Determinants of Absorptive Capacity: a systematic literature review

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RESUMO

Objetivo – Apresentar uma revisão da literatura sobre os determinantes da Capacidade de Absorção (CA), que possibilita os *spillovers* de produtividade oriundos dos Investimentos Diretos Estrangeiros (IDE) em países desenvolvidos e em desenvolvimento.

Arcabouço teórico – Esta pesquisa baseia-se na literatura de que, antes de se beneficiar de *spillovers*, empresas precisam de um nível mínimo de conhecimento e de capacidades.

Método – Uma Revisão Sistemática de Literatura (RSL) dos estudos empíricos sobre CA e *spillovers* de produtividade é apresentada. No total, 60 artigos foram analisados.

Resultados – A RSL revelou que capital humano e investimentos em P&D são os determinantes mais citados. P&D é particularmente importante para países em desenvolvimento.

Implicações práticas e sociais – Políticas públicas voltadas ao desenvolvimento do P&D podem ser estratégias facilitadoras de *spillovers* de produtividade em países em desenvolvimento.

Originalidade – Este artigo analisa os determinantes da CA enquanto considera como tanto os países desenvolvidos e em desenvolvimentos podem se beneficiar do IDE, o que é de suma importância considerando o crescimento do IDE em países em desenvolvimento.

Palavras-chave – Investimento Direto Estrangeiro. Produtividade. *Spillover*.

ABSTRACT

Purpose – To conduct a literature review on the determinants of Absorptive Capacity (AC), which allows for productivity spillovers from Foreign Direct Investment (FDI) in developed and developing countries.

Theoretical framework – This study is based on the literature indicating that before benefiting from spillovers, companies need a certain level of knowledge and expertise.

Design/methodology/approach – A Systematic Literature Review (SLR) of empirical studies on AC and productivity spillovers is presented. A total of 60 articles were reviewed.

Findings – The SLR revealed that human capital and R&D investments are the most frequently cited determinants of AC. R&D is especially important for developing countries.

Research, Practical & Social implications – Public policies targeting R&D development may be a valuable strategy to facilitate productivity spillovers in developing countries.

Originality/value – This paper analyzes the determinants of AC while verifying how both developed and developing countries can benefit from FDI, which is of great importance considering the growth of FDI in developing countries.

Keywords - Foreign Direct Investment. Productivity. Spillover.

1. INTRODUCTION

Absorptive Capacity (AC) is one of the most influential concepts in management literature. AC was first introduced by Cohen and Levinthal (1989) and then developed by Zahra and George (2002) in the context of learning and innovation of a company, and is currently a keyword for a variety of strategies, administrative routines, and learning processes that influence a company's ability to exploit the external knowledge needed to build other organizational capacities (TODOROVA; DURISIN, 2007; ZAHRA; GEORGE, 2002).

Cohen and Levinthal (1990) and Malaguerra (2014) define AC as the ability to recognize, assimilate, and apply new information for commercial purposes. Lapan and Bardhan (1973) point out that companies need a certain level of AC before benefiting from technologies developed by other companies. Malaguerra (2014) states that AC is important in all countries, especially for countries that seek to approach the technological frontier.

Most studies typically measure AC with R&D proxies, therefore ignoring other dimensions and their implications for different organizational results. Thus, the variables do not establish a time horizon or frequency of activities and carry an R&D bias, which is not the only possibility of using external knowledge. Yet, they establish multiple indicators for capacity based on processes/routines, and the measures are benchmarked, qualifying the level of AC.

Accordingly, the necessity to use knowledge and technologies from external sources is increasing, as they become a vital component of national innovation processes (GRIMPE; SOFKA, 2008; KING; LAKHANI, 2011), allowing companies to increase their resource base and adapt to the market (ZAHRA; GEORGE, 2002). Therefore, Smeets (2008) emphasizes that AC determines the intensity and signal of spillovers.

Lapan and Bardhan (1973) argue that companies need a specific AC before they benefit from other companies' technologies. Cohen and Levinthal (1989) argue that increasing R&D activity increases efficiency indirectly by accelerating the assimilation of technologies developed elsewhere.

Amidst this debate, the ability to attract Foreign Direct Investment (FDI), according to Sari *et al.* (2016), can bring immense benefits to the host country. FDI refers to an investment that seeks to acquire a lasting interest in a company whose exploration takes place in a foreign country, and the investor intends to influence the company's management (IMF, 1998). In

sum, these incoming multinational corporations provide direct and indirect benefits to the host economy. According to Barro and Sala-i-Martin (1997), FDI can positively contribute to the convergence of developed and developing countries, and these investments particularly increase imitation activities in developing countries. The direct benefits of foreign affiliates can result in new investments, productive capacity, demand for labor, demand for intermediate goods, and sometimes exports that stimulate national income or economic growth, therefore providing new opportunities while increasing tributary revenues (TAKII, 2005). Therefore, FDI is perceived as a knowledge source for the economy, and, in many cases, has been an essential element in economic development strategies. Thus, it is necessary to analyze the determinants of AC to maximize the effects of spillover from FDI on the productivity of nations.

In this context, this article aims to perform a Systematic Literature Review (SRL) on the determinants of AC in developed and developing countries aiming towards productivity spillovers deriving from FDI. It is noteworthy that FDI has increased significantly for developing countries over the past two decades. This significantly increased importance has received particular attention in discovering the relationship between FDI and economic growth in the host country. In this way, finding out the factors that impact the incoming FDI volume in a given economy and the effects of that capital on the receiving nation's economic growth is critical since these impacts may be conditioned to the host country.

The results obtained have direct implications for the future formulation of industrial policies to attract FDI and programs encouraging the competitiveness of national industries by increasing their total productivity. Specifically, the now identified determinants of AC will serve as targets to be achieved prior to a possible FDI attraction policy to enhance positive productivity spillovers, and to avoid negative spillovers relative to competition for the domestic industry.

This study is organized into three sections besides this introduction. Section 2 presents the Systematic Literature Review (SLR) technique. Section 3 brings the results and discussions of this paper. Finally, section 4 presents the concluding remarks.

2. METHODOLOGICAL PROCEDURES

A systematic literature review provides a methodical, explicit, and replicable synthesis of a given topic (REIM *et al.*, 2015). SLR is a vital research endeavor by itself and not merely

a review of previous writings. It responds to specific research questions, and is a method that locates existing studies, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in a way that allows reasonably clear conclusions to be reached about what is and is not known (DENYER; TRANFELD, 2009).

