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A non-parametric analysis of competitiveness efficiency: The relevance of firm size and the configuration of competitive pillars

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Abstract This study employs a DEA model with a single constant input to analyze the competitiveness performance of a unique sample of 103 knowledge-intensive business service (KIBS) firms from Hungary, Spain, Colombia and Costa Rica for the year 2017. Also, we assess how the configuration of competitive pillars—strengths and weaknesses—impacts efficiency and how firm size moderates this relationship. The mean efficiency scores by which the competitiveness output can be optimized is 47.43%. The results suggest that the configuration of competitive pillars has important implications for efficiency analyses. For small businesses, competitive-enhancing actions should focus on mitigating competitive weaknesses that are detrimental to efficiency. Also, a configuration of competitive pillars in which one or various competitive strengths prevail is more beneficial for small businesses. Managerial tools such as the proposed competitiveness measure may offer useful information on what strategic actions can contribute to optimize business competitiveness.

Introduction

A central idea in the resource-based view of the firm (RBV) is that businesses acquire or develop specific resources and capabilities that interact with the existing ones for creating competencies as they pursue competitiveness and,

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consequently, superior performance (Barney, 1991; Prahalad and Hamel, 1990). Competitiveness is linked to the development of a competitive advantage, and is often conceptualized as the capacity of the organization to efficiently amalgamate its resources and capabilities seeking to create value-adding, hard-to duplicate competencies (Barney, 2001).

Nevertheless, organizations have different incentives to undertake competitiveness-enhancing actions and they do not realize the generally positive effects of such investments at the same intensity (see e.g., Newbert, 2007). The heterogeneous distribution of resources and capabilities among competing firms has been invoked as a relevant aspect that contributes to explain both the dissimilar ability of businesses to create a resource-based competitive advantage and the differences in business competitiveness (Sirmon et al., 2010).

Also, in this study we argue that firm size is a relevant characteristic that helps explain why some firms have access to more resources than others—i.e., the heterogeneous distribution of resources—and why the configuration of existing resources and capabilities—i.e., the building blocks of competitiveness—impacts businesses at different intensities. But, why do we assume that the configuration of competitive pillars (or strategic factors) conditions businesses' competitive efficiency? Furthermore, why do we expect firm size to moderate the impact of the business' configuration of competencies on the level of competitiveness efficiency?

Concerning the first question, RBV literature has traditionally emphasized the role of value-adding competencies for competitive advantage (e.g., Newbert, 2007). Moreover, Wernerfelt (1984, p. 1972) defines a resource as ''anything which could be thought of as a strength or weakness of a given firm''. Thus, it is plausible to argue that business competitiveness is the result of the amalgamation of a set of complex and heterogeneous (strong and weak) resources and capabilities. Following this discussion, the effect of competitive weaknesses has recently drawn scholarly attention (Arend, 2004; Sirmon et al., 2010). This research stream distinguishes competitive inadequacies (weaknesses) from distinctive competencies (strengths), and evaluates the role of each in shaping competitiveness.

In the case of the second research question, small businesses—i.e., firms with up to 50 employees—are not scaled-down versions of large firms and various arguments may explain the competitive discrepancies between these two groups. First, smaller and larger businesses differ from each other in many aspects, including the strategic design ('fire-fighting' style of SMEs viz.-a-viz. formal planning of larger firms), the access to financial and human resources, organizational structure, and their vulnerability to changing market conditions (Man et al., 2002). Also, the limited capacity of small firms to develop networks affects their market behavior, that is, the way in which they compete (Robinson and Simmons, 2018).

Second, and in a closely related manner, the characteristics of small businesses' operations are likely less conducive to develop economies of scale, thus reducing the incentives for adopting monitoring and information systems and for developing competitiveness-enhancing investments (Fuchs and Kirchain, 2010). Third, large firms have a greater capacity to gather information and evaluate the configuration of their competitive factors seeking to delineate their strategic moves based on their strong strategic aspects (competitive strengths). On contrary, managers of small businesses often lack such information to identify strategic weaknesses (bottlenecks) that may outweigh their competitive strengths and, ultimately, negatively impact their competitiveness (Arend, 2004; Sirmon et al., 2010).

Although much has been said about the drivers of competitiveness (see, e.g., Newbert, 2007), other equally important variables—such as firm size—that are not uniformly distributed among firms have been sidelined in previous research. Scholarly studies often treat firm size as a control variable, assuming that this variable only has a direct effect on firm performance. By examining only the direct impact of firm size, research fails to recognize part of the heterogeneity of businesses and their underlying (direct and indirect) performance consequences (Fang et al., 2016; Lafuente et al., 2018; Robinson and Simmons, 2018).

In line with these arguments, this study first focuses on the competitiveness construct by verifying how the associations between resources and capabilities shape competitiveness. Second, we evaluate how the configuration of competitive pillars (weaknesses and strengths) conditions competitiveness efficiency and how firm size moderates this relationship.

The empirical application uses an international sample of 103 knowledge-intensive business service (KIBS) firms located in Europe (Hungary and Spain) and Latin America (Colombia and Costa Rica) for the year 2017. There are various considerations when conducting a homogeneous analysis in countries with different levels of development. First, there are significant structural differences within and between developed and developing countries in terms of industrial specializations, business size and access to different resources. Second, these structural differences may overlap with institutional dissimilarities (e.g., market regulation or development of financial markets). Nevertheless, it would be interesting to know if businesses operating in developing economies are as similar to each other as organizations located in some EU countries, and to identify the similarities or disparities between developed and developing countries. Therefore, the use of a homogenous instrument (questionnaire) in different settings permits to generate comparable competitiveness data that can reveal country-specific performance patterns as a result of different constraints faced by local businesses.

Also, the proposed analysis of the role of both the configuration of competitive pillars and firm size on competitiveness efficiency provides an opportunity to assess, in developed and developing settings, how different competencies contribute to competitiveness in contexts where the interactions between resources and capabilities are complex and heterogeneous.

In the first stage, we evaluate the competitiveness efficiency of the sampled business. Building on RBV postulates, competitiveness has been analyzed from multiple angles, often using aggregate estimates that capture the contribution of different resources and capabilities (Fernhaber and Patel, 2012). Despite the rigorous efforts, underlying these studies are methodological approaches that ignore the interactions that may exist between the variables that form

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competitiveness. To address these issues, we measure competitiveness via an index number that incorporates into the analysis system-level constraints between the 46 analyzed variables that, grouped in ten competitive pillars, represent different resources and capabilities shaping competitiveness (Lafuente et al., 2016).

Because competitiveness—a desired business outcome—is measured via an index number, we employ the DEA method with a single constant input to evaluate business efficiency at country level in a model that uses the proposed competitiveness score as the only output (Lovell et al., 1995; Lovell and Pastor, 1999). The second stage introduces the efficiency scores in a truncated model that evaluates how the configuration of competitive pillars (competitive strengths and weaknesses) as well as firm size impacts competitiveness efficiency.

Rather than analyzing the sources of competitive advantage, this study seeks to produce insights on how firms can generate valuable information that helps orchestrate their competitive pillars with the objective to enhance competitiveness. Also, by examining the outcomes that flow from the creation or development of competencies from a systemic perspective, managers of small businesses might be in a better position to balance strategic investments with actions that contribute to capitalize on the organization's resources and capabilities.

