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The Role of Technology-Transfer-Oriented Subsidies in Building Companies' Absorptive Capacity and Innovation: Evidence from Peruvian MSMEs

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ABSTRACT

Micro, small, and medium-sized enterprises (MSMEs) have been acknowledged to play a key role in promoting innovation and economic development. In Peru, 99.5% of formal firms are MSMEs, thus promoting innovation in these firms could have a significant impact on the Peruvian economy. In spite of *Innovate Peru*'s efforts, Peru is still one of the countries that invests the least in innovation, with MSMEs offering low value added. *Innovate Peru* has launched programs (technological missions) to improve MSMEs' innovation through technology-transfer-oriented subsidies, which may strengthen companies' absorptive capacity (AC) and thus their capabilities to identify and integrate internal and external knowledge. This study assesses the impact of these programs on MSMEs. Data were collected from 85 MSMEs that participated in *Innovate Peru*'s technological missions between 2014 and 2016. Findings show that all the dimensions of AC have a positive impact on innovation; however, the impact of economic subsidy was found to be non-significant. Theoretical and practical implications are discussed.

Keywords: Technology Transfer, Absorptive Capacity, Innovation, Government Subsidy, MSMEs

Ⅰ. Introduction

The Organization for Economic Cooperation and Development (OECD) recognizes micro, small, and medium-sized enterprises (MSMEs) as an engine of sustainable economic development (OECD, 2017), representing 99% of all companies in OECD countries, 60% of formal workers, and between 50% and 60% of value added (OECD, 2019). Even though MSMEs are responsible for some radical technological innovations (OECD, 2017), these companies are better characterized by the adoption

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of externally generated technologies, making incremental improvements in different contexts to generate value (OECD, 2017). These types of companies face various challenges and barriers along the innovation process, and thus, governments should intervene to reduce information asymmetry, coordination problems, financial barriers, and negative spill-over effects (Crespi and Castillo, 2020). The intervention modality is usually through an innovation agency (OECD, 2017).

In Latin America, the percentage of MSMEs is similar to that of the OECD countries, representing 99% of all companies and 61% of formal employment (Dini and Stumpo, 2020). However, there are substantial differences in terms of economic contribution (Dini and Stumpo, 2020). Likewise, this region invests substantially less in innovation than the average of 2.58% reached by the OECD countries (World Bank, 2018). With the exception of Brazil, the rest of the economies invest less than 1% of their GDP in innovation (World Bank, 2018). The effect of this gap is reflected in the global innovation index, where Latin American countries are between positions 54 and 106 out of 131 countries (Cornell University et al., 2020).

In the case of Peru, the country invests barely 0.12% of its GDP (World Bank, 2018). This situation may restrict its economic growth because a large percentage (99.5%) of the formal Peruvian companies are MSMEs, but they have the lowest levels of innovation expenditure in the country (Ministry of Production, 2018). To increase the competitiveness of this type of companies, the National Innovation Program for Competitiveness and Productivity (*Innovate Peru*) was created in 2014, becoming the most recent innovation agency in the region. Peruvian MSMEs, however, still present low levels of innovation; in the period 2015-2017, 46.63% of them made no effort to innovate (Ministry of Production, 2019). This context suggests there is an opportunity to grow economically in Peru through the promotion of innovation within MSMEs, and thus it is timely to assess the effect of *Innovate Peru*'s initiatives.

To achieve the economic growth of these companies and the country at large, and considering that MSMEs are often adopters of innovations (Prokop and Stejskal, 2019), especially in emerging economies, it is necessary to build internal capacities in these companies to benefit from the innovation process and translate technology adoption into sustained competitive advantages (Zahra and George, 2002). Among these capacities, absorptive capacity that refers to an appropriate acquisition, assimilation, and use of external knowledge is critical for technology adoption (Todorova and Durisin, 2007). However, prior empirical studies have found mixed results of the impact of absorptive capacity on innovation levels, suggesting that this relationship depends on the features of the context in which companies compete. Hence, it is important to assess the impact of the technology-transfer-oriented subsidies granted by *Innovate Peru* on the creation of absorptive capacities in MSMEs and their innovation levels, which may help the Peruvian government to enhance innovation policies.

Based on the above discussion, the present study aims to analyze the effect of technology-transfer-oriented subsidies on companies' absorptive capacity and innovation in the context of MSMEs that were beneficiaries of *Innovate Peru*. Within innovation activities, this study focuses on technology adoption because, in emerging economies, MSMEs must invest in technological updating processes (technological catch-up) to stay competitive (Petti et al., 2019).

