the minimum

Table 2. Statistical summary of SOEs at sectorial level.

Sector	Variable	Mean	Std Dev.	Min	Max
Total EPE data	Sales *	15,030	3,672	0,000	23,390
N = 258	Growth	0.281	1.895	−2,076	20,011
	Investment in R&D *	4,793	6,367	0,000	17,750
	Intensity of R&D	0.068	0.639	0,000	10,000
	Investment in Fixed Capital *	9,347	6,427	0,000	20,585
(B) Exploitation of mines and quarries					
N = 27	Sales *	16,477	2,893	12,567	23,390
	Growth	−0.050	0.483	−0.994	0.934
	Investment in R&D *	6,871	6,556	0,000	16,395
	Intensity of R&D	0.038	0.099	0,000	0.509
	Investment in Fixed Capital *	11,475	4,904	0,000	18,381
(C) Manufacturing					
N = 36	Sales *	17,313	3,434	0,000	20,416
	Growth	0.852	4,092	−1,253	20,011
	Investment in R&D *	6,506	7,433	0,000	17,268
	Intensity of R&D	0.052	0.168	0,000	0.840
	Investment in Fixed Capital *	12,419	7,131	0,000	20,585
(D) Electricity, gas and steam supply					
N = 102	Sales *	13,571	3,382	0,000	18,703
	Growth	0.232	1,681	−2,076	13,238
	Investment in R&D *	3,819	5,800	0,000	15,925
	Intensity of R&D	0.131	1.014	0,000	10,000
	Investment in Fixed Capital *	8,506	6,053	0,000	18,142
(E) Water and sewerage					
N = 30	Sales *	15,689	1,114	13,219	17,595
	Growth	0.213	0,861	−1,931	2,071
	Investment in R&D *	3,248	5,152	0,000	14,201
	Intensity of R&D	0.008	0.022	0,000	0.108
	Investment in Fixed Capital *	6,611	6,550	0,000	16,118
(F) Construction					
N = 3	Sales *	16,374	0.096	16,286	16,476
	Growth	0.095	0.027	0.076	0.114
	Investment in R&D *	0,000	0,000	0,000	0,000
	Intensity of R&D	0,000	0,000	0,000	0,000
	Investment in Fixed Capital *	12,776	0.968	11,666	13,442
(G) Wholesale and Retail Trade					
N = 30	Sales *	16,521	2,170	11,542	19,896
	Growth	0.151	0,449	−1,160	1.240
	Investment in R&D *	6.012	6,708	0,000	16,093
	Intensity of R&D	0.013	0.022	0,000	0.085
	Investment in Fixed Capital *	10,205	5,494	0,000	16,017
(H) Transportation and storage					
N = 3	Sales *	15,279	0.071	15,202	15,342
	Growth	0.046	0,133	−0.049	0.140
	Investment in R&D *	9,982	2.251	8,517	12,574
	Intensity of R&D	0.025	0.041	0.001	0.072
	Investment in Fixed Capital *	7,793	6,805	0,000	12,560
(I) Accommodation and food					
N = 9	Sales *	18,513	1,454	16,951	20,451
	Growth	0.084	0.073	−0.009	0.184
	Investment in R&D *	12,021	7,033	0,000	17,750
	Intensity of R&D	0.053	0.066	0,000	0.205
	Investment in Fixed Capital *	16,378	2,179	13,438	19,925
(J) Information and communication					
N = 12	Sales *	13,562	2,930	6,908	16,088
	Growth	0.595	0.930	−0,150	2,442
	Investment in R&D *	0.944	3,270	0,000	11,327
	Intensity of R&D	0.005	0.016	0,000	0.055
	Investment in Fixed Capital *	3,938	5,838	0,000	12,794
(K) Financial and insurance activities					
N = 3	Sales *	11,590	0.094	11,513	11,695
	Growth	0.091	0.060	0.049	0.134
	Investment in R&D *	0,000	0,000	0,000	0,000
	Intensity of R&D	0,000	0,000	0,000	0,000
	Investment in Fixed Capital *	8.748	0,400	8,517	9,210

* Corresponds to the logarithm.

Table 3. Estimation of models. State-owned enterprises.