The remainder of the paper is organized as follows. Second section presents the theoretical underpinning. Third section describes the proposed competitiveness measure, the data and the methodological approach. Fourth section offers the empirical results. Finally, fifth section presents the concluding remarks and implications of the study.

Background literature

Competitiveness within the resource-based theory of the firm framework

Resource-based view (RBV) theorists propose that the outcomes resulting from the associations between resources and capabilities—labeled competencies—contribute to enhance business competitiveness and subsequent performance (Prahalad and Hamel, 1990; Wernerfelt, 1984). In this discussion, Barney (1991) suggests that the uneven distribution of resources and capabilities among businesses explains differences in business endowments and the dissimilar ability of businesses to create a resource-based competitive advantage. Therefore, businesses with superior systems and structures achieve higher performance and maintain their competitiveness level on the basis that their resources and capabilities are not easily duplicable or surpassable (Barney, 2001).

In this sense, competitiveness is a multidimensional construct characterized by its long-term orientation, controllability and dynamism, and is often conceptualized as the capacity of the organization to amalgamate its resources and capabilities seeking to create value-adding competencies (Douglas and Ryman, 2003).

Studies rooted in the RBV show a great deal of variation in the resources and capabilities used to operationalize competitiveness. For example, variables related to the product and business operations are ''usual suspects'' in competitiveness analyses (Fernhaber and Patel, 2012). Prior research has also analyzed the role of relevant competencies related to human capital (Julien and Ramangalahy, 2003), internationalization (Belderbos and Sleuwaegen, 2005), networking (Kingsley and Malecki, 2004), and marketing (O'Cass and Weerawardena, 2010). Recent technology advances, such as the rapid expansion of the Internet and the drastic fall in the costs of technologies and communication, have allowed the development of IT-based competencies—e.g., exploitation of ITs, database management and e-commerce—which have drawn scholarly attention (Aral and Weill, 2007).

Perhaps because of the difficulties of measuring competitiveness, most empirical studies have sought to evaluate the individual contribution of different resources or capabilities to performance via factor analysis or structural equation models (Newbert, 2007). Underlying this approach is the assumption that competitiveness is evident in organizations whose resources and capabilities are positively correlated to performance.

Organizations are a bundle of resources and capabilities and these ingredients do not work in isolation. As Newbert (2008, p. 751) points out, ''it is unlikely that a firm's competitive position is solely attributable to any one specific resource or capability.'' Instead, businesses pursuing a competitive advantage must demonstrate the ability to exploit their resources and capabilities in such a way that their full potential is realized.

Competitiveness should be evaluated from a holistic approach to better understand how organizations ''do business'' (Barney, 2001). The core of our analysis is to match resources and capabilities with the creation of value-adding competencies, while acknowledging the multidimensionality of competitiveness as well as the complementarities that exist between the business' resources and capabilities.

The configuration of the system of competencies: competitive strengths and weaknesses and the role of firm size

By acknowledging the interconnectedness of resources and capabilities, in this study we analyze competitiveness based on the configuration of the business' system of competencies. We argue that the potentially positive value that a focal competency may create is a function of both its availability and the configuration of the system of competencies within the business.

Also, it should be noted that we assume that competencies fall on a continuum from weakness to strength, and that their position on this competitive continuum is heterogeneous across businesses in a particular point in time, that is, competencies that are weak points for a business can constitute a competitive strength for another firm.

In the context of this study, configuration refers to a multidimensional property that varies across firms, and is defined as the degree to which the business's resources and capabilities are connected by a single theme (Miller, 1996). Building on the configuration theory developed by Miller (1986), the elements of a system cannot fully be understood in isolation, so the analysis of the whole system is inevitable.

While it is easy to copy a single element, competitive advantage lies ''...in the power of the orchestrating theme and the degree of complementarity it engenders among the elements'' (Miller and Whitney, 1999, p. 13).

This argument is in line with RBV postulates that organizations are a bundle of interconnected resources and capabilities, and accurate competitiveness analyses should take into account the role of the business' configuration of competencies (competitive strengths and weaknesses). For example, technology and knowledge are highly interconnected resources in professional service businesses, such as financial or knowledge-based consultancy firms. The use of obsolete technology might prove itself ineffective when it comes to capitalize on human capital resources. Skilled employees will likely struggle with internal procedures in their day-to-day routines. In this example, and regardless of the overall business competitiveness level, poor technology implementation—i.e., in terms of software and hardware—creates a bottleneck that limits the full exploitation of employees' knowledge and deteriorates both competitiveness and business operations. On contrary, the contribution of human capital to business competitiveness will increase as the organization harmonizes other resources—i.e., technology—or develop competitive strengths.

The analysis of the success or failure of any competitiveness-enhancing strategy is inevitably connected to the businesses' configuration of competencies. From a strategic management perspective, performance analyses based on the net-effect logic stresses that competitiveness is a function of available competencies, and that the configuration of competencies (strengths or weaknesses) determines the overall competitiveness level (Arend, 2004; Sirmon et al., 2010). That is, the net-effect logic mostly focuses on the role of the dominant competitive forces, and the analysis of the effects of competitive strengths and weaknesses based on this approach may become a potentially critical analytical viewpoint that can contribute to understand the conditions under which businesses can alter their strategies.

Traditionally, the analysis of value-adding competencies (competitive strengths) is at the heart of RBV research (Sirmon et al., 2010). Within the RBV frame value is defined as the ability of a business to use a rare capability to exploit an opportunity, to improve efficiency or to neutralize a threat (Barney, 1991). In this sense, rarity is defined in terms of supply or market availability, while value refers to the potential to generate a measurable benefit for the firm.

This approach—i.e., focused on competitive strengths—has fueled research which has mostly hypothesized that businesses capable of acquiring and exploiting valuable competencies will achieve superior performance for two reasons (Sirmon et al., 2010). First, increased competitive strengths allow the business to react to changing market conditions in unique ways (Douglas and Ryman, 2003). Second, the complementarities between strong competitive factors multiply the value that each can create for consumers, and allow businesses to improve the price/quality relationship of their products/services (Sirmon et al., 2010).

Competitive strengths undoubtedly have a positive impact on competitiveness; however, when comparing smaller viz.-a-viz. larger businesses at least two interconnected aspects suggest that the strengths-competitiveness relationship is stronger in the latter group. First, large firms have more opportunities to capitalize on competitiveness-enhancing investments—e.g., technical upgrades, product development, training programs—via scale economies, while small businesses are exposed to resource constraints that often lead to adopt imitative business models and to offer a reduced product portfolio. For example, Fuchs and Kirchain (2010) find that strategic choices of optoelectronic component manufacturers are reliant on firm size, and that the dominant strategy of small manufacturers is based on product specialization (design and manufacturing) and cooperation with other businesses in the sector—mostly evident via vertical integration—that permit to benefit from scale economies.

Second, following the definition of the configuration of competencies described above, the complementarities between competencies become evident when the marginal value of a given strength is amplified by increases in other strengths (Sirmon et al., 2010). This argument is in line with Wernerfelt (1984, p. 171) who states that ''by specifying the size of the firm's activity in different product markets, it is possible to infer the minimum necessary resource commitments. Conversely, by specifying a resource profile for a firm, it is possible to find the optimal product market activities.''

