The European Journal of Comparative Economics
Vol. 18, no. 1, pp. 105-136
ISSN 1824-2979

The technology balance of payments and international competitiveness: a panel data analysis of southern European countries, 2000-2017

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Abstract

The scant literature that addresses issues related to the Technology Balance of Payments (TBP) often refers that a surplus balance may correspond to a high degree of technological autonomy, a low level of technology imports, or an inability to assimilate foreign technologies. It is not clear, however, from this literature whether, and to what extent, the balance of the TBP is related to countries' international competitiveness. The purpose of this paper is to detail the evolution of the TBP for Southern European countries and to assess the extent to which it influences these countries' international competitiveness. Using static and dynamic panel data techniques on data for four Southern European countries (Greece, Italy, Portugal and Spain) between 2000 and 2017, our results highlight that a positive TBP significantly contributes to foster countries' international competitiveness.

JEL classification: O30, O31, O33

Keywords: Technology balance of payments, International competitiveness, Greece, Italy, Portugal, Spain, Panel data analysis

1. Introduction

The international transfer of technology, which often operates through foreign direct investment (Bodman and Le, 2013; Osano and Koine, 2016), international trade (Spulber, 2008), and technical licensing agreements (Tanaka et al., 2007) is critical for countries' economic growth development.

At the level of international trade, the emphasis has been placed mainly on tangible trade flows (Lusch and Vargo, 2014; Ariu, 2015). The international flow of intangible goods has been less explored (Freund and Weinhold, 2002; Corrado et al., 2013), despite the growing importance of the so-called knowledge-based economies (Francois and Hoekman, 2010, Paz-Marín et al., 2015). International trade flows of

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We would like to thank the Editor-in-Chief, Dr. Alessandro Melcarne, and two anonymous reviewers for their helpful comments and constructive criticisms that help to improve the paper. The usual disclaimer applies. The second author further acknowledges the support by the Portuguese public funds through FCT - Fundação para a Ciência e a Tecnologia, I.P., in the framework of the project with reference UIDB/04105/2020.

http://dx.doi.org/10.25428/1824-2979/202101-105-136

intangibles are recorded in the Technology Balance of Payments (TBP), and its balance reflects the ability of a country to sell/ acquire technologies from abroad (OECD, 2009).

There are very few cross-country studies on the TBP. Those that exist (e.g., Horn, 1982; Sirilli, 1991; Sánchez and Vicens, 1991; Saiz, 2005; Coelho et al., 2011; Avallone and Chedor, 2012) focus on the deficit values of TBP registered in a certain country, and do not relate the balance of the TBP to that country's international competitiveness. It is also not clear whether the balance of the TBP determines the international competitiveness of a country (e.g., Horn, 1982; Godin, 2005; Coelho et al., 2011; Avallone and Chédor, 2012). In fact, a surplus balance may correspond to a high degree of technological autonomy, a low level of technology imports, or an inability to assimilate foreign technologies (OECD, 2009). Moreover, the deficit values recorded in the TBP of a given economy can be interpreted differently (Biedma, 2003; Godin, 2004). They may stem from a country's effort to increase its competitiveness (Coelho et al., 2011), from an effort on the part of the companies aimed at increasing competitiveness in their area of performance (Biedma, 2003), or from an increase in foreign technology imports or a decrease in revenues (OECD, 2009).

Thus, the present paper seeks to contribute empirically to the limited literature on the TBP, by assessing the extent to which TBP matters for countries international competitiveness in its diverse dimensions, price competitiveness, labor productivity, and total factor productivity (TFP) growth. Specifically, it aims at answering the following research question: Does a surplus in TBP increases countries' international competitiveness?

We answer this question by focusing on a specific set of countries, the four countries from the Southern Europe. This set constitutes a relevant case study for several reasons. First, these countries are characterized by an industrial structure that is relatively dependent on the so-called traditional sectors where, at a first glance, the possession and trade of intangible assets are not so critical for international competitiveness (Molero, 1995; Teixeira et al., 2014). Second, in the European context, the most recent (2017) Innovation Union Scoreboard places the Southern European countries together with a set of other Western (Malta) and Eastern (Czech Republic, Estonia, Cyprus, Lithuania, Hungary, Slovakia, Latvia, Poland, Croatia) European

member states in the Moderate Innovators category, that is, relatively laggard in what innovation performance is concerned. The Moderate Innovators countries usually perform bellow the EU average on all innovation indicators, particularly for intangible related assets such as public-private co-publications, and EPO patent applications, although they outperform the EU average for non-R&D innovation expenditures, and trademark applications (EU, 2017). Thus, given this blurred picture, the relevance of intangible assets for moderate innovators' international competitiveness deserves further analysis. Third, contrary to their moderate innovators counterparts, Southern Europe is an geographical area with specific and common features, paths of development characterized by a distinct variety of capitalist organization, often described as Mediterranean VoC (Hay and Wincott, 2012), maintaining certain characteristics in the organization of economic, social and political institutions that provide them a 'hugely different socio-political etiquette' (Ferrera, 1996) that differ from their more developed Western neighbours such as Germany, the Netherlands, Austria and Finland, and which makes them worthy of analysis and justify an individualized study as a group (Ferrera, 2005; Baumeister and Sala, 2015; Regan, 2017).

To test for the existence of an eventual relationship between TBP and international competitiveness, this study performs a causality analysis resorting to fixed- and random-effects and system-GMM panel estimation methods involving the four Southern European countries (Greece, Italy, Portugal and Spain) over a relatively long time period, 2000-2017.

Estimations based on static and dynamic panel data evidence that the TBP balance does matter for Southern Europe countries' international competitiveness, regardless how this latter is proxied (price-competitiveness, labor productivity or TFP growth). Such finding is relevant for economies with similar characteristics to Southern Europe, i.e., countries characterized by a level of intermediate technological development. For such countries, the need for increasing innovative performance, most notably based on intangible related assets, is fundamental to enhance their international competitiveness. Thus, policies should be formulated and implemented to promote increased efforts regarding the development of assets such as patents, licenses, trademarks, and services with technical content.

The remaining sections are structured as follows. Section 2 provides an overview of the state-of-the-art in the literature on TBP and international competitiveness. Section 3 describes the methodology used. Section 4 presents the empirical results. Finally, the last section presents the conclusions, main contributions, policy implications, and limitations and paths for future research.