Variable	Model 0	Model 1	Model 2	Model 3
Growth $_{(t-1)}$	0.039	0.037	0.041	0.040
R&D intensity $_{(t-1)}$	10.093 ***	10,113 ***	10.048 ***	10.067 ***
Inv. Fixed Capital $_{(t-1)}$	−0.253 *	−0.253 *	−0.259 *	−0.259 *
Size $_{(t-1)}$	2.071 ***	2.063 ***	2.084 ***	2.075 ***
Control				
Location		0.025		0.025
Sector			−0.0709	−0.073
Constant	0.227	0.019	0.535	0,331
N	84	84	84	84
R^2	0.181	0.182	0.182	0.182
F	10.341	8.380	8,049	6,797
Prob> F	0.000	0.000	0.000	0.000
Aic	559.977	561.937	561.932	563.889
Bic	572.131	576,522	576.517	580,905
Mean VIF	1.37	1.30	1.33	1.28

* P < 0.05; ** p < 0.01; *** p < 0.001

variation of (R^2) between the models and the results of AIC and BIC tests, it is concluded that the model that best fits the data is Model 0, since fewer variables explain the same proportion as the other three models.

Results to the four models show that growth in sales on the previous period (*Growth* $_{(t-1)}$) has no statistically significant effect *($p < 0.05$)* in variation of sales of the current period. The effect of R&D on SOEs growth is significantly positive *($p < 0.001$)* in the four models estimated. According to this result, an increase in R&D investment has a positive impact on sales growth of SOEs; this result confirms the hypothesis *H1* raised by this research.

The organization size likewise has a significant positive effect *($p < 0.001$)*, so we can say that in this case, an increase in the organization size influences positively the growth in sales of SOEs. Moreover, the Fixed Capital Investment of previous period *(t-1)* has a significant negative effect *($p < 0.05$)* on sales growth. According to this result, an increase in fixed capital investment during the previous year influences negatively the growth of sales of SOEs.

Moreover, note that in this case the sector and location variables do not have a significant effect, or any influence at all, on sales growth in SOEs.

In sum, our results show a significant positive effect of R&D and firm size on SOE's growth in sales in line with previous research conducted on private firms (Singh and Whittington 1975; Griliches and Mairesse 1984; Brenner and Rushton 1989; Morbey and Reithner 1990; Rao and Arkin 2003; Coad 2007; García and Romero 2012). Moreover, we find that an increase in fixed capital investment during the previous year negatively influences the growth in sales of SOEs. Our results further confirm the work of Carlin and Mayer (2003) who find that growth is mainly related to investment in R&D, rather than investment in fixed capital.

5. Conclusions

In this paper, we accept the idea supported by previous literature that, in general, private firms invest in R&D in order to grow and ultimately survive. But, what happens

to public firms? In an attempt to answer this question, this research studies the effect of R&D on sales growth in public enterprises in Ecuador.

This research has been conducted using data from the National Survey of Activities of Science, Technology and Innovation of Ecuador (ACTI) 2016; the information for period 2012–2014 for state-owned enterprises has been selected as working sample.

From the theoretical review a stochastic endogenous model has been created, based on the Gibrat's Law (Sutton 1997; Coad 2007; García and Romero 2012), to measure the impact of R&D on SOEs' sales growth. Furthermore, additional variables of size and fixed capital investment and control variables of economic sector and SOE location have been included.

This is the first paper that presents information about R&D in public companies of Ecuador. Along with the theory, it estimates by ordinary least squares (OLS) four econometric models showing the impact of R&D on sales growth as the main element of research; it also shows the effect of size and investment in fixed capital.

Both public and private companies invest in R&D in order to increase sales, growth or survive. Traditionally public companies are considered as unimaginative or not concerned with innovation (Borins 2002; Florio 2014b), so that their study has not been considered relevant in the field of economy of innovation. This study provides empirical evidence about the importance of investment in R&D on the growth of public enterprises, contributing in this way to fill the gap and the debate about the relevance of R&D management and innovation in SOEs as an essential element for improving national and international positions, given that SOEs are outstanding instruments for achieving of social and economic national objectives.

In line with Schumpeterian economy, innovation is an essential element for economic and business growth (Schumpeter 1947). In this sense R&D becomes an important engine for SOEs. In this study the variable (R&D intensity) can be seen as a proxy for innovation; however, it is necessary to highlight that R&D is only one of the elements that can determine innovation in enterprises.