We now turn our attention to the role of weaknesses on competitiveness. Competitive weaknesses represent the dark side of competencies, and the analysis of their influence on competitiveness has gained increased attention (Arend, 2004; Sirmon et al., 2010). These studies highlight various factors that explain the negative effect of competitive weaknesses on performance. First, competitive weaknesses increase the business' vulnerability to market conditions or competitors' actions, which is detrimental to performance (West and De Castro, 2001). Second, firms with clear competitive weaknesses have a lower possibility to pursue business opportunities. For example, lack of access to certain resources and capabilities—e.g., financial resources, human capital, networks—limits the firms' capacity to engage in new strategic actions. This is likely the case of small firms. On contrary, large businesses can spread investment costs over greater output so that the returns of such competitiveness-enhancing investments are increasing in firm size (Arora and Cohen, 2015).

Third, competitive weaknesses create a bottleneck of resources and capabilities that increases the business' unit cost by limiting the capacity to exploit other valuable competencies. For example, Douglas and Ryman (2003) show how skilled physicians are attracted to larger hospitals that offer cutting-edge technologies and deliver new services. Therefore, skilled people seek employment in businesses where their abilities are rewarded; while hospitals using obsolete technologies will become unattractive to skilled employees, thus increasing the competitive weaknesses of the organization.

Based on these arguments, it is plausible to argue that the negative effect of competitive weaknesses is greater among small businesses. For example, resource-constrained small businesses often assign employees to perform tasks for which they are unprepared, thus tasks are performed

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poorly and additional resources are needed to correct problems in business routines. This argument is in line with Lazear (2004) who stresses that entrepreneurs are jack-of-all-trades whose weak skills are detrimental to the business' production function.

Data, variable definition and method

Data

The empirical illustration uses a unique primary dataset drawn from an international research project on competitiveness developed by a team of universities from four countries: Colombia (Universidad de la Costa, Barranquilla), Costa Rica (Costa Rica Institute of Technology), Hungary (University of Pécs), and Spain (Polytechnic University of Catalonia). The data were collected specifically for the purpose of this study and the process was entirely supervised by team members of each of the participating universities.

The selection process of the surveyed firms was two folded. First, each participating team identified a group of businesses operating in different industries. In this stage, top managers are a relevant respondent group, and in an initial telephone call for approval an appointment with one of the owners of a top manager was set. In the second step a face-to-face interview was carried out to one of the owners (only if he/she is in top management team) in the case of firms smaller than 20 employees, while for businesses larger than 20 employees a top executive—irrespective of whether he/she has ownership rights or not—was interviewed. The data collection process was achieved through self-administrated, structured interviews where managers were asked to answer essentially close questions. The survey was conducted by members of the participating teams, and the data was collected between March and June 2017. The questionnaire was subject to a pre-test to correct potentially misleading or confusing questions. Further details about the Global Competitiveness Project as well as about team members can be found at https://www.sme-gcp.org.

Because of their relevance for the development and consolidation of knowledge-based economies (Lafuente et al., 2017), in this study we focus on the competitiveness analysis of knowledge-intensive business services (KIBS) firms. KIBS firms are innovation bridges that interplay with other economic agents acting as purchaser, provider or partner, which implies a deep interaction between KIBS businesses and the end customer (Cusumano et al., 2015). One example of services provided by KIBS is the management of large samples of digital information, namely big data. Opresnik and Taisch (2015) show that this service adds significant value to manufacturers' offering especially in B2B relationships by providing customers with tools that can be used to enhance cost saving policies and develop more informed strategic decision-making. KIBS businesses show a distinctive way to access, create and integrate knowledge in their processes (Cusumano et al., 2015; Lafuente et al., 2017).

According to the European Commission (2012), KIBS firms encompass a wide range of activities including those related to computing, information and communication technologies (NACE Rev-2: 62); architectural and engineering technical services (NACE Rev-2: 71); research and development (NACE Rev-2: 72); as well as organizational-oriented services (NACE Rev-2: 69, 70, 73 and 78)—i.e., legal and accounting and auditing services, management consultancy, advertising and market research—and other knowledge-oriented services (NACE Rev-2: 74). To identify KIBSs and non-KIBSs firms in our sample, interviewees were asked to detail the main activity of their firm, according to this classification.

In the final sample it is possible to identify a total number of 103 KIBS firms for which a complete dataset of the analyzed variables could be constructed. The final sample includes 28 Hungarian businesses, 25 Spanish businesses from the Catalonia region, 26 Colombian businesses from the Barranquilla region, and 24 Costa Rican businesses.

The competitiveness index: computation issues and variable description

Instead of using aggregate metrics to evaluate the individual contribution of the analyzed competitiveness components, in this study we follow the methodology proposed by Lafuente et al. (2016) to measure competitiveness via a systemic index number. These authors define competitiveness as *the mutually dependent bundle of ten pillars—human capital, product, domestic market, networks, technology, decision making, strategy, marketing, internationalization, and online presence—that allow a firm to effectively compete with other firms and serve customers with valued goods/services.*

The selected competitiveness pillars match RBV postulates (see e.g., Barney, 1991; Wernerfelt, 1984), and their relevance flows from the recognition that multiple interactions that can take place within a business and that the intensity of these interdependent relations affect competitiveness. To account for the multidimensional nature of the relations between the analyzed competitive pillars (competencies), we employ a five-step procedure to compute a business competitiveness index (CI).

In the first step, the selected variables ($j = 1, \ldots, J$ and $J = 46$) used to build the competitive pillars are normalized in the [0,1] range as (the description of the 46 variables used in this study is presented in Table A1 of Appendix):

$$x^*_{i,j} \frac{x_{i,j}}{\max(x_j)}, \quad j = 1, \ldots, J \text{ and } i = 1, \ldots, N \tag{1}$$

In Eq. (1) $x^*_{i,j}$ is the normalized value for the jth variable obtained for the ith business, while $x_{i,j}$ is the original value of the focal variable. The selected benchmarks ($\max(x_j)$) are, for each variable (j), the highest score and these proxy the country-specific best practices, while all remaining values are related to these benchmarks. We use the distance normalization approach because, contrary to the *min-max* technique (mean of zero and variance of one), this approach preserves the observed relative difference among the analyzed firms.

The second step deals with the computation of the ten competitiveness pillars that form the competitiveness index ($\mathbf{v} = (v_1, \ldots, v_{10})\ R^V$). The pillar scores are the average value of the variables (j) included in each pillar ($\mathbf{v}$). Also, pillar values are normalized in the [0,1] range to ease the

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interpretation of the results. The normalized competitiveness pillar scores are computed as follows:

$$p_{i,v} \frac{J_{j^v i} x^*_{i,v}}{J_v}, \quad v = 1, \ldots, 10 \text{ and } j_v = 1, \ldots, J_v \tag{2a}$$

$$p^*_{i,v} \frac{p_{i,v}}{\max(p_v)}, \tag{2b}$$

Note that the pillar scores ($p_{i,v}$) are computed at firm-level (i = 1, ..., N) and that the number of variables used to estimate each pillar (j_v = 1, ..., J_v) may vary across pillars (**v**).