2. Literature review: TBP and competitiveness

2.1. Technology Balance of Payments (TBP)

The TBP, devised in accordance with OECD guidelines, provides information on the international circulation of technology (Madeuf, 1983; Çokgüngör, 2015), and is an important tool for the understanding of trade relations among countries (Negri et al., 2011). Thus, as an indicator of output, the TBP "reflects the capacity of a country to sell intangible technology abroad and the extent to which it makes use of foreign technologies" (Denis et al., 2006, p. 51), by recording money flows paid or received for the use of patents, licenses, knowledge, brands, models, designs, industrial research and development (R&D), and technical services, including technical assistance (Madeuf, 1983; Sirilli, 1991; Sáiz, 2005; OECD, 2009; Coelho et al., 2010; Heitor and Bravo, 2010; Bento and Fontes, 2016).

The TBP Manual covers the different flows that give rise to a recorded entry in the TBP (OECD, 1990). However, there are three conditions that must be fulfilled in order for an operation to be registered in the TBP. First, the transaction must be international, i.e., involve partners from different countries; second, the transaction must be commercial, involving a flow of revenue/expenditure between the parties involved; and third, the transaction should only correspond to payments related to trade in intangible assets and/or the provision of technological services (OECD, 1990; Sirilli, 1991; Coelho et al., 2010).

The data on the TBP have to primarily provide an accurate measurement of intangible technology trade (Mendi, 2007) and a partial indication of Science & Technology output (Matos and Coelho, 2010). By analyzing the technological profile of the OECD and European countries, Avallone and Chédor (2012) found that countries with a high Gross Domestic Expenditure on Research and Development (GERD) as a percentage of GDP are the countries that export more technology.

However, given the variety of ways in which technology can circulate internationally, the TBP might not represent, according to some authors (e.g., Madeuf, 1983; Godin, 2005), a completely reliable indicator of technology diffusion. Specifically, TBP does not record all international transactions involving intangible assets (Horn, 1983; Madeuf, 1983; Godin, 2005; Matos and Coelho, 2010), namely transactions involving transfers associated with subsidiaries of multinational corporations (Madeuf, 1983). The transfer of technology from multinational companies to their subsidiaries does not explicitly involve licensing agreements or the transfer of know-how and acquisitions, as well as their payments, insofar as they may correspond to the transfer of technology necessary for their operation (OECD, 2005). Other types of technology transfer that are not recorded on the TBP include cross-licensing agreements on the basis of reciprocity (Horn, 1983; Madeuf, 1983).[1]

The TBP may also have other limitations (Patel and Pavitt, 1995; Godin, 2005). In addition to not measuring intangible technology that is transferred internationally based on the imitation of innovations (R&D products, regardless of reverse engineering), the underlying data collection may be imprecise due to the lack of harmonization between countries.

The limitations associated with the balances of the TBP have been referenced (e.g., Horn, 1983; Madeuf, 1983; Godin, 2005; Matos and Coelho, 2010). Nonetheless, TBP can still be used as an (albeit partial) indicator of international technology transfer, as the balance provides information about: the level of independence in terms of intangible technology; the origin of the technology used in the production system or exports; the relationship between a country's R&D effort and its technology revenues; the ability of a country to develop or cooperate with other countries in the development of new technologies (Technopolis Consulting Group, 2010).

In this perspective, the TBP balance is considered a determinant of the competitiveness of countries (e.g., Heitor and Bravo, 2010, Çokgüngör, 2015; Bento and Fontes, 2016), reflected in the benefits associated with the international technology market, as these lead countries to increase the range of experiences and coordinate the

[1] Fiscal regulation is also a factor that determines the measurement of technology transfer, insofar as it leads to a distortion of the data reported by private companies. Attempts to avoid paying taxes and exchange controls are reflected in increased transfers between multinationals and subsidiaries through royalties and a form of profit transfer (Horn, 1983; OECD, 2005).

extension of R&D activities (Spulber, 2008). Additionally, the TBP allows the established trade relations among countries in the present to serve as a basis for new relations in the future (Negri et al., 2011).

2.2. International competitiveness

The concept of international competitiveness is regularly applied in the analysis of performance and macroeconomic objectives (Aiginger, 1988) by comparing a number of economic resources that support the interpretation of a country's international trade trends vis-à-vis its trading partners (Durand and Giorno, 1987; Pires, 2012; Nallari and Griffith, 2013; WEF, 2015b). As Turner and Van't dack (1993, p. 9) contend, "[f]ew economic indicators attract as much controversy as those of international competitiveness (…) [given] the imprecision of the concept (…) [it] can be used to cover almost any aspect of market performance (…) product quality, the ability to innovate, the capacity to adjust rapidly to customers' needs (…)."

Indeed, the international competitiveness of countries is a complex multidimensional phenomenon (Cellini and Soci, 2002; Siggel, 2006; Nurbel, 2007; Liliana-Viorica, 2012; Liučvaitienė et al., 2013; Aiginger et al., 2013). Given its complexity, this concept is usually approached from several perspectives. One perspective, more associated with the neoclassical paradigm, is based on the question of relative prices/wages (Neary, 2006; Zambujal-Oliveira and Castro, 2011; Hamoria and Hamori, 2011).

According to the relative price perspective, a country's competitiveness improves when its relative costs of production, particularly those associated with labor, are lower than those of the countries with which it competes directly at international level (Hamoria and Hamori, 2011). Thus, countries where labor regulation and taxation are more demanding/higher, competitiveness tends to be lower (ECB, 2005), since high labor costs lead to a lower market share (in terms of exports) (Fagerberg, 1988; Cellini and Soci, 2002; Godin, 2004; Siggel, 2006; Guichard et al., 2009). In summary, faced with a decrease in relative prices, the country becomes more competitive due to an increase in exports (Zambujal-Oliveira and Castro, 2011), through access to new markets and the existence of orders (McGeehan, 1968).

Another approach, associated with a more institutionalist/evolutionist view, encompasses dimensions other than relative prices, namely referring to welfare and productivity outcomes resulting from improvements in innovation (Fagerberg, 1996; Godin, 2004; Walter, 2005; Kharlamova and Vertelieva, 2013) and political frameworks (Haque, 1995; Pedersen, 2010).

This more holistic view of competitiveness covers, apart from relative prices (WEF, 2015a), other dimensions such as quality of education/training, physical infrastructure, availability of technology/innovation, macroeconomic stability, the development of the financial market and the efficiency of the business market. Hence, competitiveness includes all the structural factors that are not necessarily reflected directly in prices (Hatzichronoglou, 1996). Productivity (often measured in terms of real GDP per capita) translates the mechanism by which these different factors affect countries' competitiveness (Montanari et al., 2014).