The results of this study show that R&D investment has a significant positive effect on sales growth in public enterprises in Ecuador. The result of this work confirms previous studies by (Griliches and Mairesse 1984; Brenner and Rushton 1989; Morbey and Reithner 1990; Rao and Arkin 2003; Coad 2007; García and Romero 2012), taking into account that these studies were performed on a sample of private companies. Previous literature is ambiguous about this relationship: while a number of analyses report a positive relationship between both variables, many others do not. Furthermore, the relationship between R&D investment and a firm's growth varies depending on the industry, country and length of time of the analysis (García and Romero 2012, 1084). The main contribution of this paper is to test the relationship between R&D investment and growth in sales in a sample of SOE firms from a developing country. Our results confirm that Research & development (R&D) is one of the key drivers for state-owned enterprise´s growth and, consequently, for economic growth in a developing country. Gumus and Celikay (2015) found that R&D expenditure has a positive and significant effect on economic growth for countries in the long run. In particular, for developing countries, they found a weak effect in the short run but a strong one in the long run.

Moreover, according to the estimated models, the company size has a positive effect on sales growth. This result is consistent with previous studies (García and Romero 2012; Singh and Whittington 1975) where they found that the growth of companies is related to the organization size.

Regarding Capital Fixed Investment, the results show that it has a negative effect on sales growth. This result should be taken with caution given that it could be caused due to: a) the kind of fixed assets in which the public enterprises invest; b) investment takes more time before showing a positive effect on the growth of company; not the year after the investment, due to the ability of learning and internalization of the new investment by the SOE. This result further confirms the work of (Carlin and Mayer 2003) who find that growth is mainly related to investment in R&D, rather than investment in fixed capital. However, it has been demonstrated that over time investment in fixed capital can help to increase productivity and growth of countries or companies (Kuznets 1973; Abramovitz 1956; De Long and Summers 1991); however, these same papers show doubts about the real contribution of *FCI* to growth, due to its reduced effect on growth (De Long and Summers 1991).

This paper confirms that in this case there is no autocorrelation in growth of public enterprises, unlike results found in previous studies that were conducted for samples of private companies (García and Romero 2012; Bottazzi and Secchi 2003), where the existence of autocorrelation with lagged variable of growth was detected. On the other hand, when we included the control variables *(economic sector and locations)*, the results were not significant for these variables. In the case of SOEs in Ecuador the province where the company is located and the economic sector have no effect on sales growth. This is not a definitive result, the result is only for this case and may be influenced by the sample size; previous studies with large samples of private companies show that both the economic sector and location have significant effects in growth (García and Romero 2012).

This work points to some recommendations for managers and directors of public companies: a) it is important for state-owned enterprise to invest in R&D as this will increase revenue, allowing company growth, improving productivity, allowing a better position for the company within the economic sector in which it operates. b) The resources for R&D by themselves generate additional benefits; as demonstrated in this paper, R&D contributes to growth in sales, so it is desirable to include within the budget of the SOEs an account designed for this purpose. c) If the State seeks to achieve national development goals through public enterprises, it is necessary for the central government to maintain and increase investment in research and development in order to increase public value, improve service delivery, develop new or improved products and increase the SOEs' productivity.

As regards the limitations of this study, the analysis period is short and the sample small. Although the information provided is dynamic, it could be strengthened or tested in a temporal analysis in a broader panel. The small size of the sample is the main limitation since lack of information due to the use of a small sample can cause noise affecting the results. This is a pioneer paper about this field in Ecuador; this work is not comparable with previous studies.

As future research, it is possible to identify the economic and social impact of innovation by SOEs, cooperative relations between public enterprises, and technology transfer, among others. Also, in the future it would be interesting to compare the results obtained for public

enterprises with those for private firms. In fact, we have already tried to estimate the four models proposed using a sample of private firms. Data were taken from the same database, the National Survey of Activities of Science, Technology and Innovation of Ecuador (ACTI). As we mentioned above, this covers a sample of 6,275 organizations, divided into 6,189 (98.6%) private companies and 86 (1.4%) public companies. However, when analysing the sample of private firms, we realised that, in spite of the large number of such firms included in the sample, only a small percentage of them invest in R&D. In fact, 88.38% (5,470) of them report having invested 0.00 US$ in R&D. This might be because of the economic structure of a country like Ecuador in which 90% of private firms are commercial. We therefore decided against estimating the models using the sample of private firms because our main goal is to study the relation between investment in R&D and growth in sales at business level, and this relation cannot be analysed in a sample of firms that hardly invests at all in R&D. The largest percentage of investment in R&D in Ecuador today is by public firms which is the reason why we focus on these. In the future, if Ecuador becomes more developed and has private firms that focus less on sales and more on investment in R&D, then it might be appropriate to perform the analysis for private firms that the reviewer suggests.