The third step equalizes the marginal effect resulting from improvements in a competitiveness pillar ($p_{i,v}$), and estimates the strength and direction of the adjustment for each pillar by finding the root of the following expression for δ:

$$y_{i,v} = p^{*\delta}_{i,v} \tag{3a}$$

$$\sum_{i=1}^{N} p^{*\delta}_{i,v} - N\bar{y}_v = 0 \tag{3b}$$

In Eqs. (3a) and (3b) δ represents the ''strength of adjustment'' for the *vth* pillar, that is, the δth moment of $p_i{}^*{}_{,v}$ is exactly the pillar's average value ($\bar{y}_v$). Eq. (3b) draws a decreasing and convex function, and the solution for δ is obtained by implementing the Newton-Raphson method with an initial guess of zero (Atkinson, 2008). After estimating δ, computations are straightforward. From Eqs. (3a) and (3b) note that if:

$$\bar{p}^*_v < \bar{y}_v \quad \delta < 1$$

$$\bar{p}^*_v = \bar{y}_v \quad \delta = 1$$

$$\bar{p}^*_v > \bar{y}_v \quad \delta > 1$$

Therefore, by solving Eqs. (3a) and (3b) we obtain the strength (and direction) of the adjustment (δ) for the analyzed pillars (**v**).

The fourth step adds the penalty for bottleneck to the computation of the competitiveness index in order to consider the interconnectedness between the ten competitiveness pillars. Mathematically, the penalty of bottleneck is modeled via a correction form of an exponential function of ae^{bx} (Tarabusi and Guarini, 2013). The penalty function has the following form:

$$h_{i,v} = \min(p^*_{i,v}) + (1\, e^{(p^*_{i,v}\ \min(p^*_{i,v}))}) \tag{4}$$

where $h_{i,v}$ is the post-penalty value for the vth pillar and $\min(p^*_{i,v})$ is the lowest pillar value reported for the ith business. Eq. (4) shows that, for each business and each pillar, the bottleneck penalty is obtained by adding one minus the base of the natural logarithm of the negative difference between the focal index pillar ($p^*_{i,v}$) and the lowest normalized pillar value reported for that business (Eqs. (3a) and (3b)).

Finally, in the fifth step we use results from Eq. (4) to estimate the competitiveness index (CI) for each firm as the sum of the ten pillars as follows:

$$CI_i = \sum_{v=1}^{10} h_{i,v} \tag{5}$$

From our questionnaire it is possible to obtain information for 46 variables related to different resources and capabilities. These variables are grouped in the ten competitiveness pillars (competencies) analyzed in this study. Following the methodology described in ''The competitiveness index: computation issues and variable description'' section, these variables are used to build the competitiveness index. Respondents were asked along a five-point scale to value the individual importance of a series of resources and capabilities. These resources and capabilities are only valuable if deemed so by the respondents (Priem and Butler, 2001). In the proposed Likert-type scale a value of '1' identifies a low relevant variable, while a value of '4' represents a highly relevant variable. The value of '0' indicates that the focal resource or capability has no strategic value whatsoever (Douglas and Ryman, 2003), while the remaining points of the scale ensure the uniform evaluation and quantification of the study variables. Also, the division of the positive scale values (from 1 to 4) allows a sufficient degree of differentiation in the valuation of the analyzed variables (Lederer et al., 2013).

The description of the 46 variables used to build the competitiveness pillars are presented in the Appendix (Table A1). Table 1 presents, for each country, descriptive statistics for the analyzed competitive pillars (Eq. (4)) and the competitiveness index (Eq. (5)).

In line with the literature presented in ''Competitiveness within the resource-based theory of the firm framework'' section, one would be tempted to question whether the competitive pillars accurately represent the competitiveness construct. To further corroborate the appropriateness of the variable selection process, a robustness check was carried out based on the estimation of a principal component factor analysis that evaluates how well the 10 observed pillar values reflect business competitiveness. At the country level, results in Table 1 reveal that the reliability test (Cronbach's alpha) for the ten competitiveness pillars ranges between 0.8537 (Costa Rica) and 0.9299 (Colombia). This result confirms that, for each analyzed country, the selected pillars efficiently measure the competitiveness construct (Nunnally and Bernstein, 1994). Therefore, the competitiveness score (Eq. (5)) is the output employed in the DEA model that evaluates the competitive efficiency of the KIBS firms included in the sample (''Methods: DEA model with a single constant input and truncated regression analysis'' section).

Methods: DEA model with a single constant input and truncated regression analysis

When dealing with multiple inputs yielding multiple outputs, efficiency literature often makes use of data envelopment analysis (DEA) frontier methods (see, e.g., Cooper et al., 2011; Grifell-Tatjé and Lovell, 2015). The primary technological assumption of DEA models is that production units (in

Table 1 Competitiveness score of KIBS firms: descriptive statistics.

	Colombia	Costa Rica	Hungary	Spain	Total
Competitiveness	5.2582	5.6560	4.6797	5.3405	5.2136
Domestic market	0.4937	0.5205	0.5057	0.5398	0.5144
Networking	0.5200	0.6052	0.4618	0.5346	0.5276
Internationalization	0.4763	0.5497	0.4478	0.5324	0.4993
Human capital	0.5913	0.5970	0.4920	0.4915	0.5414
Product	0.4770	0.6372	0.4400	0.6294	0.5412
Technology	0.5181	0.5276	0.4623	0.5628	0.5160
Marketing	0.5792	0.5010	0.4169	0.5178	0.5019
Online presence	0.4500	0.6213	0.5183	0.4735	0.5142
Decision making	0.6045	0.5492	0.4406	0.5320	0.5295
Strategy	0.5480	0.5472	0.4945	0.5266	0.5281
Observations	26	24	28	25	103
Cronbach's alpha	0.9299	0.8537	0.9189	0.8788	0.9011

our case, businesses) (i) use a set of $\mathbf{x}$ ($x_1,\ldots, x_K$) R^K inputs to produce a set of $\mathbf{y}$ ($y_1, \ldots, y_M$) R^M outputs, and that these sets form the technology in the sector (T):

$$T\{(\mathbf{x}, \mathbf{y}) : \mathbf{x}\,\text{can produce}\,\mathbf{y}\}.$$

Underlying the described technology is the presence of observable vectors of inputs and outputs. Nevertheless, in many applications there is no explicit input or output data available. In the context of non-parametric analyses, there are two main motivations to evaluate the efficiency level of a set of units of analysis via DEA models without explicit input data. First, several multi-dimensional evaluation problems do not require input or output data, and the performance evaluation relative to the best practice frontier or to targets set by managers or policy makers become the objective of the analysis. Examples of such problems include the performance of road traffic safety units (Odeck, 2006), countries' performance in the Olympic Games (Soares de Mello et al., 2009), the achievement of the Kyoto protocol targets (Lo, 2010), and the performance of Chinese research institutes (Liu et al., 2011).

Second, in many applications the output variables are ratio or aggregate variables (e.g., GDP per capita, value added per employee), and the data do not permit to distinguishing the specific input levels necessary to produce the analyzed outputs. Examples include the performance analysis of macroeconomic indicators (Cherchye et al., 2004) and the performance evaluation of the OECD Better Life Index (Mizobuchi, 2014).

In both cases, the modeled technology considers that the desired output (**y**) is produced by a single constant input. In the context of this study, businesses introduce and deploy different resources to enhance their competitiveness level. Therefore, in models like ours—i.e., where a composite index number is the only output (**y**) used in the analysis and the specific inputs linked to the output are hard to identify—the use of radial DEA models with a single constant input is appropriate for evaluating the efficiency level of businesses' competitiveness relative to the best practice frontier.