International trade, based on the performance of the countries' exports/imports (Durand et al., 1992; Fagerberg, 1996), reveals their competitiveness, reflecting their ability to sell products/services (McFetridge, 1995). In addition, the firms' investment decisions affect the competitiveness of a given country, since they depend on each firm's financial structure (Cleary, 1999) and on subordinate government incentives for R&D activities to improve the firms' innovative activity (IMD, 2015) and their technological competitiveness (Abelson, 1991).

Often, the various dimensions of the competitiveness of countries are reflected in the different possibilities of measuring international competitiveness, such as the cost of production, the revealed comparative advantage and the real exchange rate (consumer prices, unit labor costs, export prices), which are related to the performance of trade (Menzler-Hokkanen, 1989; Marsh and Tokarick, 1996; Siggel, 2010; Swagel, 2012).

Consequently, comparisons between countries require the use of exchange rates to convert prices and costs into a common currency (Sharples, 1990; Marsh and Tokarick, 1996). This requires that a number of criteria be met, which, according to Durand and Giorno (1987), means that all goods subject to and open to competition are considered and that the data must be compiled from sources of information with guarantees of comparability at international level.

2.3. Determinants of international competitiveness

A myriad of factors can contribute to countries' international competitiveness. Among the most frequently referred it stands (Mitschke, 2008; Schwab, 2018): the international transfer of technology, as reflected in the TBP, human capital endowments, innovation efforts, macroeconomic policy, trade openness, and the quality of institutions (see Figure 1).

The international transfer of technology, which is reflected in the TBP, is primarily responsible for higher levels of international competitiveness of countries, according to several authors (e.g., Gurbiel, 2002; Reisman, 2005; WIPO, 2009; Kamoyo and Chidoko, 2013; Ghoochkanlo, 2015). The vital role played by the different categories of disembodied technology - patents, licenses, trademarks, technical assistance - on country's competitiveness can be traced in a number of ways (Lin et al., 2016). Patents provide an incentive for firms to invest in R&D, innovation, technological and market information, which is a key factor in competitiveness. According to Mossinghoff (1984: 238), "patent system helps protect domestic markets against foreign competitors who copy products (…) [and] intellectual property provides an important source of international license fee income". Additionally, trademarks provide product recognition in the international marketplace and "become a strategic asset to firms competing on the basis of product differentiation and customer loyalty" (Çela, 2015: 125).

The qualification of human capital is essential to increase productivity and innovation performance (Khan et al., 2009; Blind, 2012), because, besides reaching higher productivity levels, countries with more skilled workers are more likely to brainstorm, leading to an increase in innovative activity (WEF, 2015b) and more efficient production by their companies (Porter, 1990; O'Donnell and Blumentritt, 1999; Firoiu et al., 2009; Daneci-Patrau and Patache, 2012). Through investment in the training and development of human capital, firms benefit from increased productivity, thus making them more competitive (Khan et al., 2009; Sekuloska, 2014). More qualified human capital encourages the development of new production techniques (Godfrey, 2008) and more efficient production (Porter, 1990; O'Donnell and Blumentritt, 1999).

Additionally, R&D investment levels are indispensable to strengthen international competitiveness (Clark and Fujimoto, 1992; Pilinkiene, 2015) in that they foster the

creation of new products, improving existing products as well as performance in international trade (Salim and Bloch, 2009). The entrepreneurial environment, particularly incentives (R&D activities aimed at improving innovative business activity), resources provided by capital markets, and the quality of infrastructure (Hatzichronoglou, 1996; IMD, 2015), influences the investment decisions of companies (Cleary, 1999) and their impact on productivity (WEF, 2015b). In particular, "efficient and innovative companies [and countries] tend to increase their market shares, reduce average costs and prices for customers" (Greene et al., 2007, p. 5), leading to an increase in demand and exports.

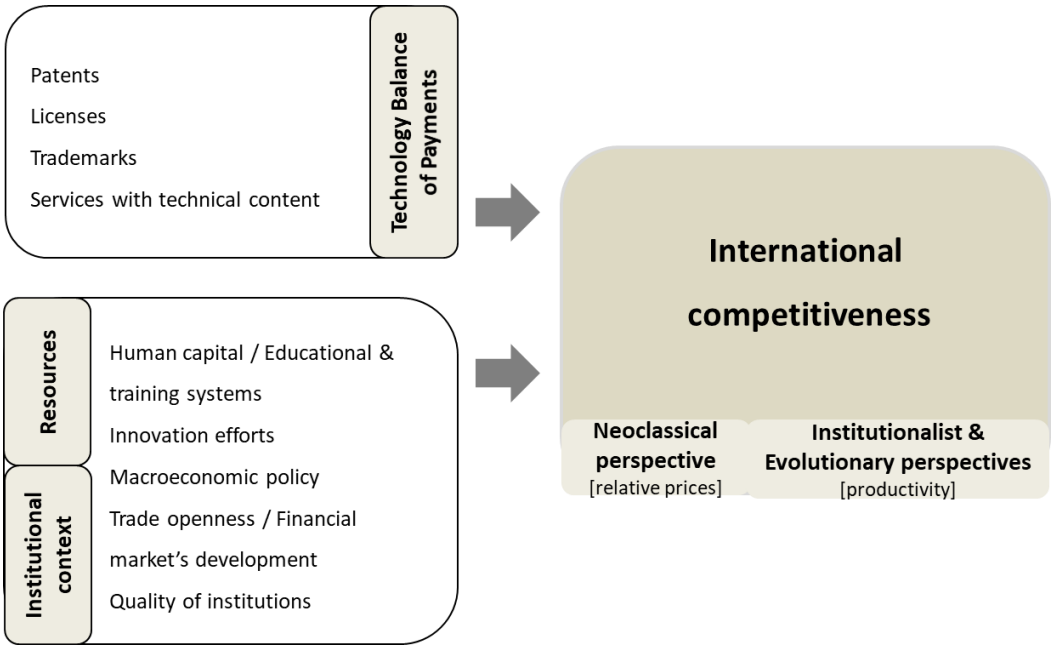
Macroeconomic policy - fiscal and monetary- directly affects competitiveness: infrastructure, R&D, private investment, education, and the regulatory system (Vietor and Weinzierl, 2012). The intensity of government intervention affects the competitiveness and the macroeconomic stability of countries, since greater indebtedness by governments is reflected in an increase in interest rates (Cantwell 2005). Consequently, high public deficits have the potential of crowding out private consumption and investment, being associated with high tax levels that undermine international competitiveness (Banyár, 2017).