We applied the Systematic Literature Review (SLR) technique to analyze the main determinants that influence the AC and its impact on productivity. We used the Scopus and Web of Science databases to represent the most important studies in this research field. Note that these databases were chosen as they have the most extensive global collections of articles and publishers, and have been used in several other systematic literature reviews. The next subsection presents the literature review procedure *Knowledge Development Process – Constructivist* (ProKnow-C) applied for the articles' selection and analysis.
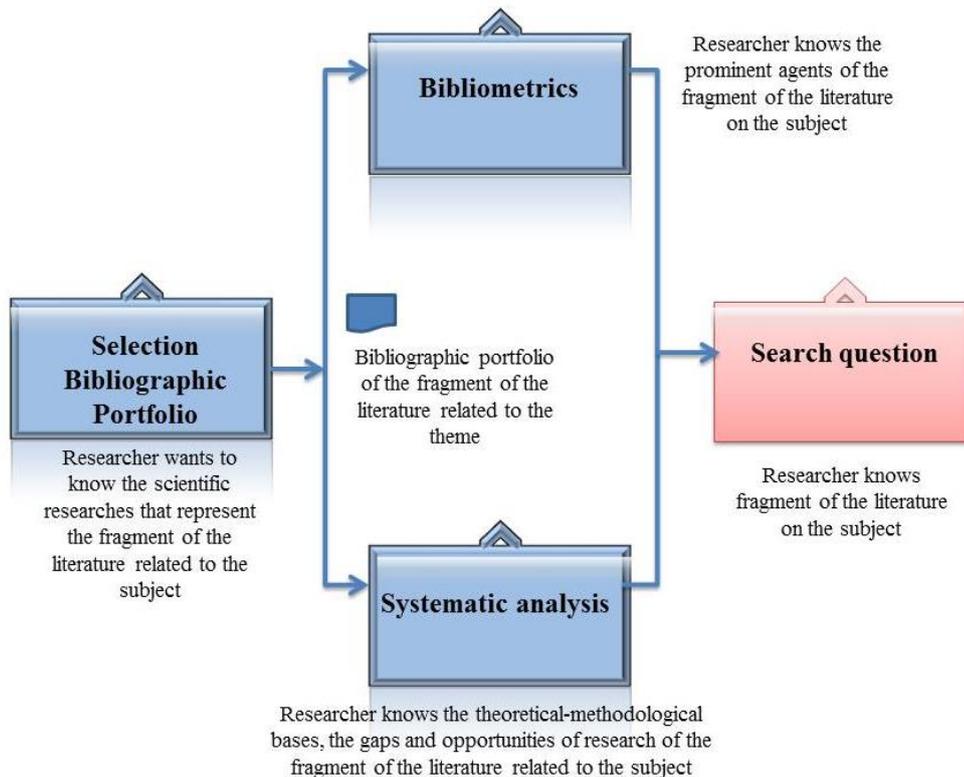
2.1 ProKnow-C

For the selection of scientific publications, the Knowledge Development Process-Constructivist (ProKnow-C), developed by the Laboratory of Multicriteria Decision Support Methodologies (LabMCDA), Federal University of Santa Catarina (UFSC), was used as an intervention tool. ProKnow-C has already been used in other studies that have investigated a multitude of topics (NUERNBERG *et al.*, 2016; CARDOSO *et al.*, 2016; AFONSO *et al.*, 2012; LACERDA *et al.*, 2012). Lacerda *et al.*, (2012), Ensslin *et al.*, (2012) and Rosa *et al.*, (2012) claim that the identification of relevant articles that generate knowledge and support the conduct of scientific research has become very complex given the abundance of information available.

ProKnow-C has the main goal of providing knowledge about a fragment of scientific literature. The instrument leads the researcher (i) to select a Bibliographic Portfolio (PB) of scientific and relevant articles that answer the research topic; (ii) to perform an investigation and an analysis of the characteristics of this PB (*i.e.,* bibliometric analysis); (iii) to critically reflect on the position of the studies, based on the theoretical affiliation established by the researcher (*i.e.,* systematic analysis); and (iv) to point out the gaps and opportunities of future research, based on the knowledge generated in the previous two stages. All the steps require the active participation of the researcher for its accomplishment. Thus, the constructivist process occurs and evolves based on the interests and delimitations established by the

researcher (SILVA *et al.*, 2014; DUTRA *et al.*, 2015). Therefore, the process is composed of four stages, as shown in Figure 1.

Figure 1 - Stages of the ProKnow-C methodology

Source: the authors (2020).

In order to reach the objective of the research, only the first 3 main stages (in blue) of the ProKnow-C tool were applied since the objective of this review is not to analyze points that have not yet been studied by authors but to analyze the determinants of AC considering the studies already carried out. Thus, to carry out the first three stages of the methodology, each stage was broken down into steps.

Stage 1 – Selection of the Bibliographic Portfolio

- Step 1: Refine the main keywords through a network of keyword co-occurrence;
- Step 2: Evaluation of articles published in the main databases, using a set of pre-established keywords.

Stage 2 - Bibliometrics

- Step 1: Screening of articles found by reading their titles and abstracts (filter);

- Step 2: Selection of publications for in-depth analysis;
- Step 3: Building the profile of the scientific production of each selected article, identifying the main research strategies.

Stage 3- Systematic Analysis

- Step 1: Analysis of the scope of each selected article;
- Step 2: Selection of determinants. In this case, these are the variables cited as capable of affecting the AC, and therefore were selected as proxies of the AC.

3. SYSTEMATIC LITERATURE REVIEW

This section represents the methodological characterization of the ProKnow-C that was applied for the selection and analysis of articles.

3.1 Methodological characterization

Research based on Production Engineering usually begins with selecting scientific documents for the composition of the theoretical foundation and to identify the gaps in the literature (CAUCHICK *et al.*, 2010). Faced with the number of scientific articles currently available, one of the researcher's difficulties is to find out which studies are relevant for the field.

This research is characterized as a qualitative and quantitative approach (GREENER, 2008; CRESWELL, 2007). Our study is considered qualitative because it comprises procedures to obtain a portfolio of scientific articles. This analysis is based on the perception of the researchers who lead the study. Complementary, this study is quantitative because it seeks identifiable and observable objective facts, through the use and manipulation of numbers, both regarding the procedures pertinent to the identification of the bibliographic portfolio (for example, to analyze the scientific recognition of the articles) and the bibliometric analysis of this portfolio.

From this perspective, this research is inductive because it aims to generate knowledge - a theoretical framework for scientific research - from the identification of studies closely related to the determinants of AC (GREENER, 2008). As for the technical procedures, the research is characterized as bibliographical (RICHARDSON; PERES, 1999), and the data sources are secondary since all the information was obtained from scientific publications.