Ⅱ. Theoretical Background

2.1. Research Gap

Prior research has shown that companies need certain internal capacities to capitalize on the benefits associated with innovation adoption, including those that are technology-based (Damanpour, 1991; Hameed et al., 2012). These internal capacities may translate these innovations into sustained competitive advantages (Barney, 1991; Teece et al., 1997; Zahra and George, 2002). Among these capacities, those needed for an appropriate use of external knowledge are critical for the technology adoption process (Todorova and Durisin, 2007). This type of capacity is known as absorptive capacity, and is defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990; p. 128).

Previous studies found mixed results about the impact of absorptive capacity on innovation (Mikhailov and Reichert, 2019). This section has been divided into three parts: 1) studies on absorptive capacity in non-MSMEs in non-Latin American countries, 2) studies on absorptive capacity in non-MSMEs in Latin American countries, and 3) studies on absorptive capacity in MSMEs.

In the first part, there are studies that found a positive relationship between absorptive capacity and innovation, as is the case of Kostopoulos et al. (2011), who analyzed 461 general Greek companies from the manufacturing and services sectors; Tseng et al. (2011), who focused on 88 Taiwanese knowledge-intensive service companies; and Lau and Lo (2019), who assessed the case of 200 Hong Kong manufacturing companies. In contrast to these results, other studies did not find evidence of a relationship between these two variables. It can be mentioned as examples the studies by Ritala and Hurmelinna-Laukkanen (2013), who focused on 138 Finnish companies in the manufacturing, information and communication technologies (ICTs), commerce, construction and services sectors; Leal-Rodríguez et al. (2014), who analyzed 110 Spanish companies in the automotive sector; and Petti et al. (2019), who focused on 166 manufacturing companies in the province of Canton in China.

In the second part (studies about non-MSME companies in Latin American countries), findings are also not consistent. For example, Bittencourt and Giglio (2013), who focused on Brazilian manufacturing companies, found a significant impact of absorptive capacity on innovation. Similar results were reported by Solis-Vásquez et al. (2017), who found evidence for this relationship in Mexican petrochemical companies. There are, however, other studies that failed to find empirical evidence supporting this effect, for example, Engelman et al. (2017), who studied manufacturing companies in Brazil.

In the case of the third part (studies about MSMEs), only five studies were identified. Four of those found a positive relationship between absorptive capacity and innovation. Scuotto et al. (2017) used a sample of 215 worldwide MSMEs from knowledge-intensive and labor-intensive industries, while De Zubielqui et al. (2016) based their study on 838 MSMEs from South Australia. The other two studies focused on European companies: Kohlbacher et al. (2013) analyzed 257 MSMEs from the manufacturing and services sectors in Central Europe, while Vega-Jurado et al. (2008) assessed 84 Spanish MSMEs. In contrast, the fifth study, based on 403 Colombian MSMEs in the manufacturing, construction, commerce, and services sectors, did not find evidence for the aforementioned relationship

(González-Campo and Ayala, 2014). This last study is the only one that analyzed the effect of absorptive capacity on innovation in Latin American MSMEs. Thus, considering the small number of studies about Latin American companies, the non-conclusive results across companies (specially MSMEs), and the importance of MSMEs for countries' development, further analysis of the relationship between absorptive capacity and innovation in Latin America MSMEs is required.

Additionally, this study assesses the role of innovation agencies in the technology adoption process. There are studies that show mixed effects of subsidies on companies' innovation. On the one hand, Basit et al. (2018) studied 1,039 German companies in the service sector, finding that subsidies had a positive impact on organizational innovation. Similarly, Hall et al. (2009) found a positive relationship between subsidy and research and development (R&D) activities. Their findings were obtained from a sample made up of 10,757 Italian manufacturing MSMEs. In contrast, Gustafsson et al. (2016), who analyzed 284,662 Swedish manufacturing companies, and Koski and Pajarinen (2013), who studied 403,058 Finnish companies, both found that subsidies do not impact long-term business performance.

Finally, when combining both fields of study (i.e., absorptive capacity and the role of innovation agencies), only one study has been identified that focused on companies that are beneficiaries of innovation subsidies (Nieto and Quevedo, 2005), specifically Spanish companies that were beneficiaries of the Center for Industrial Development—Spain's Innovation Agency. Their results show a positive relationship between absorptive capacity and innovation. However, considering the mixed results described in previous paragraphs, it is important to generate further analysis of this phenomenon in Latin American MSMEs in new contexts.