Trade openness, through the amplification of domestic-foreign competition, increasing the range of opportunities to attract FDI, access to new markets, and technology transfer, enhances business efficiency (Kharlamova and Vertelieva, 2013; WEF, 2015b). In addition, countries characterized by higher levels of trade openness experience increased chances to exploit technological innovations and avoid research duplication (Duczynski, 2000). International trade enables countries to access to a wide variety of products and generate spillover effects via trade-partner countries' knowledge improvements that foster productivity growth (Capolupo and Celi, 2008). Ultimately, high industrial and business productivity leads to enhanced international competitiveness (Porter, 1990).

The provision of adequate institutional infrastructure is essential to achieve higher levels of productivity (Haque, 1995), stimulating business efficiency and the movement of workers (WEF, 2015b). Given that high quality institutions prevent the sizing of property (Rodrik et al., 2004), create a better contract enforcement (Nunn, 2007), produce favorable business environment and legal structure (McGuinness, 2007;

Chanda and Dalgaard, 2008), encourage firms to use better technology and invest in R&D (Loayza et al., 2005), they spur competitiveness and economic performance (Aron, 2000). In contrast, poor institutional quality is associated with unfavorable business environments (Monte and Giannola, 1997), corruption, excessive bureaucratization (Scalera and Zazzaro, 2010), insufficient provision of public services and infrastructures, and insecurity (Lasagni et al., 2015).

Figure 1 Conceptual framework - TBP and international competitiveness



Source: Own elaboration.

3. Methodology

3.1. Main hypothesis and econometric specification

The present analysis is focused on the four Southern European countries - Greece, Italy, Portugal and Spain – encompassing the period from 2000 to 2017.

According to Section 2, the main hypothesis of the present study is that TBP critically and positively influences countries' international competitiveness. As such, the empirical strategy followed includes resorting to quantitative estimation techniques namely static and dynamic panel data. When it is aimed to estimate effects involving

several countries over a certain period of time these are the most appropriate techniques (Howie and Kleczyk, 2007).

In panel data, sectional units are observed over time, combining time and space dimensions (Gujarati, 2004). These have several important advantages over the data in sectional or temporal series (Hsiao, 2003), namely, they provide a greater variability of the data, a greater amount of information, lower collinearity between the variables, higher degrees of freedom and, thus, more efficiency in the estimation (Baltagi, 2005). They also provide a means of solving a frequent econometric problem, the existence of omitted (unmeasured, unobserved) variables correlated with explanatory variables, which generates heterogeneity and sends the estimates (Baltagi, 2005).

When individual heterogeneity results from non-random factors, it is not verified the hypothesis of the independence of the terms of perturbation in relation to the explanatory variables, it is preferable an estimation with fixed effects (Hsiao, 2003). In the present case, non-randomness in the choice of countries to be included in the analysis will be a factor generating endogeneity of the explanatory variables. This estimation is done as a function of the variation of the observations against the average for each individual, eliminating all effects that do not vary with time and establishing an independent term for each individual implies the loss of degrees of freedom. The study of the correlation between the explanatory variables and the terms of perturbation is done by the Hausman test (Hausman, 1978), having as null hypothesis the absence of fixed effects.

Additionally, in order to allow exploring the dynamic relationships of the time and sectional series between the TBP and international competitiveness, take into account the existence of country-specific non-observed effects, helping to control the possible endogeneity of explanatory variables; and producing consistent estimates even in the presence of heteroscedasticity, we also estimate the models resorting to the dynamic panel data approach. In this case, the Generalized Moment Method (GMM) is used, which involves estimating the model parameters by specifying the momentum conditions, matching the population moments to their sample counterparts and solving the resulting equations (Marques, 2000). The first estimators referenced as GMM estimators for dynamic models with panel data are those proposed by Arellano and Bond (1991), which constitute GMM estimators in first difference. As highlight in

Teixeira and Queirós (2016), the efficiency gains obtained with the two-step GMM estimators, compared to the one-step GMM estimators, tend to be small and, as the two-step GMM estimators converge to their asymptotic distribution slowly, in a finite sample, random errors may be undervalued (see Bond et al., 2001). For the generalized Moment Method to obtain consistent estimates it is necessary that there is no autocorrelation in terms of perturbation (Lee and Perera, 2013). As such, the residues of the differentiated model may have significant first-order correlation but no second-order correlation (Bond et al., 2001). If this is not the case, the moment conditions are not valid. For this, the Arellano-Bond AR (1) and AR (2) tests (Arellano and Bond, 1991) are used, which have as null hypotheses the absence of first and second order correlation, respectively.

In general terms, the econometric specification of the static (S) and dynamic (D) panel models to be estimated are defined respectively as:

$$\mathrm{Comp}_{it}^{S} = \beta_1^S + \beta_2^S\,\mathrm{TBP}_{it} + \beta_3^S \mathrm{HC}_{it} + \beta_4^S \mathrm{R\&D}_{it} + \beta_5^S \mathrm{G}_{it} + \beta_6^S \mathrm{TO}_{it} + \beta_7^S \mathrm{IQ}_{it} + \mu_i^S + \varepsilon_{it}^S$$

$$\mathrm{Comp}_{it}^{D} = \alpha_1 \mathrm{Comp}_{it-1} + \beta_1^D + \beta_2^D\,\mathrm{TBP}_{it} + \beta_3^D \mathrm{HC}_{it} + \beta_4^D \mathrm{R\&D}_{it} + \beta_5^D \mathrm{G}_{it} + \beta_6^D \mathrm{TO}_{it} + \beta_7^D \mathrm{IQ}_{it} + \mu_i^D + \varepsilon_{it}^D$$

in which *i* represents the index of countries and *t* represents time.

Comp international competitiveness of country *i*

TBP balance of the TBP of each country, in percentage of GDP

HC human capital

R&D investment in R&D by firms in percentage of GDP

G Government/public expenditure in percentage of GDP

TO degree of trade openness of the country

IQ Institutional quality/rule of law

u specific effect, fixed over time

ε error term

3.2. Data collection process and description of the proxy variables

Based on the availability of data, the time horizon defined for the countries that constitute the analysis - Greece, Italy, Portugal and Spain - covers 18 years (2000-2017).

The time series were built based on several data sources. A summary of the dependent and independent variables is presented in Table 1.

Regarding the dependent variable, international competitiveness, and according to the literature review (Section 2), three proxies were considered: Real Effective Exchange Rate Index, which proxies price competitiveness, and labor and total factor productivity, which reflect non-price competitiveness.

Real Effective Exchange Rate Index (REER) (base year 2010) measures the real value of a country's currency against the basket of the trading partners of the country, was obtained from the World Development Indicators (WDI) by the World Bank.