3.2 Selection Bibliographic Portfolio

In this section, we present the bibliographic portfolio to achieve the relevant articles about AC. Moreover, we describe the number of studies found using the bibliographic portfolio.

3.2.1. Selection bank gross articles

The selection of studies is a crucial step to achieve a reliable database which represents the most important studies in a research field. In this sense, we used a protocol with four keywords applied to two research databases. Moreover, we limited our analysis to documents written as article type (which is the most common way to transmit knowledge within the scientific community) and in English. We did not limit the number of analyzed years to guarantee that all articles in this research field appear in our database. Our search shows that 960 articles are available. Table 1 summarizes our protocol.

Table 1 - ProKnow-C Phase - Selection of the gross articles bank

ProKnow-C Phase	International Portfolio
Gross Items Bank Selection	
Consulted databases	Scopus and Web of Science
Keywords	Productivity AND Absorptive Capacity knowledge Spillover AND Absorptive Capacity
Delimitation	Type of publication: Journal article English language Time limit: not limited
Date of consultation	March 2018
Results	960 articles

Source: the authors (2020).

3.2.2. Article bank filtering

For the filtering stage, an SLR protocol was generated, which is presented in Appendix A with the main information about the research. The protocol includes the strategies used for searching and selecting primary studies, the criteria and procedures for selecting the studies, and the process of study selection. Table 2 shows the number of papers selected in the databases in detail.

Table 2 - ProKnow-C Phase - Filtering articles

Criteria for analysis	Scopus	Web of Science
Articles identified with keywords	219	741
Selected papers after summary analysis	55	40
Number of papers shared in both databases		35
Total articles reviewed		60

Source: the authors (2020).

From the selected articles, 18.33% (11 articles) of the sample presented a nationwide study population, encompassing several countries (ALDIERI *et al.*, 2018; FOSTER-MCGREGOR *et al.*, 2017; KHORDAGUI; SALEH, 2016; HUEBLER *et al.*, 2016; KRAMMER, 2010; KELLER, 2010). These articles will be analyzed separately since the study population of countries is our focus of study.

The articles previously mentioned used the panel data structure. Of the entire sample, 50 articles (83.3%) used panel data, 5 articles (8.3%) cross-section data, and 5 articles (8.3%) were not mentioned, including this one literature review.

Of the sample, 31.6% (19 articles) analyzed developed countries, 56.6% (34 articles) focused on emerging countries, and 11.6% (7 articles) did not identify the study population, were literature reviews, or worked with several non-explicit countries or regions.

3.2.3 Test of the representativeness of the bibliographic portfolio

The number of citations is a useful tool for identifying the most important studies. However, recent articles did not have enough time to become prominent articles. Table 3 shows the fifteen most cited articles among the 60 selected, along with the number of citations in the Scopus and Web of Science databases in March 2018.

Table 3 - Fifteen articles most cited in the literature.

Author(s)/Year	Citations in Scopus	Citation in Web of Science
Girma (2005)	182	149
Zhang *et al.* (2010)	116	109
Barrios and Strobl (2002)	58	47
Keller (2010)	49	**
Marcin (2008)	39	19
Ahmed (2012)	28	15
Higoacuten and Vasilakos (2011)	22	4
Krammer (2010)	16	**

Caragliu and Nijkamp (2012)	20	18
Anwar and Nguyen (2014)	17	**
Miguelez and Moreno (2015)	15	12
Augier *et al.* (2013)	14	12
Qi et al (2009)	13	10
Sánchez-Sellero *et al.* (2014)	11	11
Hamida (2013)	10	8

**article not in the base
Source: the authors (2020).

Among the selected articles, the most cited were Girma (2005) and Zhang *et al.* (2010). Girma (2005) examined the relationship between AC and technology spillovers using enterprise-level data from the UK manufacturing industry. Zhang *et al.* (2010) analyzed the effect of the diversity of origins of FDI countries on domestic firms' productivity. It should be added that pioneering articles such as Barrios and Strobl (2002) and Marcin (2008) also show numerous citations. Figure 2 illustrates this result.

Figure 2 - Fifteen most cited articles in the literature
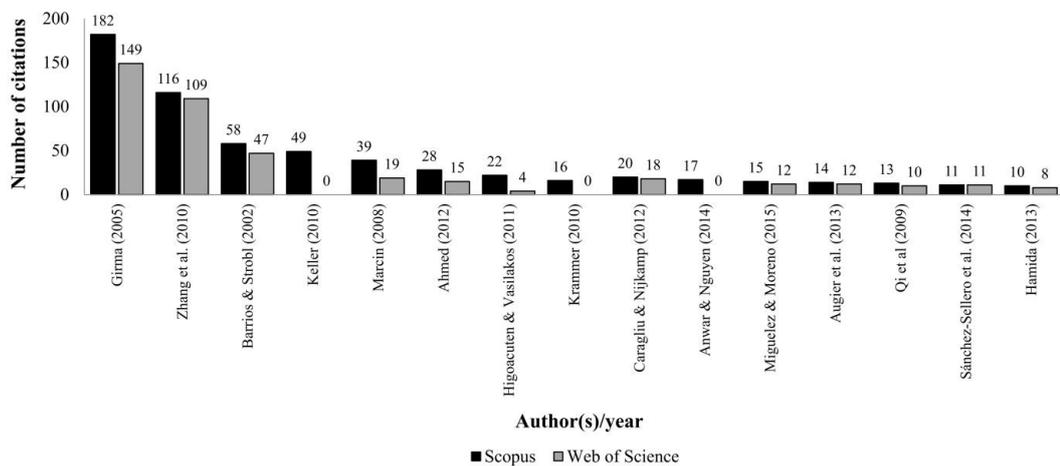
Source: the authors (2020).

In contrast, some recent studies bring new insights in this research field, such as Sánchez-Sellero *et al.* (2014) and Hamida (2013). Sánchez-Sellero *et al.* (2014) was found that R&D activities increase the generation of new knowledge and the FDI absorptive capacity. Internal R&D activities have the most positive effect; outsourced activities have a negative impact. This explains the decision to outsource R&D for small innovations that

require unspecified investments. In Hamida (2013), the results show that only local companies that have thoroughly invested in AC benefit from spillovers, mainly due to technology transfer. This benefit appears to occur both at the regional and external levels.

Girma (2005), the most cited, examined the relationship between AC and technology spillovers using company-level data from the UK manufacturing industry and used the threshold regression model, while Hamida (2013) used the regional FDI distribution to test regional and inter-regional spillovers, however the aim was to adapt the production function. Girma's differential was the use of the threshold model. Furthermore, the bibliometric analysis is an important tool to describe the studies under analysis. The next section brings some findings.