Moreover, in view of the open innovation concept that implies that innovations result from the sharing of competences among different players throughout and beyond the value chain, with deep implications for a company's external relationships (Chesbrough 2003; Chesbrough, Vanhaberbeke, and West 2006), in future it might be of interest to explore new interactions between private and public research that allow firms to accumulate competences and resources to exploit the opportunities that arise from multi-faceted demands (Kratzer, Meissner, and Social 2017). Also, in the future more independent variables could be included in models to identify more factors influencing SOE growth and thus raising the explanatory power of the models estimated. Finally, since one year for return on investments for machinery and equipment is not always enough, in future we will try to include a longer time lag in this variable by using a sample of firms that provides data from several years.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Aboal, D., and E. Tacsir. 2017. "The Impact of Subsidies on Researcher's Productivity: Evidence from a Developing Country." Research Evaluation 26 (4): 269–283. doi:10.1093/reseval/rvx031

Abramovitz, M. 1956. "Resource and Output Trends in the United States since 1870." *NBER Chapters* 1–23. doi:10.2307/3498218.

Abramovitz, M. 1994. "Catch-Up and Convergence in the Postwar Growth Boom and After." In *Convergence of Productivity Cross-National Studiesand Historical Evidence*, edited by W. Baumol, R. Nelson, and E. Wolf, 86–125. Oxford University Press.

Acha, V., and K. Balazs. 1999. "Transitions in Thinking: Changing the Mindsets of Policy Makers about Innovation." *Technovation* 19 (6): 345–353. doi:10.1016/S0166-4972(99)00032-2.

Aghion, P., P. Askenazy, N. Berman, G. Cette, and L. Eymard. 2012. "Credit Constraints and the Cyclicality of R&D Investment: Evidence from France." *Journal of the European Economic Association* 10 (5): 1001–1024. doi:10.1111/j.1542-4774.2012.01093.x.

Aghion, P., P. A. David, and D. Foray. 2009. "Science, Technology and Innovation for Economic Growth: Linking Policy Research and Practice in "STIG Systems"." *Research Policy* 38 (4): 681–693. doi:10.1016/j.respol.2009.01.016.

Amat, O., and J. Perramon. 2011. "High-Growth Cooperatives: Financial Profile and Key Factors for Competitiveness." *Revista Economía Pública, Social Y Cooperativa.* 73: 81–98.

APSC. 2011. *State of the Service Report: State of the Service Series 2010–2011*. Edited by Australian Public Service Commission. Canberra: Commonwealth of Australia.

Archibugi, D., and A. Coco. 2004. A New Indicator of Technological Capabilities for Developed and Developing Countries (Arco). *World Development* 32(4), Pergamon: 629–654. doi:10.1016/J.WORLDDEV.2003.10.008.

Ardishvili, A., S. Cardozo, S. Harmon, and S. Vadakath. 1998. "Towards a Theory of New Venture Growth". In *Babson Entrepreneurship Research Conference*, 21–23. Ghent, Belgium.

Arduini, D., F. Belotti, M. Denni, G. Giungato, and A. Zanfei. 2010. Technology Adoption and Innovation in Public Services the Case of E-Government in Italy. *Information Economics and Policy* 22(3), Elsevier B.V.: 257–275. doi:10.1016/j.infoecopol.2009.12.007.

Balsmeier, B. 2017. Unions, Collective Relations Laws and R&D Investment in Emerging and Developing Countries. *Research Policy* 46(1), North-Holland: 292–304. doi:10.1016/J.RESPOL.2016.11.005.

Bartel, A. P., and A. E. Harrison. 2005. "Ownership versus Environment: Disentangling the Sources of Public-Sector Inefficiency." *Review of Economics and Statistics* 87 (1): 135–147. doi:10.1162/0034653053327595.

Bernier, L. 2014. "Public Enterprises as Policy Instruments : The Importance of Public Entrepreneurship." *Journal of Economic Policy Reform* 17 (3): 253–266. doi:10.1080/17487870.2014.909312.

Bezes, P., D. Demazière, T. Le Bianic, C. Paradeise, R. Normand, D. Benamouzig, F. Pierru, and J. Evetts. 2012. "New Public Management and Professionals in the Public Sector. What New Patterns beyond Opposition?'." *Sociologie Du Travail* 54, Elsevier Masson SAS: e1–e52. doi:10.1016/j.soctra.2012.07.001.