The data for labor productivity was obtained from the dataset the OECD and refers to the level of GDP per capita measured in USD (constant prices 2010 and PPPs). Data for the relative variation in total factor productivity (TFP) was obtained from Penn World Table database and reports total factor productivity (TFP) levels at constant purchasing power parity (PPP) rates relative to the US.

Our core independent variable is the balance of TBP (in percentage of the GDP). The main novelty of this study was the use of unique data for the balance of TBP for the countries of Southern Europe. Data for this variable was extracted from statistical reports associated with each country and complemented by both international and national databases, such as the OECD, and PORDATA.

The proxy for human capital (HC) is the average number of years of total schooling of individuals aged 15 up to 64 years old. This information was extracted from Barro and Lee's (2013, 2015) database, which includes quinquennial data from 1950 until 2015, and previsions from 2020 until 2040.

To measure the innovation efforts, we considered the variable Gross expenditure on R&D (GERD) as a percentage of the GDP. This data was gathered from the Main Science and Technology Indicators from the OECD.

Table 1. Description of the variables, proxies and data sources, 2000-2017

		Variable	Proxy	Countries	Data source (with link)
Dependent	**Comp**	Competitiveness	REERI (in ln)[1]	Portugal; Spain; Greece; Italy	World Bank, as available on http://data.worldbank.org/indicator/PX.REX.REER
			Labour productivity (in ln)		OECD, as available on https://data.oecd.org/lprdty/gdp-per-hour-worked.htm
			TFP Growth (in %)		Penn World Table 9.1, as available on www.ggdc.net/pwt
Independent	**TBP**	Balance of the TBP (current prices) of each country as a percentage of GDP		Portugal	Pordata, as available on http://www.pordata.pt/DB/Portugal/Ambiente+de+Consulta/Tabela
				Spain	Statistical Bulletins, as available on http://www.bde.es/bde/es/secciones/informes/Publicaciones_an/Balanza_de_Pagos/index1999.html INE, as available on http://www.ine.es/jaxi/menu.do?type=pcaxis&path=%2Ft14/p057&file=inebase&L=1
				Greece	Isabelle Desnoyers-James, Directorate for Science, Technology and Innovation, OECD OECD, as available on https://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV#
				Italy	Statistical Bulletins, as available on https://www.bancaditalia.it/pubblicazioni/bilancia-tecnologia/index.html?com.dotmarketing.htmlpage.language=1
	HC	Human capital – average years of schooling of population aged 15-64 years old [2]		Portugal; Spain; Greece; Italy	Barro-Lee Educational Attainment Dataset http://barrolee.com/Lee_Lee_LRdata_dn.htm & http://barrolee.com/data/oup_download_c.htm
	R&D	Gross R&D expenditures as a percentage of GDP			OECD, as available on https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB
	G	Government/ Public expenditure as a percentage of GDP			World Bank, as available on http://databank.worldbank.org/data/reports.aspx?source=2&series=NE.CON.GOVT.ZS&country=
	TO	Degree of trade openness (Ratio of exports plus imports of goods and services as % of GDP)			World Bank, as available on http://databank.worldbank.org/data/reports.aspx?source=2&series=NE.IMP.GNFS.ZS&country=
	IQ	Institutional Quality (Rule of law, ranking in ln)			World Bank, as available on https://databank.worldbank.org/data/source/worldwide-governance-indicators

Note: 1 Real Effective Exchange Rate Index, Base year: 2010; 2 Since the data available are five-yearly, for the missing years the values were obtained by linear interpolation.
Source: Own elaboration.

Finally, the other independent variables include, government expenditure (G), measured by the general government final consumption expenditure (% of GDP); degree of trade openness (TO), measured by the ratio of exports plus imports in GDP, and institutional quality (IQ), measured by the 'rule of law', which "captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and

in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence".[2] All these proxies were gathered from the World Development Indicators (WDI) by the World Bank.

4. Evolution of the TBP and international competitiveness

4.1. Brief descriptive analysis of the relevant variables

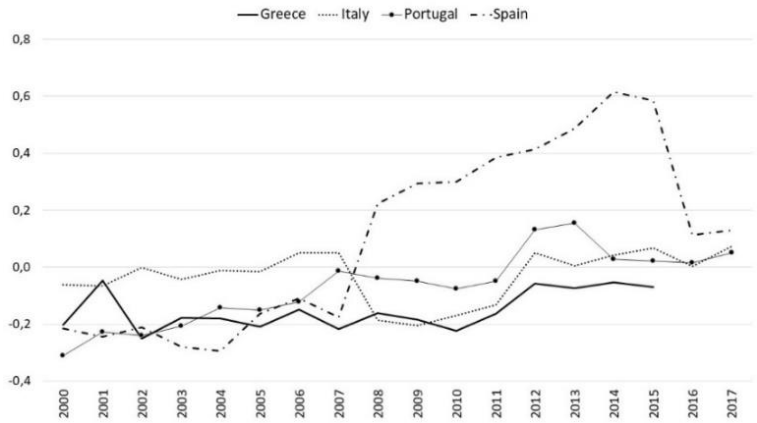
The balance of TBP (as a percentage of GDP) presents a mean value of -0.034% (Table 2). This indicator reaches the highest value for Spain (0.61%), in 2014, due to the knowledge-intensive services that were responsible for the increase in sales of intangible assets (Guarasa and Pajares, 2012), and the lowest, -0.31% for Portugal, in 2000.

During the 18 years considered in this study, the evolution of the TBP balance (as a percentage of GDP) is similar for the Southern European countries as a whole, being generally negative (see Figure 2), which reveals a trend towards net import of technology and lack of technological capacity. Notwithstanding the similarities, we can point to three relatively distinct patterns of evolution between the four countries considered. Spain observed a surplus at the peak of the economic crisis - 2008 - while in the case of Portugal and Italy, the surplus only occurred after the economic crisis. Greece during the whole period maintains a persistently negative TBP. One of the main problems of the Greek economy is the existence of a weak infrastructure for the dissemination of information and knowledge (Kastelli and Tsakanikas, 2000).

The REER in most of the years under analysis shows a trend towards appreciation for all countries (Figure 3), reflecting a general loss of international price-competitiveness. This appreciation is the result of wage changes, which resulted from the growth of nominal wages substantially higher than the growth of labor productivity, which implied a rise in unit labor costs (Allard et al., 2005; Blanchard, 2006). However, after 2009 that there is a considerable improvement in international price-competitiveness given the depreciation of the effective real exchange rate and wage moderation which is different for each country (OECD, 2013). Greece was the 'best performer' at this level, observing a sharp depreciation of the effective real exchange rate.