3.3 Bibliometric portfolio analysis

Bibliometry is characterized by the quantitative disclosure of a bibliographic portfolio's statistical data that aims to manage the information and the scientific knowledge of a specific subject through document counting (ENSSLIN *et al.*, 2010). In this study, bibliometrics involve the analysis of journals, publications per year, and publications by geographic regions.

Figure 3 shows the degree of relevance of the journals in the bibliographic portfolio. In other terms, this analysis shows which journals stand out by the number of published articles. Seven international journals present a relevant number of publications. The Journal Economics of Innovation and New Technology stands out for 4 published articles (FOSTER-MCGREGOR *et al.*, 2017; BEHERA, 2017; BLOCH, 2013; LOPEZ-GARCIA; MONTERO, 2012), followed by the Research Policy journal with 3 published articles (QIU; LIU; GAO, 2017; LIANG, 2017; MIGUELEZ; MORENO, 2015).

The articles published on the Economics of Innovation and New Technology present studies that examine the occurrence of productivity spillovers from Foreign Direct Investment (FDI) as well as the role of AC in this process. Also, studies published on the Research Policy analyze how high CA regions make the most of external flows of knowledge and information through mobility and networks of inventors, as well as exploring how industrial links, resources and the location of domestic geographic companies affect the diffusion of technology brought about by FDI.

Figure 3 - Relevance of journals
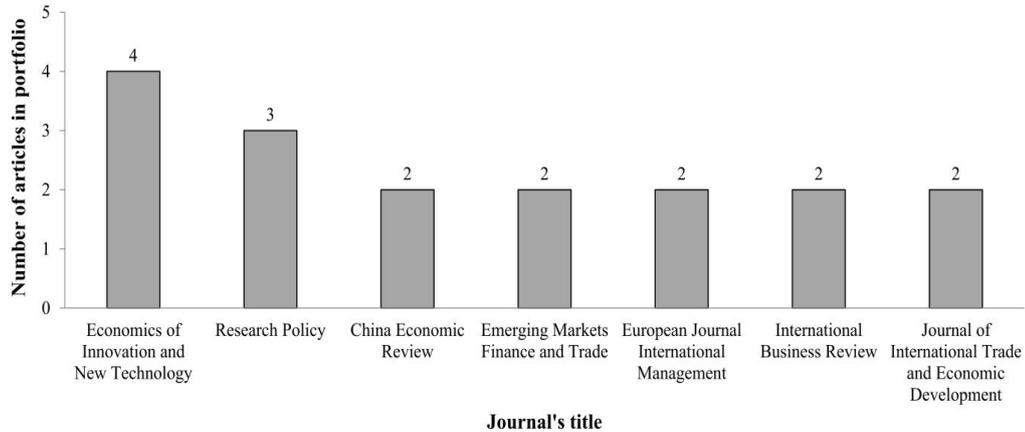
Source: the authors (2020).

It is noteworthy that some journals are specific for developing countries, such as China Economic Review and Emerging Markets Finance and Trade. This is a piece of evidence that the AC subject is an important approach to developing economies. Moreover, we found the European Journal International Management among journals with the most published articles in AC, revealing that this field is also relevant for developed economies.

Figure 4 shows the number of papers published in the bibliographic portfolio, highlighting the year 2017 with the highest number of publications. It is noteworthy that the year 2018 was not completed, given the possibility of increasing the number of the same publications. We found little variation in the number of publications between 2000 and 2009, which corresponds to only one study per year. In contrast, between 2010 and 2015, we found a higher number of publications on AC from 3 to 6 publications per year. More importantly, the years 2016-2017 highlight the growing attention that AC has been receiving by the research community. In 2016, 10 studies were published in this research field. Moreover, in 2017, 17 studies were published analyzing the AC approach. This finding reveals a larger number of studies in the last years, which confirms an upward curve in the number of publications.

Figure 4 - Number of papers published per year
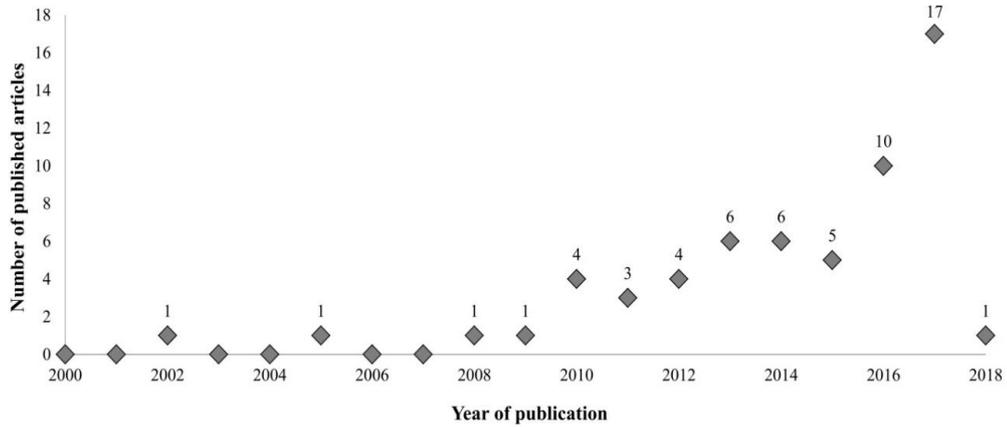
Source: the authors (2020).

Figure 5 reports the number of articles published by geographical region. Surprisingly, we found that 22,7% of the studies analyzed are from China. Other studies analyzed countries like Spain (13,6%), Turkey (9,1%), South Korea (6,8%), the USA (4,5%), Malaysia (4,5%), UK (4,5%), and Russia (4,5%). It is noteworthy that Latin American and African countries are under-represented in geographical distribution. More studies about AC are required in countries like Brazil, South Africa, Bolivia, Peru, Ghana, and Ethiopia, among others. Furthermore, more investigation is necessary to understand the lack of studies in these regions.