Building on the work by Lovell et al. (1995) and subsequent contributions by, among others, Lovell and Pastor (1999), Liu et al. (2011) and Karagiannis and Lovell (2016), the following linear program computes, at the country level (c), the output-oriented DEA model with one output (i.e., the competitiveness score (Eq. (5)) and a single constant input that evaluates the performance of the competitiveness score among the sampled firms (i):

$$D^c(1, CI^c) = \max\ \theta_i \quad \text{subject to} \quad \begin{array}{ll} \sum_{i=1}^{N}\lambda_i^c CI_{i,m}^c \geq \theta_i CI_{i,m}^c & m = 1, \ldots, M \\ \sum_{i=1}^{N}\lambda_i^c x_{i,k}^c \leq 1 & k = 1, \ldots, K \\ \sum_{i=1}^{N}\lambda_i^c = 1, \quad \lambda_i^c > 0 & i = 1, \ldots, N \end{array} \tag{6}$$

The solution value of in Eq. (6) is the efficiency score computed for the *ith* firm operating in country *c*. Note that for efficient firms 1, while for inefficient firms 1 and 1 points to the degree of inefficiency. Keep in mind that one output ($\mathbf{y}$ = 1,..., $M \wedge M = 1$)—i.e., the competitiveness index (Eq. (5))—is introduced in the model presented in Eq. (6), and that the single constant input (**x**) is a i 1 vector of 1s ($K = 1$). The term $\lambda_i{}^c$ is the intensity weight used to form the linear combinations of the sampled businesses in each country (N), and the restriction $\Sigma_i{}^N{}_{=1}\ \lambda_i{}^c = 1$ imposes variable returns to scale to the technology.

To evaluate the role of the configuration of competitive pillars on efficiency, in the second step we regress the computed inefficiency score (Eq. (6)) against a set of variables related to the business profile and the configuration of competitive pillars (competitive weaknesses and competitive strengths). The truncated regression method is used to estimate coefficients and the full model has the following form:

$$\theta_i = \beta_0 + \beta_1\,\text{Competitive weakness}_i + \beta_2\,\text{Competitive strength}_i + \beta_3\,\text{Small firm}_i + \beta_{13}\,\text{Small firm}_i \times \text{Competitive weakness}_i$$

$$+ \beta_{23}\,\text{Small firm}_i \times \text{Competitive strength}_i + \beta_4\,\text{Firm age}_i + \beta_5\ \text{Country}_i + \varepsilon_i \quad (7)$$

In Eq. (7) the efficiency score (*i*) is the dependent variable, *j* is the vector of parameter estimates computed for the independent variables, and is the error term. Note that, to verify the potentially moderating role of firm size in the relationship between the configuration of competitiveness (strengths and weaknesses) and efficiency, we introduce a dummy variable that takes the value of one for businesses with up to 50 employees in 2017 as a proxy measure of firm size. Also, we added to our model interaction terms between the firm size variables and the variables linked to the configuration of competitiveness. As we indicated in ''The configuration of the system of competencies: competitive strengths and weaknesses and the role of firm size'' section, our approach to competitiveness distinguishes the presence of any focal competency from its level. Thus, the proposed competitiveness measure assumes that competitive strengths and weaknesses are two ends of a common competitive continuum, and that at a particular point in time business competencies are positioned on this competitive continuum. This approach permits to map the configuration of competitiveness which is heterogeneous across businesses, that is, competencies that are cataloged as weaknesses for a business can constitute a competitive strength for another firm.

Following this argument line, we created two variables in order to verify if competitive strengths and weaknesses influence the competitiveness efficiency of the sampled KIBS firms.

To ensure estimation accuracy we first obtained, for each business, the skewness of its ten competitive pillars. The skewness statistic indicates how symmetrically distributed is a set of observed values (Greene, 2003, p. 879). For the purposes of our study, this variable contributes to reveal the configuration of competitive pillars and the sampled businesses were grouped as follows. A left skewed result (negative skew: <0) points to a concentration of values on the right tail of the distribution, which points to the presence of bottleneck competitive pillars (competitive weaknesses). A right skewed distribution (positive skew: >0) suggests that pillars are highly concentrated in the left tail of the distribution of competencies, that is, few high-performing pillars shape competitiveness (competitive strengths). This grouping strategy allows for a strong degree of differentiation, in terms of the configuration of the competitiveness system. Also, a reasonable number of cases fall into each of the categories (competitive strengths = 30 observations, competitive weaknesses = 73 observations).

Because the role of competitive strengths and weaknesses on efficiency is not homogeneous within and between businesses (Arend, 2004; Sirmon et al., 2010), in the second step we created two variables to allow for different slopes in the effects of these two categories of the configuration of competitiveness pillars. First, the variable associated with the level of competitive weakness equals the skewness value for businesses reporting a left skewed distribution (negative skew: <0), and equals zero otherwise. Second, the level of competitive strength equals the skewness value for businesses whose competitive pillars show a right skewed result (positive skew: >0), and equals zero otherwise.

Finally, we include as control variables business age—expressed in years—and a set of country dummy variables that rule out the effects on efficiency of different local economic and country-specific environmental conditions. Descriptive statistics for the study variables are presented in Table 2. Note that in the regression models the efficiency score and the variable linked to firm age are introduced as logged terms in order to minimize potential estimation problems that may arise from their high dispersion.

Empirical results

This section presents the results of the efficiency analysis. Table 3 shows for each country the summary statistics of the efficiency scores (Eq. (6)).

Overall, the findings in Table 3 reveal that, on average, the analyzed KIBS businesses can improve the efficiency of their competitiveness score by 47.43%. Additionally, note that the group of Hungarian businesses shows the poorest results (average inefficiency = 1.6692), while Spanish businesses report the highest efficiency levels (average inefficiency = 1.3426).

Table 4 reports the estimates of the truncated models that regress the efficiency score against the configuration of competitive pillars, firm size and the control variables. Model 1 is the baseline specification which includes the variables linked to competitive strengths and weaknesses, firm size and the control variables. Model 2 includes the main effects of the configuration of competitive pillars (strengths and weaknesses), firm size as well as the interaction terms between firm size and these variables (strengths and weaknesses).

To address the threat of collinearity, we computed the average variance inflation factor (VIF) for all variables. The average VIF value for model 1 is 1.48 and ranges between 1.19 and 2.78, while for model 2 the average VIF is 2.18 (ranging between 1.20 and 4.79). Note that all the VIF values do not exceed 10—a generally accepted rule of thumb for assessing collinearity. The results for this diagnostic test do not raise collinearity concerns.

Concerning the key results of the analysis, from model 1 in Table 4 we note that the coefficient for competitive weaknesses is negative and statistically significant ($_1$ 0.0832 and *p* value 5%), while the parameter for competitive strengths is not significant. Keep in mind that our approach to the configuration of competitiveness assumes that strengths and weaknesses are two ends of a common competitive continuum and that, for each business and at a particular point in time, businesses are positioned on this competitive continuum based on the characteristics of their competitive configuration. In this sense, Fig. 1 offers a graphical representation of the relationship between strengths, weaknesses and efficiency based on coefficients obtained from model 1 in Table 4. In the figure, the vertical axis is the estimated efficiency level, while the horizontal axis indicates the values of the competitive continuum used to evaluate the configuration of competencies. Control variables are set at their sample means.

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Table 2 Descriptive statistics and bivariate correlations.