In short, the present study aims to fill the following research gaps: 1) little knowledge (few studies and non-conclusive results) about absorptive capacity in companies from developing countries, 2) little, non-conclusive empirical evidence of the effect of absorptive capacity in MSMEs, and 3) lack of research about the impact of subsidies given by innovation agencies (this study will focus specifically on technology-transfer-oriented subsidies). The following research question is proposed: what is the impact of absorptive capacity on innovation in MSMEs that received a technology-transfer-oriented subsidy in Peru?

2.2. Innovate Peru and Technological Missions: Technology-Transfer-Oriented Subsidies

According to the 2019 competitiveness index (Schwab, 2019), Peru was ranked 65 out of 141 countries. Based on this index, ICT adoption (position 98 out of 141) and innovation capacity (position 90 out of 141) are among Peru's main weaknesses. In terms of ICT adoption, only 52.5% of the adult population are internet users (Schwab, 2019). In addition, there is a gap between urban and rural areas. For instance, 52.9% and 62.9% of households in Lima have access to a computer and internet connection, respectively, while these percentages are only 7.5% and 5.9% in rural areas (INEI, 2020).

In terms of innovation capacity, according to the 2020 Global Innovation Index, Peru is ranked 76 out of a total of 131 economies (Cornell University et al., 2020). This report further explored the Peruvian innovation system, finding that it is characterized by low R&D investment, a low rate of companies that engage in innovation, a lack of intellectual prop-

erty generation, a low proportion of companies that export knowledge, and low collaboration between academia and companies in R&D projects (Cornell University et al., 2020).

There are various barriers that inhibit innovation activities. First, knowledge is a public good, and thus competitors can take advantage of the innovation, creating a negative spillover effect (Crespi and Castillo, 2020). Other barriers are information asymmetry regarding the financial return of innovation, asymmetric information regarding knowledge and diffusion of technologies, and coordination problems between innovation networks (Crespi and Castillo, 2020). In such cases, governments intervene as part of their innovation policy, generating financial instruments to support innovation within companies (Meissner and Kergroach, 2019).

In Peru, the innovation agency is *Innovate Peru*, which was created in 2014 to increase business productivity by strengthening the actors of the innovation ecosystem and facilitating the interrelation between them (Innóvate Perú, 2020b). This institution has funded more than 3,400 innovation-related projects, investing more than one thousand million soles with various types of support for companies (Innóvate Perú, 2020b). For example, on the supply side, *Innovate Peru* provides grants for business R&D, venture capital, technology incubators, and grants for collaborative R&D (Innóvate Perú, 2020b). On the demand side, this organization provides grants for technology adoption and technology extension, among others (Innóvate Perú, 2020b).

The present study focuses on the subsidies for technology adoption (i.e., technology transfer). The specific instrument to be assessed is technological missions, which co-finance companies to obtain information, knowledge, practices or production techniques from abroad (Innóvate Perú, 2020a). Companies receiving this support are expected to visit foreign companies, technology centers or parks, specialized R&D institutions, or specialized technology fairs or events, for a maximum of six months (Innóvate Perú, 2020a). This program targets MSMEs or manufacturing associations. In terms of financial subsidy, the maximum amount was set at US$ 30,000, which can be up to 75% of the total value of the project (Innóvate Perú, 2020a). Technological Missions aim to facilitate technology absorption by Peruvian companies, and thus it is expected that these companies may obtain external knowledge during these missions, and subsequently adopt the technology.

2.3. Absorptive Capacity

From the perspective of the Resources and Capacities Theory (RCT) (a resources-based view of the company), a company's resources are conceived as a set of assets, capacities, organizational processes, attributes, information and knowledge, which are controlled by the company and enable it to implement strategies for improving its efficiency and effectiveness (Barney, 1991). These resources can be internal or external to the company (Yao et al., 2015). RCT posits that resources are capable of generating competitive advantages (Barney, 1991).

In a complementary manner, the knowledge-based theory (a knowledge-based view of the company) states that knowledge is the main source of productivity and the basis of companies' income generation (Grant, 2013). From this perspective, value generation requires processes for acquiring knowledge, and further applying it within the company (Grant, 2013). The capability to identify and integrate internal and external knowledge is known as absorptive capacity (Cohen and Levinthal, 1990).

Absorptive capacity is defined as "the ability of

a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990; p. 128). This initial conceptualization of absorptive capacity was reviewed by Zahra and George (2002), who further claimed that absorptive capacity is a dynamic capacity that focuses on the creation and use of knowledge to obtain and maintain a competitive advantage. As indicated by Teece et al. (1997), the term "dynamic" refers to the ability to renew skills to achieve congruence with the business environment. Zahra and George (2002) defined this capability as "the set of organizational routines and processes through which the company acquires, assimilates, transforms and exploits knowledge to produce an organizational capacity."