Figure 5 - Number of papers published by geographic regions
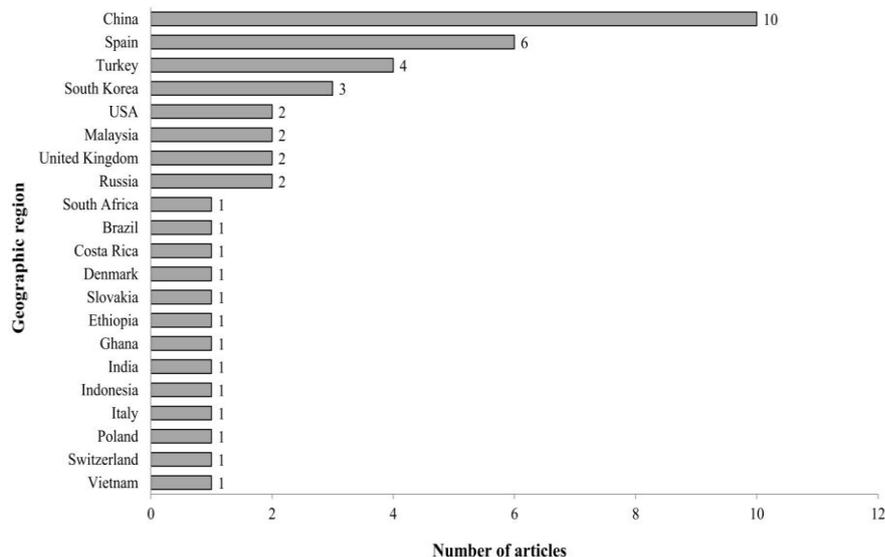
Source: the authors (2020).

3.4 Systemic analysis

Table 4 shows an analysis of the focus and main results/contributions of the 11 articles that presented the study population at the national level, being of relevance for this study, since this one is emerging and developed countries.

Table 4 - Analysis of the focus and main results/contributions of the 11 articles that presented study population at national level.

Author(s)/Year	Objective	Main results	Limitations, contributitions and/or originality
Aldieri *et al.* (2018)	Exploring how firm-level AC mediates the relationship between rent and spillovers of R&D on the one hand and turnover in another in three economic areas (Europe, Japan and the USA).	The empirical results suggest that, at the same level of AC, firms in economic areas closer to the global technological frontier tend to benefit more from pure spillovers than from rent spillovers. Conversely, companies located in areas that are not on the frontier of technology seem to benefit primarily from rental spillovers that travel along the supply chain. These results suggest that AC changes with the type of knowledge to which they can be exposed.	This article contributes to the existing literature on AC in several ways: first, it shows that the nature of knowledge issues and that companies specialize in acquiring and processing specific types of knowledge. Second, it provides a potential explanation as to why some companies appear to benefit from some types of spillovers over others and relate these differences to the characteristics of absorbed knowledge. Finally, it provides some suggestive evidence of how the distance from the technological frontier influences the level of absorptive of the firm's capacity.
Foster-McGregor *et al.* (2017)	Focus on the role of international R&D spillovers by trading intermediary products at the industry level for a broad cross-section of countries, as well as investigating the role of AC.	It has been found that foreign R&D spillovers are stronger in countries with higher AC (measured by average years of secondary schooling and R&D spending) and that they are present and economically important.	The study does not include countries at very low levels of development, which is characterized as a limitation of work. The results also supported studies that found that foreign R&D spillovers are stronger in countries with higher AC.
Khordagui and Saleh (2016)	This paper examines the role of human capital as a factor of AC for emerging economies.	The results refute the claim that there are no significant spillovers of FDI. FDI spillovers are present in the primary and tertiary sectors by controlling the number of years of schooling as a factor of AC in sampled countries. The results suggest that the impact of FDI inflows in the tertiary sector is almost equal to that of the primary sector	The contribution of this work is that the primary, secondary and tertiary sectors are examined and the analysis is expanded to take into account the main components of the sectors.

Author(s)/Year	Objective	Main results	Limitations, contributions and/or originality
		FDI inflow.	
Huebler *et al.* (2016)	Identify AC indicators and their role in South-North convergence through a channel of imported investment goods.	Regressions show that imports of machinery and other manufacturers incorporating advanced technologies are relatively strong. Import-related productivity gains tend to induce South-North convergence of labor intensities, which is not fully robust to the different model specifications. A direct and trade-free South-North convergence effect was found by improving AC in our emerging economies, represented by the joint increase in several indicators. Even under the influence of AC, a couple of decades would be needed to halve the difference in labor intensities between emerging economies and major industrialized countries.	The findings of this article on AC indicators are relatively advanced for emerging economies.
Miguelez and Moreno (2015)	To assess the extent to which AC determines the impact of knowledge flows on regional innovation	This article found strong support for the positive relationship between the geographical mobility of inventors' work and the intensity of regional innovation. In this context, it was also found that regions with high levels of AC are especially appropriate to make the most of the knowledge and information flows brought by the mobile work and cooperation networks. Both mechanisms (Mobility and Networks) can be used to access a wider range of skills, information, knowledge, inputs and skills external to the region.	The authors confirmed the results of previous work, in which both worker mobility and participation in research networks are critical means to transmit knowledge. The impact found is far from homogenous throughout the EU, with more developed regions achieving greater returns from the knowledge flows received by mobile inventors, while less advanced areas rely more heavily on networks.
Silajdzic and Mehic (2015)	To analyze the exogenous impact of FDI in economic growth, as well as to study the influence of technological and innovative capacities on growth performance among economies in	In general, the results of the empirical analysis seem to support the hypothesis that FDI contributes to economic growth predominantly through knowledge spillovers and that the higher level of technological development adopted by government and business R&D expenditures is	The paper contributed to the recent literature, using a more reliable measure of FDI, while describing the character of FDI and related knowledge spillovers, as well as examining the importance of technological and innovative capabilities to explain growth performance among transition economies not

Author(s)/Year	Objective	Main results	Limitations, contributions and/or originality
	transition.	associated with improved performance among transition economies. It has been found that the positive impact of FDI on economic growth is associated with greater capacity for knowledge and efficiency.	previously studied.
Fracasso and Marzetti (2014)	To investigate how a country's AC and relative delay affect the impact of international R&D spillovers on the TFP.	The results suggest that AC is positively associated with international R&D spillovers. A good number of countries in the sample exhibit a greater elasticity than that estimated by a linear panel model (homogeneous parameter), while South Korea, Portugal and Ireland score worse than all other countries. Interestingly, but not surprisingly, Greece, Italy and Spain occupy an intermediate position.	The authors adopted a series of updated econometric measures to make robust inference in unspecified forms of heteroscedasticity and serial and simultaneous correlation in the data. The authors' knowledge is the first time that this method is used in an applied empirical study.
Elmawazini (2014)	Contribute to the empirical literature by investigating the hypothesis that external direct investment (FDI) flows produced positive productivity spillovers for Gulf Cooperation Council (GCC) countries during the period 1995 to 2011.	The results show that FDI flows produce weak and negative productivity spillovers for GCC countries through their own or their interaction with the host country's AC. In addition, empirical results show that efficiency change (movements to or away from the border) and political stability are the main factors affecting labor productivity growth in GCC countries. These results are consistent with previous studies of a single country on technology transfer to developing countries.	The results say that these three areas need further research. In the first place, it would be interesting to repeat the current study, incorporating more developing countries. Secondly, the link between labor productivity and income differences between the GCC and the OECD countries could be another document. Thirdly, the human capital gap between women and men, as measured by average years of secondary schooling, should also be investigated as a gap between the OECD countries and the GCC.
Castillo *et al.* (2011)	This article examines two sources of spillovers of global knowledge: external direct investment (FDI) and trade.	The empirical analysis shows positive effects of FDI and trade productivity only when the country has AC in terms of R&D; greater competition (in terms of trade) is associated with larger spillovers; and countries with high R&D efforts gain more benefits compared to those with less R&D effort. Commercial FDI and spillovers are positive and significant for scale efficiency change and overall	It is suggested that more general policies should be pursued which not only attract FDI but also benefit national enterprises, for example by building modern infrastructures, enhancing and strengthening institutions to accelerate and sustain economic growth.