		Mean	Std. dev.	Min.	Max.	1	2	3	4	5	6	7	8	9
1	Efficiency	1.4743	0.5325	1.0000	5.1685	1								
2	Competitiveness index	5.2136	1.2743	1.3516	8.0163	−0.8014	1							
3	Competitive weakness (skewness < 0)	−0.5126	0.5550	−2.3361	0	−0.1221	0.2410	1						
4	Competitive strength(skewness > 0)	0.1252	0.2783	0	1.8962	0.0077	0.0442	0.4195	1					
5	Small business (dummy)	0.8058	0.3975	0	1	0.0945	−0.2044	0.1844	−0.0939	1				
6	Firm age (years)	13.13	9.83	1	50	−0.0378	0.0937	−0.0181	−0.1231	−0.2395	1			
7	Colombia	0.2524	0.4365	0	1	0.0093	0.0204	−0.0277	0.1455	−0.1103	−0.1242	1		
8	Costa Rica	0.2330	0.4248	0	1	−0.1033	0.1923	0.0184	0.0417	−0.2520	0.2858	−0.3203	1	
9	Hungary	0.2718	0.4471	0	1	0.2247	−0.2572	0.0919	−0.1265	0.1896	−0.0461	−0.3551	−0.3368	1
10	Spain	0.2427	0.4308	0	1	−0.1407	0.0567	−0.0855	−0.0572	0.1634	−0.1081	−0.3290	−0.3120	−0.3459

Sample size = 103 KIBS businesses. Correlations between |0.1407| and |0.1923| are significant at the 10% level, correlations between |0.1924| and |0.2520| are significant at the 5% level, while correlations higher than |0.2520| are significant at 1% level.

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Table 3 Efficiency results: summary statistics.

	Mean	Median	Standard deviation	Q1	Q3	Obs.
Full sample	1.4743	1.3503	0.5325	1.1665	1.6782	103
Colombia	1.4828	1.4337	0.3881	1.1685	1.6864	26
Costa Rica	1.3750	1.3187	0.2792	1.2231	1.4671	24
Hungary	1.6692	1.4957	0.8357	1.1582	1.7152	28
Spain	1.3426	1.2313	0.3398	1.1493	1.4259	25

Table 4 Truncated regression results: the relationship between the configuration of competitiveness (weaknesses and strengths) and efficiency in different types of businesses.

	Model 1	Model 2
Competitive weakness (skewness < 1)	−0.0832 (0.0338)**	
Competitive strength (skewness > 1)	0.0640 (0.0675)	
Small business Competitive weakness (skewness < 1)		−0.1019 (0.0369)***
Small business Competitive strength (skewness > 1)		0.1490 (0.0892)*
Medium and large business Competitive weakness (skewness < 1)		−0.0124 (0.0805)
Medium and large business Competitive strength (skewness > 1)		−0.0647 (0.1058)
Small business (dummy)	0.0700 (0.0455)	−0.0255 (0.0876)
Firm age (ln years)	0.0078 (0.0244)	0.0037 (0.0243)
Country dummies	Yes	Yes
Intercept	0.7427 (0.0945)***	0.8209 (0.1135)***
Log pseudo-likelihood	40.9807	42.1939
Wald test (chi^2)	17.32***	19.47***
Pseudo R^2 (McFadden)	0.1568	0.1811
Average VIF (min−max)	1.48 (1.19−2.78)	2.18 (1.20−4.79)
Observations	103	103

Spain is the omitted country dummy variable. Bootstrapped standard errors are presented in brackets (2000 replications).
* Significance at the 10%.
** Significance at the 5%.
*** Significance at the 1%.

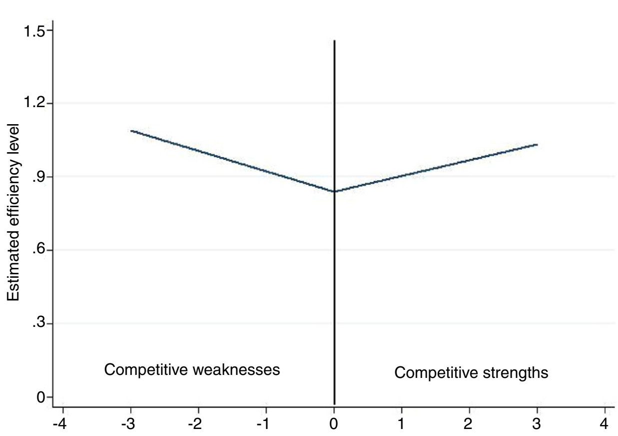

Figure 1 The relationship between competitiveness configuration (weaknesses and strengths) and efficiency
Source: Authors' elaboration based on the truncated regression results (Eq. (7)).

The results indicate that businesses with a weaker configuration of competencies—i.e., with clear competitive weaknesses—show higher inefficiency levels, and that efficiency improves as competitive weaknesses are less influential in shaping competitiveness. Therefore, competitiveness weaknesses are associated with poor competitiveness efficiency.

Once we distinguish between small and medium-large KIBS businesses, the results of the configuration of competitiveness in model 2 of Table 4 reveal two relevant findings. To aid in the interpretation of these results, we plot the variables linked to the configuration of competitive pillars based on estimates from model 2 (Eq. (7)). The results are presented in Fig. 2. Similar to Fig. 1, the vertical axis in Fig. 2 indicates the estimated efficiency level, and the horizontal axis is the competitive continuum used to evaluate the configuration of competencies of the analyzed firms. Control variables are set at their sample means.

First, the pattern of the configuration of competitiveness in model 2 of Table 4 suggests that the negative impact on

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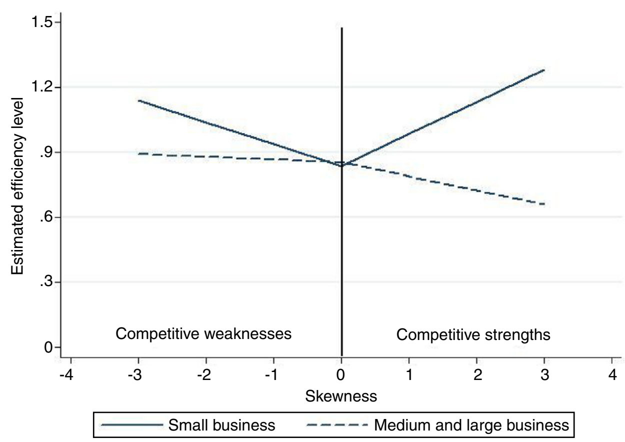

Figure 2 The relationship between competitiveness configuration (weaknesses and strengths) and efficiency in different types of businesses
Source: Authors' elaboration based on the truncated regression results (Eq. (7)).

efficiency of competitive weaknesses is more pronounced in small businesses than medium-large businesses, and that the negative relationship between competitive weaknesses and efficiency is greater among small firms. In the context of the competitiveness index, the result is in line with the view that bottleneck pillars restrain competitiveness. Also, this result suggests the increased vulnerability of small firms to competitive weaknesses related to poor access to critical resources (Sirmon et al., 2010), and to operational and strategic deficiencies (weaknesses) may limit the capacity of businesses for exploiting other valuable competencies (Arora and Cohen, 2015; Douglas and Ryman, 2003).

Second, from Table 4 we observe that the positive effect of competitive strengths on efficiency is only relevant for the group of small firms. Additionally, Fig. 2 graphically illustrates that for small KIBS firms the effect of the configuration of competitive pillars is greater in the part of the competitive continuum where strengths prevail. That is, the relative slope and magnitude of the effect of competitive strengths on efficiency among small firms ($_{23}$ 0.1490 and p value 10%) is steeper than the effect estimated for this variable (competitive strengths) in medium-large businesses ($_{23}$ 0.0647 and p value 10%). This finding highlight that the benefits of competitive strengths are better exploited by organizations (in our case, small firms) that have the capacity to generate a greater number (and more intense) of complementarities between their strong points and other relevant competencies (Fang et al., 2016; Fuchs and Kirchain, 2010).