Blomstrom, M., R. E. Lipsey, and M. Zejan. 1993. "Is Fixed Investment the Key to Economic Growth?." *National Bureau of Economic Research* 4436. doi:10.2307/2946665.

Borins, S. 2002. "Leadership and Innovation in the Public Sector." *Leadership & Organization Development Journal* 23: 467–476. doi:10.1108/01437730210449357.

Borins, S. 2012. "Making Narrative Count: A Narratological Approach to Public Management Innovation." *Journal of Public Administration Research and Theory* 22 (1): 165–189. doi:10.1093/jopart/muq088.

Botella, C., and S. Ignacio. 2012. "Innovación Para El Desarrollo En América Latina: Una Aproximación Desde La Cooperación Internacional." *Serie Avances de Investigación* 78: 20–25.

Bottazzi, G., and A. Secchi. 2003. "Common Properties and Sectoral Specificities in the Dynamics of U.S. Manufacturing Companies." *Review of Industrial Organization* 23 (3–4): 217–232. doi:10.1023/B:REIO.0000031366.28559.c1.

Bottazzi, G., G. Dosi, M. Lippi, F. Pammolli, and M. Riccaboni. 2001. "Innovation and Corporate Growth in the Evolution of the Drug Industry." *International Journal of Industrial Organization* 19 (7): 1161–1187. doi:10.1016/S0167-7187(01)00068-6.

Brenner, M. S., and B. M. Rushton. 1989. "Sales Growth and R&D in the Chemical Industry." *Research Technology Management* 32 (2): 8–15. doi:10.1080/08956308.1989.11670580.

Brynjolfsson, E., and S. Yang. 1996. "Information Technology and Productivity: A Review of the Literature." *Advances in Computers* 43 (C): 179–214. doi:10.1016/S0065-2458(08)60644-0.

Carlin, W., and C. Mayer. 2003. "Finance, Investment, and Growth." *Journal of Financial Economics* 69 (1): 191–226. doi:10.1016/S0304-405X(03)00112-0.

Chan, H. S., and D. H. Rosenbloom. 2009. "Public Enterprise Reforms in the United States and the People's Republic of China: A Drift toward Constitutionalization and Departmentalization of Enterprise Management." *Public Administration Review* 69 (SUPPL. 1). doi:10.1111/j.1540-6210.2009.02087.x.

Chang, H.-J. 2002. *Kicking Away the Ladder? Economic Development in Historical Perspective*. London: Anthem Press.

Chang, H.-J. 2007. *State-Owned Enterprise Reform*. New York: United Nations.

Chesbrough, H. 2003. "The Logic of Open Innovation: Managing Intellectual Property." *California Management Review* 45 (3): 33. doi:10.2307/41166175.

Chesbrough, H., W. Vanhaberbeke, and J. West, eds. 2006. *Open Innovation: Researching a New Paradigm*. Oxford: Oxford University Press on Demand.

Choi, S. B., B. I. Park, and P. Hong. 2012. "Does Ownership Structure Matter for Firm Technological Innovation Performance? the Case of Korean Firms." *Corporate Governance* 20 (3): 267–288. doi:10.1111/j.1467-8683.2012.00911.x.

Coad, A. 2007. "A Closer Look at Serial Growth Rate Correlation." *Review of Industrial Organization* 31 (1): 69–82. doi:10.1007/s11151-007-9135-y.

Coccia, M. 2017. "Economics of Science: Historical Evolution." *SSRN Electronic Journal*. doi:10.2139/ssrn.2967120.

Crespi, G., D. Giuliodori, R. Giuliodori, and A. Rodriguez. 2016. The Effectiveness of Tax Incentives for R&D+i in Developing Countries: The Case of Argentina. *Research Policy* 45 (10), North-Holland: 2023–2035. doi:10.1016/J.RESPOL.2016.07.006.

Damanpour, F. 1987. "The Adoption of Technological, Administrative, and Ancillary Innovations: Impact of Organizational Factors." *Journal of Management* 13 (4): 675–688. doi:10.1177/014920638701300408.

David, P. A., and D. Foray. 2002. "An Introduction to the Economy of the Knowledge Society." *International Social Science Journal* (84). doi:10.1111/1468-2451.00355.

De Long, B., and L. H. Summers. 1991. "Equipment Investment and Economic Growth." *Quarterly Journal of Economics* 106 (2): 445–502. doi:10.2307/2937944.