| Author(s)/Year	Objective	Main results	Limitations, contributions and/or originality
		productivity factor change. The empirical results show that intra-country productivity spillovers are present in Latin American countries. Countries with R&D expenditures receive more productivity spillovers than those without it.	
Krammer (2010)	To use the latest developments in the integration and infrastructure techniques of the panel unit to unlink the effects of international spillovers through trade and FDI inflows into Total Factor Productivity (TFP).	The results confirm that trade continues to be an important source of productivity gains through technological spillovers to countries. According to previous findings, the significance of these effects goes beyond their national R&D efforts, clearly in the case of countries in transition and to some extent even developed ones. This proves the massive impact of international trade flows on productivity and economic growth around the world. FDI has a significant but much smaller impact, predominantly in countries in transition, where productivity differences between domestic and foreign firms are greater. Human capital significantly impacts countries' TFP levels, both directly and as a production factor, and indirectly as the main determinant of their AC over R&D efforts.	Current results contribute to the existing literature by looking at 27 earlier Communist economies and quantifying the importance of the spillover channels of these Eastern European and Central Asian countries. New improvements may consider the use of data in the industry for a better location of spillovers, which tend to cluster in certain industries. In addition, in the case of countries in transition, their industrial mix has changed significantly throughout the 1990s from industrialized countries to a more balanced economy in which the service sector has grown tremendously. Another interesting line of research could explore the size and dynamics of the indirect effects of spillovers via FDI.
Keller (2010)	To examine how international flows of technological knowledge affect economic performance in industries and companies in different countries.	Evidence of technological spillovers has been found through international trade and the activity of multinational corporations. The analysis also highlights the challenges for future empirical research, as well as the need for additional data on technology and innovation.	Not reported.

Source: the authors (2020).

The main topics covered in these articles (Table 4) refer to the search for the main AC indicators. The authors claim that the ability to attract FDI can bring immense benefits to a recipient country, as it is a source of knowledge and has been an essential element in the

development strategies of some economies. The authors state that the effects of FDI on productivity growth are dependent on AC.

The obtained results have direct implications in the formulation of industrial policies to attract FDI, along with programs aiming to encourage the competitiveness of national industries, in order to increase their total productivity and their capacity to absorb knowledge.

Table 4 is important, as it shows the determinants of AC according to the selected literature. In this sense, Figure 6 illustrates the determinants of AC, which were selected based on the used variables, the type of measurement of AC, the generation of spillovers, or cited by the articles as determinants of AC. We classified the determinants into four groups in order to analyze which factors have more proxies mentioned in the literature, as well as to maintain order. These groups are: Research (*i.e.,* investments in research and education level); Organization (*i.e.,* business technologies); Labor (*i.e.,* human capital); Finance (*i.e.,* financial management). We classified the overall group of studies (60 articles), including the national-level group (11 articles). Moreover, clustering was used to identify the weight that certain factors can offer to impact AC.

**Figure 6 -** Determinants of AC selected by the literature
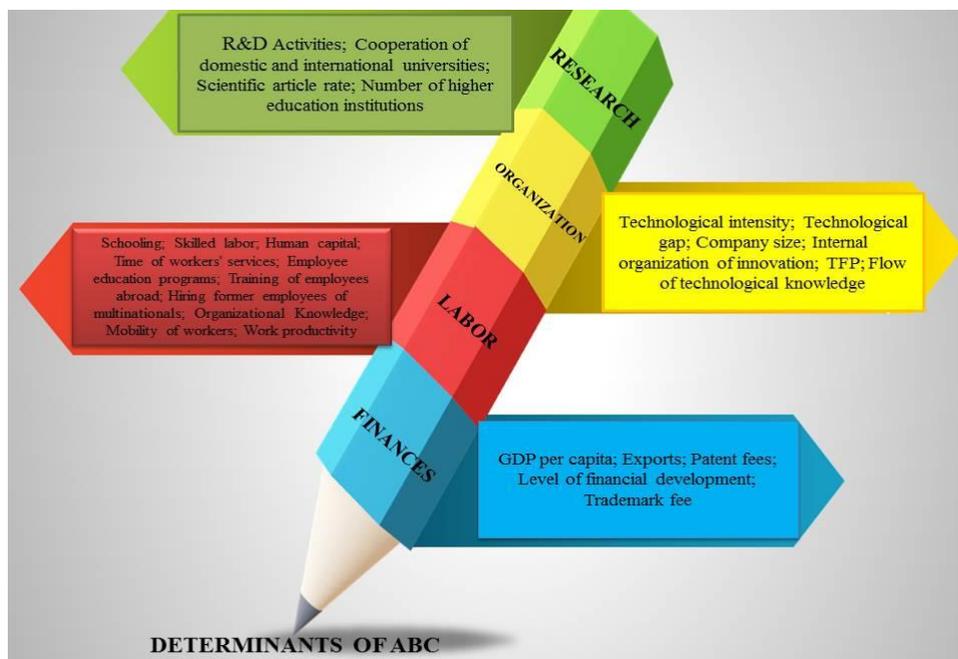
Source: the authors (2020).

Figure 7 shows the determinants for both developed and emerging countries.The main interest of this work is the selection of determinants of AC at the national level (developed

and emerging countries). Thus, we separated the possible AC indicators only for the 11 articles mentioned above.