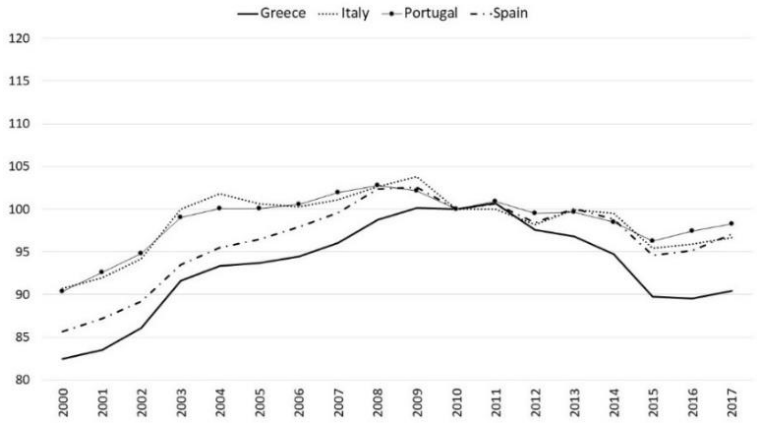
[2] In http://info.worldbank.org/governance/wgi/pdf/rl.pdf, accessed May 2019.

Figure 2: Evolution of the TBP balance (% of GDP), southern European countries, 2000-2017



Source: Own elaboration based on data from the Bank of Spain, Bank of Italy, INE, OECD and Pordata.

Figure 3 Evolution of the Real Effective Exchange Rate (REER) (base year 2010), southern European countries, 2000-2017



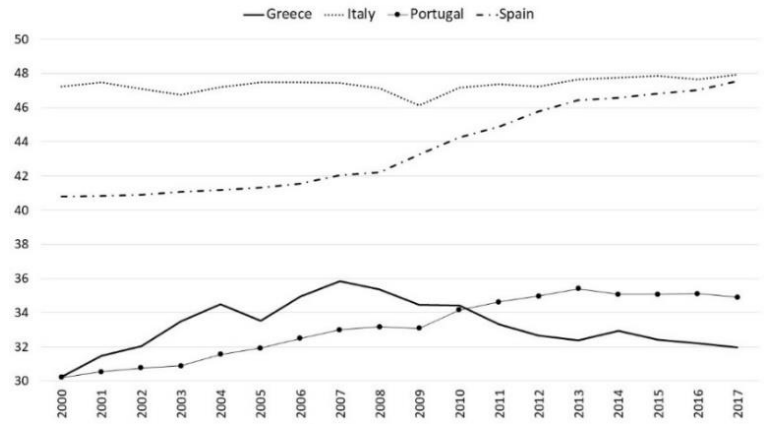
Source: Own elaboration based on data from the World Bank.

Regarding the labor productivity indicator (Figure 4), we can state that this indicator reaches the lowest value for Portugal in 2001, and the highest value for Italy in 2017. In Portugal, compared to the other countries under analysis, the relative low levels of R&D and innovation partly explain the slow productivity growth (EC, 2004). Dynamically, for Portugal, Spain and Greece albeit irregular, there is a tendency to a continuous increase (Figure 4), rising up to the economic crisis, slowing afterwards and then, with the exception of Greece, accelerating after 2009. This growth was driven by

increased hours of work and other interrelated factors such as the sharp increase in immigration, women's participation in the labor market and unemployment (OECD, 2008; OECD, 2010; EC, 2015).

Although Italy presents a moderately upward trend in labor productivity over the years, its relative feeble performance is generally associated with a dual labor market, characterized by high protection of permanent contracts, low business innovation, inadequate skills and high barriers to business creation (Dolado et al., 2011; OECD, 2014).

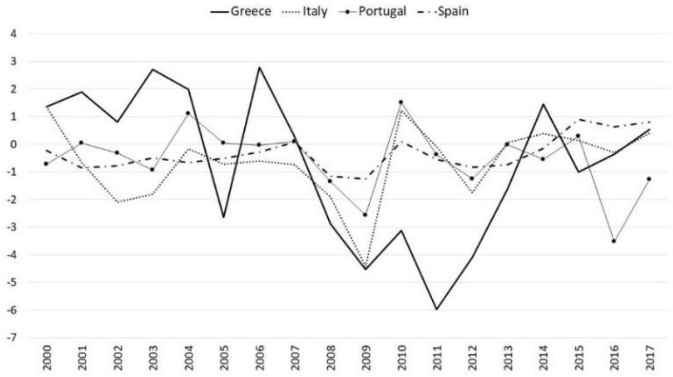
Figure 4 Evolution of labor productivity, southern European countries, 2000-2017



Source: Own elaboration based on data from the OECD.

The variable TFP growth (Figure 5) has consistently decreased (with the exception of a slight increase in the years 2006, 2010 and 2014) since 2000, reaching a global average of -0.513% with both, a maximum in 2006 and a minimum in 2011 for Greece. Several factors have contributed to the low TFP growth, namely, low investments in the education system, in R&D and innovation, and in information and communication technologies (ICT) (EC, 2004; Perugini et al., 2017). The increasing trend in recent years (since 2016) is, according to Fu and Moral-Benito (2018: 1) "mostly driven by the rise and fall of the capital-to-labor ratio (capital deepening) while the role of labor productivity is more muted, (…) [and] by the reallocation of resources towards firms with low capital deepening".

Figure 5 Evolution of total factor productivity (TFP) growth, southern European countries, 2000-2017



Source: Own elaboration based on data from the Penn World Table.

4.2. Causality analysis

According to the conceptual model (see Figure 1), in addition to the TBP, which reflects the international transfer of technology, other variables are likely to influence the countries' international competitiveness, such as human capital, public spending, the gross R&D expenditure (GERD) as a % of GDP, the R&D performed by enterprises in total R&D, the degree of openness of the countries and the institutional quality captured by the rule of law ("perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence"[3]).

We estimate nine models (see Table 3). For each of the three alternative dependent variables for international competitiveness - Real Effective Exchange Rate Index (REERI) (in ln), labor productivity (in ln), and TFP growth (in %) -, 3 distinct specifications were estimated resorting to static panel data without time fixed effects (Model A), static panel data with time fixed effects (Model B), and one step system GMM Dynamic Panel Data (Model C), which follows the work of Arellano and Bond (1991).