Concluding remarks, implications and future lines of research

In this study, we adopted a system dynamics approach to develop a managerial tool for evaluating business competitiveness. Building on insights from the RBV and the configuration theories, competitiveness is conceptualized as a multidimensional construct that results from the mutually dependent associations between resources and capabilities (Barney, 2001; Prahalad and Hamel, 1990). Understanding the drivers of competitiveness is at the heart of strategic management, and the novelty of our work relies in the analysis of competitiveness from a systemic perspective rather than analyze the individual contribution of certain resources and capabilities.

The results of the regression analysis connecting efficiency—computed via a DEA model—to the configuration of competitive pillars—i.e., the position of the configuration of competitive pillars on a competitive continuum—reveal a heterogeneous effect of competitive strengths and weaknesses on the efficiency level of small and medium-large firms.

The findings of this study have relevant implications for scholars and strategy makers. From an academic perspective, prior work has largely focused on the analysis of value-adding, hard-to-imitate competencies because they constitute a source of competitive advantage (Newbert, 2007). Nevertheless, the analysis of the role played by competitive weaknesses has recently gained increased attention among scholars (Arend, 2004; Sirmon et al., 2010). By employing a competitive continuum approach to detect the presence and the intensity level of competitive strengths and weaknesses on an international sample of KIBS firms, the proposed study of the efficiency level of business competitiveness underlines the importance of taking into account the heterogeneity of businesses' resources and capabilities—i.e., strengths and weaknesses—in competitiveness analyses.

Additionally, our analysis of the role of competitive strengths and weaknesses in different types of firms—i.e. small and medium-large firms—fuels the scholarly debate both on the need to consider the multidimensionality of competitiveness in performance assessment models (Sirmon et al., 2010), and on the relevance of acknowledging business-specific sources of heterogeneity that can affect business competitiveness (Fang et al., 2016; Fuchs and Kirchain, 2010; Robinson and Simmons, 2018).

For strategy makers, we suggest that managers need to turn their attention to the characteristics of their businesses' operations and resource endowments when considering the introduction of strategic changes oriented to modify the business' competitive level.

Our results show that the positive relationship between competitive strengths and efficiency is more important for small businesses. Also, for small firms is more important to mitigate their competitive weaknesses and move toward a more balanced configuration of their competitive pillars on the competitive continuum. These results highlight the relevance of internal analyses. Drastic changes in the configuration of competitiveness pillars may have dissimilar effects on the competitive efficiency of businesses. The results show how important information is when it comes to undertake business-specific competitive-enhancing actions. By conducting a profound analysis of the configuration of competitive pillars, managers will be in a better position both for understanding the potential value of specific investments and for determining the strategy making of the organization.

A series of limitations to the present study should be mentioned. These limitations represent avenues for future research. First, like other studies on competitiveness (see, e.g., Douglas and Ryman, 2003; Aral and Weill,

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2007; Sirmon et al., 2010), the data do not permit the direct analysis of the underlying competitiveness-enhancing processes. We present various interpretations of how competitive strengths and weaknesses impact efficiency; however, we do not assess the processes through which managers and employees acquire or develop— individually or collectively—new resources or capabilities and channel these to the business. Further research on this issue would be valuable. For example, future studies should evaluate the response of organization members to incentives created within the business, and determine the conditions under which businesses implement competitiveness-enhancing actions and how different business characteristics—e.g., size, type of operational processes—condition these processes. Second and strictly related to the previous comment, future research should further evaluate our argument on the differentiated impact on efficiency of competitive strengths and weaknesses in small viz.-a-viz. medium-large businesses.

Third, it should be noted that underlying our approach to competitiveness is the assumption that the ten competitive pillars are equally relevant in shaping the competitiveness index. However, the relative importance of competitive pillars is heterogeneous across businesses or industries, and even across countries. In this sense, future research should evaluate the effectiveness of the proposed index to measure competitiveness using techniques, such as the benefit-of-the-doubt method (Cherchye et al., 2007), that allow to compute business-specific (endogenous) weights for the analyzed competitive pillars.

Finally, the findings in this study are based on the analysis of a reduced number of KIBS firms in four countries. Obviously, the findings of this study are not generalizable to all SMEs or to all KIBS firms. The sampled businesses could have idiosyncratic characteristics (other than firm size) that impacted their competitiveness and efficiency level. Nevertheless, the results presented in this study have a strong intuitive and conceptual appeal, and are open to future verification. In this sense, future work should evaluate our arguments on how the configuration of competitive pillars affect efficiency in KIBS and non-KIBS firms using data for a wider array of industries operating in different geographic contexts.

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Appendix A.

Table A1.

Table A1 Description of the variables used to build the pillars that form the competitiveness index.

Competitiveness pillar	Variables included in the pillar
1. Human capital	The number and share of employees with higher education degree
	The problems with employees
	The share of employees participating in training programs
	The sophistication of compensation systems
	The uniqueness of human capital
2. Product	Product innovation
	Activities/effort concerning the introduction of new or amended product
	The share of new product in sales
	The uniqueness of firm's product and continuous innovation
3. Domestic market	The geographic scope of selling in Hungary
	The level of firm's competition in the market
	The expected growth of the target market in five years
	The intensity of competition
	Quick response to costumers' demand
4. Networks	The number of economic cooperation and innovation agreements
	The time of networking as compared to the establishment of the firm
	The reliance to outside help in business development
	Uniqueness of networking relationship
5. Technology	The level of firm's technology in Hungary
	The age of available technology used by the firm and technological innovation
	Environmental investment and quality assurance
	The level of application of ICT tools
	Uniqueness of applied technology, possession of license or know-how, product management and quality assurance
6. Decision making	The application of the different sources of information
	The application of financial analyses in the business
	Information sharing
	Consultation in decision making
	Administrative routines/operations
	knowledge sharing of the business organization

Table A1 (*Continued*)

Competitiveness pillar	Variables included in the pillar
7. Competitive strategy	The direction of strategy (defensive, proactive) Growth strategy based on the number of business units The leader's entrepreneurial traits The uniqueness of firm' proactive strategy
8. Marketing	The product The pricing of the main product Sophistication of distribution channels Applied marketing and communication tools Marketing innovation The uniqueness of marketing methods
9. Internationalization	The significance of foreign buyers The share of export in sales Language capabilities at business level The uniqueness of location
10. Online presence	Webpage technical characteristics Webpage offered services Webpage content Online marketing applications

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.brq.2019.02.002.