Delmar, F. 1997. "Measuring Growth: Methodological Considerations and Empirical Results." In *Entrepreneurship and the Growth of Firms*, edited by R. Donckels and A. Miettinen, 199–216. Aldershot, England: Ashgate. doi:10.4337/9781781009949.

Delmar, F., P. Davidsson, and W. B. Gartner. 2003. Arriving at the High-Growth Firm. *Journal of Business Venturing* 18(2), Elsevier: 189–216. doi:10.1016/S0883-9026(02)00080-0.

Dosi, G., C. Freeman, R. Nelson, G. Silverberg, and L. Soete. 1988. *Technical Change and Economic Theory*. Pisa, Italy: Laboratory of Economics and Management (LEM), Sant'Anna School of Advanced Studies.

Dunleavy, P., and H. Margetts. 2006. *Achieving Innovation in Central Government Organisations*. London: Stationery Office-National Audit Office.

Florio, M. 2014a. "Contemporary Public Enterprises: Innovation, Accountability, Governance." *Journal of Economic Policy Reform* 17 (3): 201–208. doi:10.1080/17487870.2014.913823.

Florio, M. 2014b. *The Return of Public Enterprise*. Milan: CSIL Working Paper. http://www.csilmilano.com/docs/WP2014_01.pdf

Freeman, C. 1989. "New Technology and Catching Up." *The European Journal of Development Research* 1: 85–99. doi:10.1080/09578818908426503.

García, J. V., and M. E. Romero. 2012. "Research, Development, and Firm Growth. Empirical Evidence from European Top R&D Spending Firms." *Research Policy* 41 (6): 1084–1092. doi:10.1016/j.respol.2012.03.017.

Geroski, P. 1999. "The Growth of Firms in Theory and in Practice." *Centre Fo Economic Policy Research* (2092): 1–30.

Geroski, P. 2005. "Understanding the Implications of Empirical Work on Corporate Growth Rates." *Managerial and Decision Economics* 26 (2): 129–138. doi:10.1002/mde.1207.

Girma, S., Y. Gong, and G. Holger. 2009. "What Determines Innovation Activity in Chinese State-Owned Enterprises? the Role of Foreign Direct Investment." *World Development* 37 (4): 866–873. doi:10.1016/j.worlddev.2008.07.017.

Goldeng, E., L. A. Grünfeld, and G. R. G. Benito. 2008. "The Performance Differential between Private and State Owned Enterprises: The Roles of Ownership, Management and Market Structure." *Journal of Management Studies* 45 (7): 1244–1273. doi:10.1111/j.1467-6486.2008.00790.x.

Gopalakrishnan, S., and F. Damanpour. 1997. "A Review of Innovation Research in Economics, Sociology and Technology Management." *Omega* 25 (1): 15–28. doi:10.1016/S0305-0483(96)00043-6.

Griliches, Z. 1979. "Issues in Assessing the Contribution of Research and Development to Productivity Growth." *The Bell Journal of Economics* 10 (1): 92–116. doi:10.2307/3003321.

Griliches, Z., and J. Mairesse. 1984. "Productivity and R&D at the Firm Level." *R&D, Patents, and Productivity* (826): 339–374. doi:10.3386/w1068.

Grönblom, S., and J. Willner. 2014. "Organisational Form and Individual Motivation: Public Ownership, Privatisation and Fat Cats." *Journal of Economic Policy Reform* 17 (3): 267–284. doi:10.1080/17487870.2014.883923.

Gumus, E., and F. Celikay. 2015. "R&D Expenditure and Economic Growth: New Empirical Evidence." *Margin: the Journal of Applied Economic Research* 9 (3): 205–217. doi:10.1177/0973801015579753.

Hood, C. 1995. "The "New Public Management" in the 1980s: Variations on a Theme." *Accounting, Organizations and Society* 20 (2–3): 93–109. doi:10.1016/0361-3682(93)E0001-W.

Hoskisson, R., M. Hitt, R. Johnson, and W. Grossman. 2002. "Conflicting Voices: The Effects of Institutional Ownership Heterogeneity and Internal Governance on Corporate Innovation Strategies." *The Academy of Management Journal* 45 (4): 697–716.

Hoy, F., P. McDougall, and D. Dsouza. 1992. "Strategies and Environments of High Growth Firms." In *The State of the Arte of Entrepreneurship*, edited by D. Sexton and J. Kasarda, 341–357. Boston: PWS-Kent Publishing.