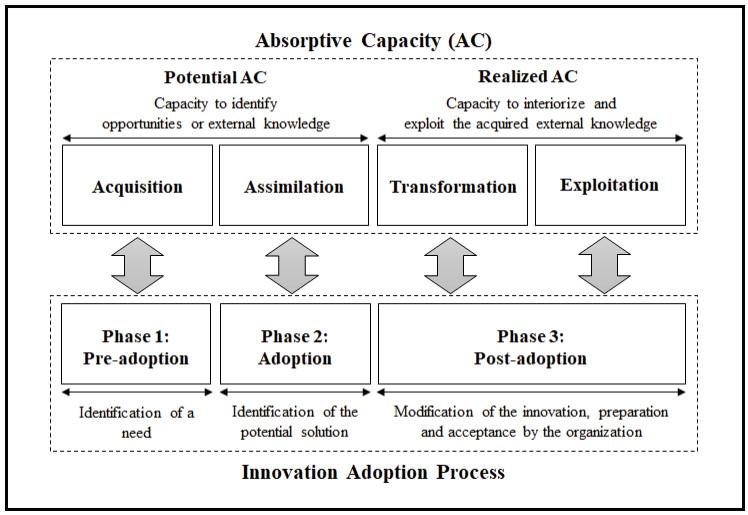
Absorptive capacity has four dimensions: acquisition, assimilation, transformation, and exploitation. The acquisition dimension refers to companies' ability to identify and acquire external knowledge that is critical to their operations (Zahra and George, 2002). The second dimension (assimilation) denotes companies' routines and processes that enable them to analyze, process, interpret, and understand the information obtained from external sources (Zahra and George, 2002). Third, transformation refers to companies' ability to develop and refine routines and processes that facilitate the combination of existing internal knowledge with newly acquired and assimilated knowledge (Zahra and George, 2002). Fourth, exploitation refers to routines and processes that enable companies to refine, extend, and take advantage of their existing skills, or create new ones by incorporating the new knowledge (Zahra and George, 2002).

Additionally, Zahra and George (2002) classified absorptive capacity into two groups: potential and realized absorptive capacity. The first group is made up of the acquisition and assimilation dimensions, and its objective is to prepare a company to acquire and assimilate external knowledge. The second group (realized absorptive capacity) encompasses the transformation and exploitation dimensions, and reflects the company's ability to take advantage of the new knowledge (Zahra and George, 2002). This distinction separates the capacity to identify opportunities of external knowledge from the capacity to internalize and exploit this knowledge (Saemundsson and Candi, 2017).

Absorptive capacity has been widely used in studies on international technology transfer, defined as "a process by which a technology supplier communicates and transmits the technology through multiple activities to the receiver, across national borders" (Nahar et al., 2006; p. 664). Technology transfer constitutes one of the main mechanisms through which an organization improves its absorptive capacity, considering that technology transfer implies acquisition, assimilation, transformation, and exploitation of technology and knowledge (Van der Heiden et al., 2016).

2.4. Innovation

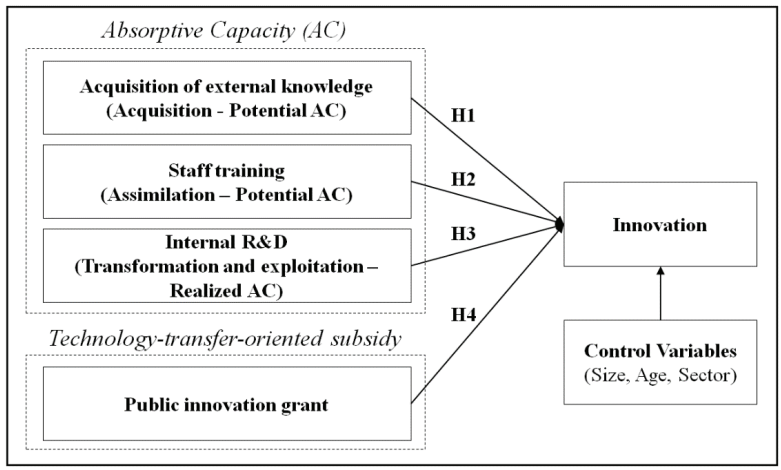
According to the fourth edition of the Oslo Manual, business innovation is defined as "a new or improved product or business process (or a combination thereof), that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm" (OECD and Eurostat, 2018, p. 20). Accordingly, innovation consists not only in the generation of a product or process but also on the value obtained from these. Innovations must differ significantly from the products or processes that the company had