Figure 7 - Absorptive Capacity determinants selected by the literature - 11 articles (national level)
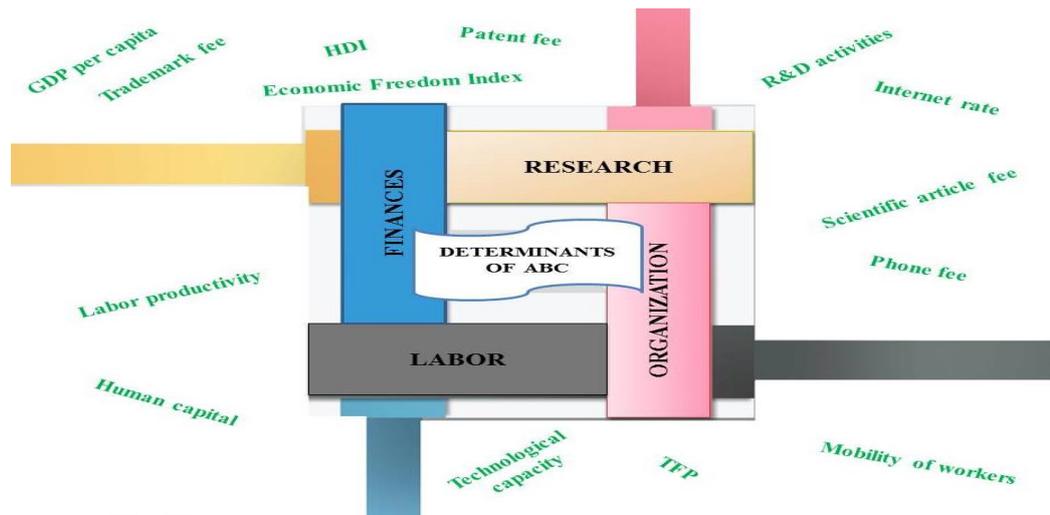
Source: the authors (2020).

Table 5 describes the definitions of these variables or means of measuring them according to the authors mentioned above.

Table 5 - Definitions of the variables according to the authors.

Author (s)/Year	AC Determinants	Definition of authors
Aldieri *et al.* (2018)	R&D activities and number of patents	The stock of R&D captures the cumulative nature of the learning process. Another measure is the percentage of self-credits, that is, the percentage of citations of patents issued by the same transferee.
Foster-McGregor *et al.* (2017)	Human capital and R&D expenditure	For the authors, the variables that capture the AC are information from the Barro-Lee[1] dataset on the average years of secondary education in the population. They followed the approach of Cohen & Levinthal (1989) using the registered R&D value of the ANBERD[2] data set as an additional indicator of AC.
Khordagui and Saleh (2016)	Human capital	The human capital variable is measured by the average years of schooling for adults over 25 years of age.

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[1] http://www.barrolee.com/. These data were used as a measure of absorptive capacity in similar studies.

[2] The OECD Business Development and Analysis (ANBERD) database presents annual R&D expenditure by industry and was developed to provide analysts with comprehensive data on business R&D expenditures.

Author (s)/Year	AC Determinants	Definition of authors
Huebler *et al.* (2016)	Participation of highly qualified labor force; Index of economic freedom; Tertiary education rate; Internet rate; Telephone rate; Scientific article rate; Patent fees; Trademark fee; Participation of the service sector; High-tech industry sharing	Participation of highly qualified labor force - Percentage of highly skilled working time in all working hours. The higher skills of workers are commonly associated with higher education, including a better understanding of technology. Index of economic freedom - The index of economic freedom in the form of registration. This index is the average of 10 sub-indices: commercial freedom, commercial freedom, monetary freedom, government size/spending, fiscal freedom, property rights, freedom of investment, financial freedom, freedom from corruption and freedom of labor. Tertiary education rate - Gross rate of tertiary education enrollment. Internet rate - This is the number of Internet users per 100 people in the population. Phone Fee - These are the registration phone lines for 100 people of the population. Scientific article fee - This is the number of scientific and technical journals journal entries within a specific country per capita. This measure indicates the intensity of basic and, to some extent, applied research. Patent Fee - This is the number of patent application registrations (by nonresidents) in a specific country divided by the population of that country. Trademark Fee - This is the trademark application registration number per capita. Trademark applications are a more applied, industry-oriented measure than patents. High-tech industry sharing - This is the record output value of the high-tech manufacturing industries divided by the total production value of the manufacturing industry. The weight of the high-tech industry in the economy is another indicator for pre-existing technologies and technological capabilities that facilitate the adoption of new technologies.
Silajdzic and Mehic (2015)	R&D Activities	Measured as a share of R&D expenditures by the business sector in the country's GDP and by total government R&D expenditures expressed as a share in the country's GDP.
Miguelez and Moreno (2015)	R&D Activities; Mobility of workers; Inventor networks	R&D Activities: R&D is not only a generator of foreground, but also a means to improve the company's ability to assimilate and exploit existing information. Mobility of workers: Geographic mobility of knowledge workers. The evidence supports the proposition about the role of AC in the assimilation of knowledge flows from labor mobility. Inventor Networks: Interregional Technology Networks. The economically least developed regions are those which benefit most from the geographical spread of knowledge through technological cooperation networks.
Fracasso and Marzetti (2014)	Human capital and R&D activities	Human capital: Average years of schooling. R&D activities: The results suggest that AC is positively associated with international repercussions of R&D.

Author (s)/Year	AC Determinants	Definition of authors
Elmawazini (2014)	GDP per capita, labor productivity, TFP, human capital, Technological capacity, Human Development Index (HDI)	GDP per capita: Developed countries are expected to have a higher level of human capital and therefore benefit more from FDI than developing countries. Labor productivity: Foreign presence has a significant positive effect on labor productivity. TFP: There are negative impacts on the Total Factor Productivity resulting from the allocation of FDI in regions that do not have minimum levels of AC. AC is defined as the TFP level in the previous period divided by the maximum TFP level in the industry. Human capital: Measured by average years of schooling. Technology capability: Measured by royalty receipts and license fees. Human Development Index (HDI): Studies on the effects of FDI have generally used human capital, represented by the average years of schooling, as a measure of the AC of the host countries. Above all, it is argued that the HDI best captures the AC of the host country. Skills can be acquired not only through formal education, but also through training and work experience; and this acquisition of skills is further supported by improvements in other social indicators.
Castillo *et al.* (2011)	Activities in R&D, human capital	R&D Activities: The presence of productivity spillovers depends on the investment efforts of local firms in R&D activities. They play an important role in the transfer of knowledge, in addition to its role as a means of innovation. Human capital: There is evidence that the positive impacts of the development of FDI flows depend on the high level of human capital and hence on the existence of "good" infrastructure in host countries.
Krammer (2010)	Human capital; R&D activities	Both human capital and domestic R&D efforts increase a country's AC and contribute to increased productivity. Human capital - average years of schooling among men over 25 years of age.
Keller (2010)	R&D Activities	The high level of R&D is consistent with the idea that countries need to develop AC to be able to produce spillover of productivity from local firms.