Hu, A. G. 2001. "Ownership, Government R&D, Private R&D, and Productivity in Chinese Industry." *Journal of Comparative Economics* 29 (1): 136–157. doi:10.1006/jcec.2000.1704.

Hu, A. G., and G. H. Jefferson. 2004. "Returns to Research and Development in Chinese Industry: Evidence from State-Owned Enterprises in Beijing." *China Economic Review* 15 (1): 86–107. doi:10.1016/S1043-951X(03)00028-2.

IBD. 2010. *La Necesidad de Innovar: El Camino Hacia El Progreso de América Latina y el Caribe*. New York: Banco Interamericano de Desarrollo.

INEC. 2012. *National Classification of Economics Activities (CIIU Rev. 4.0)*. Quito: Synthesis Analysis Unit. National Institute of Statistics and Census from Ecuador.

Jefferson, G. H., and S. Inderjit. 1999. *Enterprise Reform in China: Ownership, Transition, and Performance*. Washington D.C.: World Bank & Oxford University Press. doi:10.2307/3182096.

King, R. G., and R. Levine. 1993. "Finance, Entrepreneurship and Growth." *Journal of Monetary Economics*. doi:10.1016/0304-3932(93)90028-E.

Koppell, J. G. S. 2007. "Political Control for China's State-Owned Enterprises: Lessons from America ' S Experience with Hybrid Organizations." *Governance an International Journal of Policy and Administration* 20 (2): 255–278. doi:10.1111/j.1468-0491.2007.00356.x.

Kowalski, P. P., M. Sztajerowska, M. Egeland, M. Buge, M. Sztajerowska, and M. Egeland. 2013. "State-Owned Enterprises: Trade Effects and Policy Implications." *OECD Trade Policy Paper No. 147* 147 (2013): 1–33. doi:10.1787/5k4869ckqk7l-en.

Kratzer, J., D. Meissner, and V. R. Social. 2017. "Open Innovation and Company Culture: Internal Openness Makes the Difference." *Technological Forecasting and Social Change* 119: 128–138. doi:10.1016/j.techfore.2017.03.022.

Kuznets, S. 1973. *Population, Capital, and Growth*. New York: Norton.

Langebaek, A. 2008. "Determinantes Del Crecimiento de Las Empresas No Financieras En Colombia: Ley de Gibrat Y Otras Teorías." *Borradores De Economía* 493 (4): 1–28.

Li, W. 1997. "'The Impact of Economic Reform on the Performance of Chinese State Enterprises, 1980–1989'." *Journal of Political Economy* 105 (5): 1080. doi:10.1086/262106.

Luke, B., M.-L. Verreynne, and K. Kearing. 2010. "Innovative and Entrepreneurial Activity in the Public Sector : The Changing Face of Public Sector Institutions." *Innovation: Management, Policy & Practice* 12 (2): 138–153. doi:10.5172/impp.12.2.138.

MacAvoy, P. W., W. T. Stanbury, G. Yarrow, and R. Zeckhauser. 1989. *Privatization and State-Owned Enterprises: Lessons from United States, Great Britain and Canada*. Boston: Edited by Kluwer Academic Publisher.

Mohamed, C. 2011. "The Impact of Knowledge-Based Economy on the Development of Innovation in Services: Case of Algerian Banks and Insurance Companies." *IBIMA Business Review Journal* 2011 (January): 1–9. doi:10.5171/2011.631962.

Morbey, G. K., and R. M. Reithner. 1990. "How R&D Affects Sales Growth, Productivity And Profitabilit." *ResearchTechnology Management* 33: 11–15.

OECD. 2016. *State-Owned Enterprises as Global Competitors: A Challenge or an Opportunity?* Paris: OECD Publishing. doi:10.1787/9789264262096-en.

Oliveira, B., and A. Fortunato. 2006. "Testing Gibrat's Law: Empirical Evidence from a Panel of Portuguese Manufacturing Firms." *International Journal of the Economics of Business* 13 (January 2015): 65–81. doi:10.1080/13571510500519996.

Omran, M. 2004. "The Performance of State-Owned Enterprises and Newly Privatized Firms: Does Privatization Really Matter?" *World Development* 32 (6): 1019–1041. doi:10.1016/j.worlddev.2004.01.006.

Organisation for Economic Co-operation and Development. 2002. *Frascati Manual 2002. The Measurement of Scientific and Technological Activities Proposed Standard Practice for Surveys of Research and Experimental Development*. Paris: OECD Publishing. doi:10.1787/9789264065611-pt.