References

Aral, S., Weill, P., 2007. IT assets, organizational capabilities, and firm performance: how resource allocations and organizational differences explain performance variation. Organ. Sci. 18 (5), 763–780.
Arend, R.J., 2004. The definition of strategic liabilities, and their impact on firm performance. J. Manage. Stud. 41 (6), 1003–1027.
Arora, A., Cohen, W.M., 2015. Public support for technical advance: the role of firm size. Ind. Corp. Change 24 (4), 791–802.
Atkinson, K.E., 2008. An introduction to Numerical Analysis. John Wiley & Sons.
Barney, J.B., 1991. Firm resources and sustained competitive advantage. J. Manage. 17 (1), 99–120.
Barney, J.B., 2001. Resource-based theories of competitive advantage: a ten-year retrospective on the resource-based view. J. Manage. 27 (6), 643–650.
Belderbos, R., Sleuwaegen, L., 2005. Competitive drivers and international plant configuration strategies: a product-level test. Strategic Manage. J. 26, 577–593.
Cherchye, L., Moesen, W., Van Puyenbroeck, T., 2004. Legitimately diverse, yet comparable: on synthesizing social inclusion performance in the EU. J. Common Market St. 42, 919–955.
Cherchye, L., Moesen, W., Rogge, N., Van Puyenbroeck, T., 2007. An introduction to 'benefit of the doubt'composite indicators. Soc. Indic. Res. 82 (1), 111–145.
Cooper, W.W., Seiford, L.M., Zhu, J., 2011. Handbook on Data Envelopment Analysis, 2nd edition. Springer, New York.
Cusumano, M.A., Kahl, S.J., Suarez, F.F., 2015. Services, industry evolution, and the competitive strategies of product firms. Strategic Manage. J. 36 (4), 559–575.
Douglas, T.J., Ryman, J.A., 2003. Understanding competitive advantage in the general hospital industry: evaluating strategic competencies. Strategic Manage. J. 24 (4), 333–347.
European Commission, 2012. Knowledge-Intensive (Business) Services in Europe. Publications Office of the European Union, Luxembourg.
Fang, H.C., Randolph, R.V., Memili, E., Chrisman, J.J., 2016. Does size matter? The moderating effects of firm size on the employment of nonfamily managers in privately held family SMEs. Entrep. Theory Pract. 40 (5), 1017–1039.
Fernhaber, S., Patel, P., 2012. How do young firms manage product portfolio complexity? The role of absorptive capacity and ambidexterity. Strategic Manage. J. 33, 1516–1539.
Fuchs, E., Kirchain, R., 2010. Design for location? The impact of manufacturing offshore on technology competitiveness in the optoelectronics industry. Manage. Sci. 56, 2323–2349.
Greene, W., 2003. Econometric Analysis, 5th edition. Upper Saddle River, New Jersey.
Grifell-Tatjé, E., Lovell, C.A.K., 2015. Productivity Accounting: The Economics of Business Performance. Cambridge University Press, New York.
Julien, P.A., Ramangalahy, C., 2003. Competitive strategy and performance of exporting SMEs: an empirical investigation of the impact of their export information search and competencies. Entrep. Theory Pract. 27 (3), 227–245.
Karagiannis, G., Lovell, C.A.K., 2016. Productivity measurement in radial DEA models with a single constant input. Eur. J. Oper. Res. 251 (1), 323–328.
Kingsley, G., Malecki, E.J., 2004. Networking for competitiveness. Small Bus. Econ. 23 (1), 71–84.
Lafuente, E., Szerb, L., Rideg, A., 2016. A system dynamics approach for assessing business competitiveness. In: Working Paper presented at the 30th RENT Conference, Belgium, November 16th–18th. University of Antwerp.
Lafuente, E., Vaillant, Y., Leiva, J.C., 2018. Sustainable and traditional product innovation without scale and experience, but only for KIBS! Sustainability 10 (4), 1169.
Lafuente, E., Vaillant, Y., Vendrell-Herrero, F., 2017. Territorial servitization: exploring the virtuous circle connecting knowledge-intensive services and new manufacturing businesses. Int. J. Prod. Econ. 192, 19–28.
Lazear, E.P., 2004. Balanced skills and entrepreneurship. Am. Econ. Rev. 94 (2), 208–211.
Lederer, M., Schott, P., Huber, S., Kurz, M., 2013. Strategic business process analysis: a procedure model to align business strategy with business process analysis methods. In: S-BPM ONE-Running Processes. Springer, Berlin Heidelberg, pp. 247–263.
Liu, W.B., Zhang, D.Q., Meng, W., Li, X.X., Xu, F., 2011. A study of DEA models without explicit inputs. Omega 39, 472–480.
Lo, S.-F., 2010. The differing capabilities to respond to the challenge of climate change across annex parties under the Kyoto protocol. Environ. Sci. Policy 13, 42–54.
Lovell, C.A.K., Pastor, J.T., 1999. Radial DEA models without inputs or without outputs. Eur. J. Oper. Res. 188 (1), 46–51.
Lovell, C.A.K., Pastor, J.T., Turner, J.A., 1995. Measuring macroeconomic performance in the OECD: a comparison of European and non-European countries. Eur. J. Oper. Res. 87, 507–518.
Man, T.W.Y., Lau, T., Chan, K.F., 2002. The competitiveness of small and medium enterprises: a conceptualization with focus on entrepreneurial competencies. J. Bus. Venturing 17, 123–142.
Miller, D., 1986. Configurations of strategy and structure: towards a synthesis. Strategic Manage. J. 7, 233–249.

Miller, D., 1996. Configurations revisited. Strategic Manage. J. 17, 505–512.
Miller, D., Whitney, J.O., 1999. Beyond strategy: configuration as a pillar of competitive advantage. Bus. Horiz., 5–17, May-June.
Mizobuchi, H., 2014. Measuring world better life frontier: a composite indicator for OECD better life index. Soc. Indic. Res. 118, 987–1007.
Newbert, S., 2007. Empirical research on the resource-based view of the firm: an assessment and suggestions for future research. Strategic Manage. J. 28 (2), 121–146.
Newbert, S., 2008. Value, rareness, competitive advantage, and performance: a conceptual-level empirical investigation of the resource-based view of the firm. Strategic Manage. J. 29 (7), 745–768.
Nunnally, J.C., Bernstein, I.H., 1994. Psychometric Theory. McGraw-Hill, New York.
O'Cass, A., Weerawardena, J., 2010. The effects of perceived industry competitive intensity and marketing-related capabilities: drivers of superior brand performance. Ind. Market. Manage. 39 (4), 571–581.
Odeck, J., 2006. Identifying traffic safety best practice: an application of DEA and Malmquist indices. Omega 34, 28–40.
Opresnik, D., Taisch, M., 2015. The value of big data in servitization. Int. J. Prod. Econ. 165, 174–184.
Prahalad, C.K., Hamel, G., 1990. The core competence of the corporation. Harv. Bus. Rev. 68 (May–June), 79–91.
Priem, R., Butler, J., 2001. Is the resource-based 'view' a useful perspective for strategic management research? Acad. Manage. Rev. 26, 22–40.
Robinson, C.V., Simmons, J.E., 2018. Organising environmental scanning: exploring information source, mode and the impact of firm size. Long Range Plann. 51 (4), 526–539 (in press).
Sirmon, D.G., Hitt, M.A., Arregle, J.L., Campbell, J.T., 2010. The dynamic interplay of capability strengths and weaknesses: investigating the bases of temporary competitive advantage. Strategic Manage. J. 31 (13), 1386–1409.
Soares de Mello, J.C.C.B., Angulo-Meza, L., Branco da Silva, B.P., 2009. A ranking for the Olympic games with unitary input DEA models. IMA J. Manage. Math. 20, 201–211.
Tarabusi, E.C., Guarini, G., 2013. An unbalance adjustment method for development indicators. Soc. Indic. Res. 112 (1), 19–45.
Wernerfelt, B., 1984. A resource-based view of the firm. Strategic Manage. J. 5 (2), 171–180.
West, G.P., De Castro, J., 2001. The Achilles heel of firm strategy: resource weakness and distinctive inadequacies. J. Manage. Stud. 38 (3), 417–442.

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