The Variance Inflation Factors (VIFs) estimates, which indicate how much the variance of a regression coefficient is inflated due to multicollinearity in the model, are

[3] See https://datacatalog.worldbank.org/rule-law-estimate-0, accessed in May 2019.

below 10 evidencing that no serious issues of multicollinearity arise (Murray et al., 2012). The results of the Breusch-Pagan/ Cook-Weisberg test (rejection of the null hypothesis that tests the null hypothesis that the error variances are all equal) suggests heteroscedasticity problems (i.e., the error variances are not constant throughout the observations). To overcome heteroscedasticity issues robust standard errors were considered**.** For most of the models estimated resorting to static panel data technique, the Hausman test indicates that the fixed-effect model is the most appropriate, in line with the underlying theory. The F statistics, overall R^2, and the individual significance of the coefficients of the explanatory variables show that the estimated models present reasonable quality of adjustment.

In general, with exception of Models IA and IB (static panel data estimations for REERI), the results show that there is a positive and statistically significant relationship between the TBP balance and countries' international competitiveness. More specifically, on average, all the remaining factors being held constant, TBP surpluses are strongly associated with lower REERI, that is, higher price competitiveness, higher labor productivity, and increased dynamics in TFP.

Regarding the other independent variables and restricting the analysis to the static panel data estimations, the results show, at first glance, oddly, that countries with higher levels of human capital are associated to higher levels of the REER index, that is, lower price-competitiveness (Models IA, IB). This, however, can be explained by the fact that richer countries, which are more well-endowed in human capital are also countries which have higher costs. As expected (see Wang and Yao, 2003; Liu and Li, 2006; Fuente, 2011; Cimoli et al., 2015), human capital positively and significantly contributes to labor productivity, but only in the case time fixed effects are not included (Model IIA). Albeit in a relatively feeble way, results suggest that that improvements in human capital lead to improvements in labor productivity as more educated workers are more likely to effectively use other production factors, develop and apply new ideas (Vinding, 2006; Leal-Rodríguez et al., 2014; Kaasa, 2016).

As suggested by Balvers and Bergstrand (2002) and Isaksson (2007), public spending significantly influences the international competitiveness of Southern European countries. Specifically, when international competitiveness is measured by the REERI, the estimate associated to the public expenditure variable is positive and

statistically significant (at 1% of significance), which indicates that government expenditures undermines price-competitiveness. As such countries where public spending is higher are, on average, less cost competitive (that is, present a higher REER), since increasing public spending leads to an increased demand for non-tradables (Bouakez and Eyquem, 2015), which is reflected in an appreciation of the exchange rate and a reduction in exports (Dufrenot and Yehoue, 2005; Cakrani et al., 2013; Achamoh and Baye, 2015; Castro and Garrote, 2015).

Although no consensus exists in the literature about the influence of public spending on TFP growth (see Hansson and Henrekson, 1994; Ascari and Di Cosmo, 2005), our results (Model IIIA) evidence that countries that present lower levels of public spending (in percentage of the GDP) tend, on average, to evidence increased total factor productivity dynamics. Similarly, there is also controversy about the role of R&D expenditures on TFP growth. Some studies found evidence of a positive impact of R&D expenditures on productivity growth (Coe and Helpman, 1995; Griliches, 1998; Atella and Quintieri, 2001), whereas others do not support such evidence (Griliches and Mairesse, 1990; Jones, 1995). In general, our results suggest that gross expenditure on R&D does not help discriminating Southern European countries in terms of international competitiveness. Finally, institutional quality emerges as an important determinant of international competitiveness measured by labor productivity and TFP growth, which is consistent with both economic expectations and studies conducted in the field (e.g Hall and Jones, 1999; Lasagni et al., 2015).

Table 2. Descriptive statistics and correlation matrix

	Variable	Proxy	Descriptive statistics			Correlation Matrix								
			Mean	Min	Max	1	2	3	4	5	6	7	8	9
Dependent variables	International competitiveness	1. Price competitiveness – Real effective exchange rate index (REERI) (in ln)	4.570	4.413	4.643	1								
		2. Labour productivity (in ln)	3.658	3.408	3.869	0.2815	1							
		3. Total Factor Productivity growth rate (%)	-0.513	-6.450	2.871	-0.4209	0.0348	1						
Independent variables	TBP	4. Balance of TBP in percentage of GDP	-0.034	-0.310	0.614	0.3096	0.4477	0.0857	1					
	Human Capital	5. Number of years of schooling of the population aged 15-64 years (in ln)	2.319	2.094	2.459	-0.0886	0.4247	-0.0515	0.2354	1				
	Government/ Public Expenditures	6. Weight of public consumption in GDP	0.194	0.166	0.233	0.4333	-0.2965	-0.3836	0.0564	0.1062	1			
	Gross expenditure on R&D (GERD)	7. Ratio of GERD in percentage of GDP	1.042	0.530	1.580	0.4979	0.5246	-0.0293	0.5612	-0.0604	-0.1813	1		
	Degree of trade openness	8. Ratio of exports plus imports in GDP	0.594	0.455	0.852	0.0631	-0.4334	0.0876	0.1797	-0.4404	-0.0981	0.3003	1	
	Institutional quality	9. Rule of law (in ln)	4.230	3.853	4.433	0.0034	-0.1668	0.0565	0.653	-0.5565	-0.3381	0.0425	0.2969	1

Source: Own elaboration (extracted data from Stata v14 program)

Table 3. Static and Dynamic Panel data estimation, of the relation between international competitiveness and TBP, 2000-2017, four Southern European countries