Some variables did not have their measurements defined by the authors.
Source: the authors (2020).

We found that R&D and Human Capital are considered the most frequent determinants of AC. This finding corroborates with the literature as multinational companies play an essential role in economic development by increasing their R&D efforts, especially in developing countries. Cantwell (1995) presents evidence that the internationalization of R&D was pioneered by companies leading their respective fields. In this sense, R&D internationalization is a product of capital internationalization (*i.e.,* foreign investments), and is a response to the need to adapt products, processes and materials in developing regions, which usually lack this knowledge and depends on external sources.

R&D activities can be measured through investments in the area, workforce training or professionals linked to this type of activity. Human capital can be measured through average years of study or by the level of knowledge diffused in the region (*e.g.,* the number of people

with higher education) (MUROVEC; PRODAN, 2009; JIMÉNEZ-BARRIONUEVO *et al.*, 2011; SHENBAROW, 2014; LICHTENTHALER, 2016).

R&D investments enable innovations and, at the same time, allow the internalization of knowledge produced by other sources, especially foreign companies. Companies' skills to recognize and assimilate new knowledge are primarily due to their workers' capabilities (MUROVEC; PRODAN, 2009; JIMÉNEZ-BARRIONUEVO *et al.*, 2011; SHENBAROW, 2014; LICHTENTHALER, 2016).

Furthermore, human capital is one of the most important determinants of AC. This finding is in line with the literature since Murovec and Prodan (2009) showed that companies' skills in recognizing and assimilating new knowledge derive, to a large extent, from the individual capabilities of their workers.. Moreover, according to Castillo *et al.* (2011) human capital is important because there is evidence that the positive impacts of the development of FDI flows depend on the high level of human capital. Miguelez and Moreno (2015) comment on the positive role of AC in assimilating knowledge flows from workers' geographical mobility.

Therefore, the more training and education an employee receives, the greater will be his or her ability to assimilate and use new knowledge. Because AC depends on employees, the level of education, experience and training has a positive influence on the level of AC in companies.

It is noteworthy that R&D and human capital are important tools to boost absorptive capacity and, consequently, economic development. In this sense, policymakers must create mechanisms to encourage new R&D investments. An adequate macroeconomic environment might attract multinational companies to bring new investments to the host economy. Also, educational policies, such as formal education and professional training, could be important initiatives to increase the local human capital.

Tertiary education can be considered a proxy for human capital, and it does not represent the variation of quality between education systems worldwide. Internet rate and technological capacity appear as determinants of AC in some studies, but they require more investigation to reveal how these variables are linked with AC.

The Human Development Index (HDI) was used to determine AC in Elmawazini (2014). According to this author, the HDI affects AC because skills can be acquired through training and professional experience, and this acquisition of skills is further supported by

improvements in other social indicators. Health and economic conditions can affect productivity and technology diffusion, providing an environment conducive to innovation. Thus, the countries that are able to absorb more knowledge are also those that are able to achieve higher life expectancy, higher education level and higher incomes. Regarding the determinant Index of Economic Freedom (IEF), cited by Huebler *et al.* (2016), it can be said that in economically free societies, governments allow labor, capital and goods to move freely, and this freedom to do business, including in technology-oriented areas, facilitates innovation and adoption of new technologies. According to Elmawazini (2014), productivity gains will be linked to the Absorptive Capacity, since innovative producers are more receptive to new technologies and, thus, are able to maximize gains and reduce costs. Thus, the TFP becomes a fundamental and determining factor for the increase in CA in developed or emerging and developing countries.

4. CONCLUDING REMARKS

This study started from the hypothesis that AC has determinants that can influence countries' productivity through external investments. These determinants help measure the acquisition, assimilation, transformation, and exploitation of knowledge.

The presented hypothesis assures that FDI contributes to economic growth predominantly through knowledge spillovers and that the higher level of technological development adopted by government and business R&D expenditures is associated with improved growth performance among transition economies and that the positive impact of FDI on economic growth is associated with greater capacity for knowledge and efficiency.

Thus, the performed systematic literature review selected 14 determinants for AC, with R&D activities and human capital being the most cited in the literature. It can be stated that the presence of productivity spillovers depends on the investment efforts of local companies in R&D activities. They play an essential role in the transfer of knowledge and its role as a means of innovation. There is evidence that the positive impacts of FDI flow development depend on the high level of human capital and the existence of "good" infrastructure in host countries.

This study contributes to organizing the literature about the determinants of AC. However, this study presents some limitations. First, we did not use a large number of

keywords, which could be attached by future studies. Second, we analyzed studies written in English, which does not bring works written in Spanish, Portuguese, Chinese, and other important languages for developing countries. Third, we did not analyze in-depth research methods. Future studies could investigate which empirical methods are adequate to measure AC. Finally, future studies might analyze AC in under-represented geographic areas, which is crucial for policy recommendations in Latin American and African countries.

Finally, identifying the determinants of AC helps achieve goals before a possible FDI attraction policy. This analysis brings tools to enhance positive productivity spillovers and avoid negative spillovers related to competition for the domestic industry.

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APPENDIX A - SYSTEMATIC REVIEW PROTOCOL

Objective: To analyze the determinants of Absorptive Capacity from External Direct Investment

Formulation of the research question: What are the determinants of Absorptive Capacity?

Items related to the scope and specificities of the research question:

- Control: collection of articles and other works raised and related in bibliographic reviews of master's dissertations, doctoral theses and books related to the research area.

- Population: Countries / states / regions / cities

Strategies for searching and selecting primary studies:

The resources and strategies for research and selection of studies were defined and selected based on four fundamental items:

- Search sources: database (Scopus / Web of Science)

- English language

- Keywords: Knowledge Spillover AND Absorptive Capacity

- Date of publication: No lower or upper limits were established for the date of publication of articles.

Criteria and procedures for selection of studies:

Inclusion criteria

(I) Did the article consider the absorptive capacity as one of the variables that impact the productivity of units?

(II) Does the article consider that the generation of externalities with FDI inflows depends on the capacity of absorptive?

(III) Publication in English.

Exclusion Criteria

(I) The article does not focus on the generation of productivity spillovers

(II) The article does not consider the absorptive capacity important for the productivity of units

Selection process of studies

Preliminary selection process

Articles will be selected by reading the abstracts.

Final selection process

The articles selected by the abstract will be reviewed according to the inclusion and exclusion criteria.