Pärna, O., and V. T. Nick. 2007. "Innovation in the Public Sector: Key Features Influencing the Development and Implementation of Technologically Innovative Public Sector Services in the UK, Denmark, Finland and Estonia." *Information Polity: the International Journal of Government & Democracy in the Information Age* 12: 109–125.

Pollitt, C. 2003. "Public Management Reform: Reliable Knowledge and International Experience." *OECD Journal on Budgeting* 3 (3): 121–138. doi:10.1111/j.1467-8551.2003.00394.x.

Prebisch, R. 1950. "El Desarrollo Económico De La América Latina Y Algunos De Sus Principales Problemas." *Desarrollo Económico* 26 (103): 479–502. doi:10.2307/3466824.

Prebisch, R. 1963. *Hacia Una Dinamica Del Desarrollo Latinoamericano*. México: Fondo de Cultura Económica.

Rao, C. V., and A. P. Arkin. 2003. "Stochastic Chemical Kinetics and the Quasi-Steady-State Assumption: Application to the Gillespie Algorithm." *The Journal of Chemical Physics* 118 (11): 4999. doi:10.1063/1.1545446.

Schimke, A., and T. Brenner. 2011. *Temporal Structure of Firm Growth and the Impact of R&D*. (32): 6–8. Working Paper Series in Economics.

Schumpeter, J. A. 1934. "The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle." *Social Science Electronic Publishing* 25 (1).

Schumpeter, J. A. 1947. "The Creative Response in Economic History." *The Journal of Economic History* 7 (2): 149–159. doi:10.1017/S0022050700054279.

SENPLADES. 2013. *Empresas Públicas y Planificación - Su Rol En La Transformación Social y Productiva*. Quito - Ecuador: Secretaria Nacional de Planificación y Desarrollo del Ecuador.

Short, R. P. 1984. "The Role of Public Enterprises: An International Statistical Comparison." In *Public Enterprise in Mixed Economies: Some Macroeconomic Aspects*, edited by R. Floyd, C. Gray, and R. Short. Washington DC: International Monetary Fund.

Singh, A., and G. Whittington. 1975. "The Size and Growth of Firms." *Review of Economics Studies* 42 (1): 15. doi:10.2307/2296816.

Solow, R. M. 1957. "Technical Change and the Aggregate Production Function." *The Review of Economics and Statistics* 39 (3): 312–320. doi:10.2307/1926047.

Sutton, J. 1997. "Gibrat's Legacy." *Journal of Economic Literature* 35 (1): 40–59.

Terleckyj, N. 1980. "Direct and Indirect Effects of Industrial Research and Development on the Productivity Growth of Industries." In *New Developments in Productivity Measurement*, edited by J. Kendrick and B. Vaccara, I:357–386. Massachusetts: National Bureau of Economic Research.

Tõnurist, P. 2015. "Framework for Analysing the Role of State Owned Enterprises in Innovation Policy Management: The Case of Energy Technologies and Eesti Energia." *Technovation* 38, Elsevier: 1–14. doi:10.1016/j.technovation.2014.08.001.

Vanagunas, S., and J. Webb. 1994. "Administrative Innovation and the Training of Public Managers." *Public Personnel Management* 23 (3): 437–445. doi:10.1177/009102609402300307.

Vining, A. R., and A. E. Boardman. 1992. "Ownership versus Competition: Efficiency in Public Enterprise." *Public Choice* 73 (2): 205–239. doi:10.1007/BF00145092.

Vivarelli, M. 2014. "'Innovation, Employment and Skills in Advanced and Developing Countries: A Survey of Economic Literature." *Journal of Economic Issues* XLVIII (1): 1–33. doi:10.2753/JEI0021-3624480106.

Walker, R. M. 2006. "Innovation Type and Diffusion: An Empirical Analysis of Local Government: Public Administration." *Public Administration* 84 (2): 311–335. doi:10.1111/j.1467-9299.2006.00004.x.

Watanabe, C., and B. Asgari. 2003. "Dynamic Interactions between Assimilation Capacity, Technology Spillovers, Sales and R & D Intensity - the Case of Electrical Machinery Industry in Japan." *Technovation* 23 (1): 15–34. doi:10.1016/S0166-4972(01)00087-6.

Weinzimmer, L. G., P. C. Nystrom, and S. J. Freeman. 1998. "Measuring Organizational Growth: Issues, Consequences and Guidelines." *Journal of Management* 24 (2): 235–262. doi:10.1177/014920639802400205.