Variable	Proxy	REERI (in ln)			Labor Productivity (in ln)			TFP Growth (in %)		
		Model IA	Model IB	Model IC	Model IIA	Model IIB	Model IIC	Model IIIA	Model IIIB	Model IIIC
Lagged dependent variable	Lagged international competitiveness			0.8135***			0.7289***			0.2803*
				(0.0540)			(0.0540)			(0.1112)
TBP	Balance of TBP in percentage of GDP	-0.0247	0.0243	-0.0409*	0.1067***	0.1328***	0.0316*	3.1830**	2.7939*	1.4101**
		(0.0278)	(0.0151)	(0.0181)	(0.0275)	(0.0359)	(0.0150)	(1.5799)	(1.5369)	(0.5146)
Human Capital	Number of years of schooling of the population aged 15-64 years (in ln)	0.4588***	0.4059**	0.0268	0.5242***	0.2327	0.1603	-3.6731	-5.7104	1.4731
		(0.1453)	(0.1163)	(0.1103)	(0.1434)	(0.2980)	(0.1435)	(3.0040)	(5.7851)	(1.6011)
Government/ Public Expenditures	Weight of public consumption in GDP	2.2686***	1.2161	-0.3020	0.0942	-0.1901	-0.3807	-66.2542*	-42.8233	-31.8838
		(0.4842)	(0.6677)	(0.3248)	(0.4777)	(0.9463)	(0.5384)	(39.4791)	(37.9811)	(26.1388)
Gross expenditure on R&D (GERD)	Ratio of GERD in GDP	0.0362	-0.0170	0.0191	0.0271	0.0037	0.0114	-2.0488*	-1.6184	-0.87918
		(0.0276)	(0.0429)	(0.0204)	(0.0273)	(0.0485)	(0.0063)	(1.1795)	(1.8872)	(0.4606)
Degree of trade openness	Ratio of exports plus imports in GDP	-0.1548	0.1560	-0.1329	-0.0011	0.2542	-0.0656	0.9607	-4.5789	2.0308
		(0.1156)	(0.1364)	(0.0923)	(0.1141)	(0.2475)	(0.1009)	(2.4321)	(6.9773)	(1.3954)
Institutional quality	Rule of law (ranking, in ln)	0.1001	0.0647	0.0254	0.2532***	0.3226***	0.0839	3.3993**	-1.6628	0.49780
		(0.0668)	(0.0487)	(0.0683)	(0.0659)	(0.0880)	(0.0535)	(1.7741)	(2.2136)	(1.0280)
	Time fixed effects	No	Yes		No	Yes		No	Yes	
	Number of Observations	72	72	64	72	72	64	72	72	64
Diagnosis tests	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity	1.17 (0.2798)	5.89 (0.0153)		0.57 (0.4499)	0.79 (0.3746)		10.42 (0.0012)	1.28 (0.2582)	
	Robust standard errors	No	Yes		No	No		Yes	No	
	Mean VIF [Max]	1.78 [2.20]	7.44 [14.19]		1.78 [2.20]	7.44 [14.19]		1.78 [2.20]	7.44 [14.19]	
Goodness of fit	Hausman Test (p-value)	24.84 (0.0001)	142.73 (0.000)		<0	<0		2.50 (0.8681)	10.69 (0.9861)	
	F-stat (p-value)	16.85 (0.000)	39.52 (0.000)		16.43 (0.000)	4.86 (0.000)		21.69 (0.0014)	51.02 (0.000)	
	Overall R^2	0.040	0.2482		0.2805	0.0207		0.2502	0.5201	
	Specification of the dynamic panel data			lag (0 2) no level robust small			lag (0 2) no level robust small			lag (0 2) no constant robust small
	Instruments			Public expenditures; Rule of law			Public expenditures; trade openness; Rule of law			Public expenditures; Rule of law
Adequacy of the instruments	AR(1)			-1.84 (0.066)			-2.56 (0.018)			-2.46 (0.045)
	AR(2)			-1.87 (0.075)			-1.29 (0.198)			-1.68 (0.092)

*Note: The standard deviations are in parentheses; *** (**) [*] Statistically Significant at 1% (5%) [10%]; The Hausman test does not show systematic differences between the coefficients derived from the fixed and random effects in the case of the IIIA and IIIB models. Models C were estimated using the one step system GMM Dynamic Panel Data approach following the work of Arellano and Bond (1991).*

5. Conclusion

Structural change processes have occurred in most of the countries involving a movement towards a knowledge-based economy. Such movement demands a profounder understanding of the role of intangible assets, not only for countries' economic growth but also for countries' international competitiveness (Jona-Lasinio and Meliciani, 2018).

The international trade flows of intangible assets such as patents, licenses, knowledge, brands, models, designs, industrial research and development (R&D), and technical services, are recorded in the Technology Balance of Payments (TBP). A positive balance (surplus) of the TBP reflects the ability of a country to sell technologies abroad. The few studies that addressed the TBP (Horn, 1982; Sirilli, 1991; Sánchez and Vicens, 1991; Saiz, 2005; Coelho et al., 2011; Avallone and Chedor, 2012) have focused mainly on explaining TBP deficits. The relation between TBP and country's international competitiveness has been relatively overlooked.

Until the most recent world financial crisis (2008-2009), most of the Southern European countries observed noticeable TBP deficits. However, from therein with exception of Greece, the remaining Southern European countries (Italy, Portugal and Spain) experience marked improvements in their TBP. Given that these countries rank relatively behind in terms of innovation (are classified as moderate innovators) and are characterized by an industrial structure relatively dependent on relatively low knowledge intensive sectors (Molero, 1995; Teixeira et al., 2014), it would be illuminating to assess the extent to which improvements at the level of TBP are associated with increases in international competitiveness. To the best of our knowledge, this issue has not yet been investigated. Thus, in the present paper, we resort to static and dynamic panel data involving four southern European countries – Greece, Italy, Portugal, Spain - between 2000 and 2017.

Overall, our results evidence that the TBP (as % of GDP) plays a key role in the international competitiveness of Southern European countries, particularly in non-price competitiveness. Indeed, when international competitiveness is measured by labor productivity and TFP growth, surpluses of TBP are associated with increased international competitiveness. This suggests that improving international

competitiveness is likely to be associated with productivity gains which may derive from increased productive specialization in industries that are increasingly based on intangible assets such as patents or trademarks.

Given the positive effect of TBP surpluses on countries' international competitiveness, it is recommended that Southern European governments undertake initiatives not only to protect intellectual property rights, and foster R&D intensive services, but also to encourage technological trade. Investments should be directed to knowledge- and technology-intensive activities aimed at improving intellectual capacity, which has direct impact on companies, sustaining their competitive advantage, as well as an indirect impact by generating new ideas/ knowledge and even greater ease of absorption of foreign technologies. Thus, an environment for the promotion of technology-based companies should be created, which will help fostering the competitiveness of countries based on more innovative activities that, in addition to increasing returns to scale, create jobs and improve the population's welfare/ quality of life.

Despite its novelty, there are some worth note limitations, which nevertheless constitute interesting avenues for further research. First, as earlier referred TBP does not directly measure the exchange of technology between parent company and its affiliates, that is, technological flows on intra-firms or within multinational companies. Second, we derive our empirical results from a sample of four Southern European countries, thus raising the concern about the generalization to other countries. Future research should broaden the study to a wider set of countries, most notable those whose competitive advantages rely on highly intensive R&D industries, such as the innovation leaders (e.g., Denmark, Finland, Luxembourg, the Netherlands, Sweden, and the United Kingdom) or the strong innovators (e.g., Austria, Belgium, France, Germany, Ireland, and Slovenia). Third, we did not analyze whether the TBP specific type of components - patents, licenses for patents, know-how; models and designs, trademarks, technical services and R&D – may distinctly contribute to a country's overall technological balance. Although data on the specific components for the southern European countries considered were not adequately harmonized to permit such an analysis, this could be a challenging research path using more developed, larger samples of countries.

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