<Figure 1> Relationship between Absorptive Capacity and Innovation Process

implemented before. In other words, the innovation must be new for the company that is implementing it, regardless of its degree of novelty in the local or international market. By this definition, innovation can be generated internally or acquired from external sources (Damanpour, 1991). The adoption of an innovation (innovation acquired from external sources) refers to the assimilation of a product, service, business process, or practice that is new for the adopting company (Hameed et al., 2012). Generally, an innovation adoption process consists of three phases. The first phase is called the pre-adoption phase, and it encompasses the activities related to the identification of a need or productive gap, acquisition of external knowledge, and search for possible solutions (Pichlak, 2016). The second phase consists on the decision to adopt the innovation. This phase embraces the processes related to the identification of the solution in terms of a strategic, financial, and technological assessment, as well as the allocation of resources for its acquisition (Damanpour and Schneider, 2006). The third phase is called post-adoption phase, and includes activities related to the modification of the adopted innovation, the preparation of the organization for its appropriate use, and the acceptance of the innovation by the company's employees (Hameed et al., 2012). <Figure 1> summarizes the relationship between absorptive capacity and the innovation adoption process.

In the case of MSMEs, these companies are often adopters of innovations, so absorptive capacity is especially important for them (Prokop and Stejskal, 2019). Companies with technological gaps tend to prioritize the acquisition and adaptation of existing technologies rather than developing them internally (Petti et al., 2019; Wu et al., 2009). Now, it is common to find this type of company (with technology gaps) in emerging economies (Nagano et al., 2014). Latin American companies often make incremental innovations rather than radical innovations (Crespi and Castillo, 2020). Incremental innovations generate marginal changes because their main strategy is based on the use of external knowledge to improve existing products and services (Damanpour and Gopalakrishnan, 1998; Jansen et al., 2006).



<Figure 2> Research Model

Ⅲ. Research Hypotheses

<Figure 2> summarizes the proposed research model. This model focuses on assessing the effect of the dimensions of absorptive capacity and technology-transfer-oriented subsidies on MSMEs' levels of innovation.

3.1. Impact of the Dimensions of Absorptive Capacity

Companies with high levels of absorptive capacity are more likely to innovate (Nieto and Quevedo, 2005; Zou et al., 2018). As Figure 1 shows, potential absorptive capacity, understood as the capacity to recognize the value of external knowledge—acquisition and assimilation of knowledge—is aligned with phases 1 and 2 of the innovation adoption process (Damanpour and Schneider, 2006; Pichlak, 2016). For its part, phase 3 of this process is aligned with the realized absorptive capacity, under which the recently acquired and assimilated knowledge is used for commercial purposes (Cohen and Levinthal, 1990).

The first phase of the innovation adoption process refers to the use of external knowledge to solve a need or productive gap (Pichlak, 2016). In this matter, companies have different sources from which they can acquire and accumulate external knowledge, such as universities, other companies, research centers, or technological fairs. For such external knowledge to be tangible, the company must first identify it (Kostopoulos et al., 2011). Therefore, in order to promote innovation in the company, the first step is to acquire external knowledge (Liao et al., 2010), which refers to the acquisition dimension of absorptive capacity.

The rationale behind this positive impact is that by acquiring and absorbing external knowledge, companies are more likely to identify market opportunities, anticipate demand, and identify new technologies and products (Fores and Camison, 2011). Now, considering the dynamic nature of absorptive capacity, companies with high capacity to absorb external knowledge (acquisition dimension) will have high levels of accumulated knowledge stocks, which is an input for the innovation process (Fosfuri and Tribó, 2008).

H1: Acquisition of external knowledge has a positive impact on innovation

Innovation adoption (phase 2) is the result of an organizational learning process (Cohen and Levinthal, 1990; Zahra and George, 2002), which is consistent with the assimilation dimension of absorptive capacity. Human capital plays an important role in ensuring knowledge transfer that promotes organizational learning (Bittencourt and Giglio, 2013). Prior studies used training activities as an indicator of the knowledge assimilation process (Fores and Camison, 2011; Kostopoulos et al., 2011). Cohen and Levinthal (1990), for instance, claimed that companies can improve their absorptive capacity levels through training activities. In turn, these capacities may improve technology adoption (Clausen, 2013). The more trained companies' workers are, the better they will be at assimilating external knowledge, which may further improve companies' innovation levels (Un, 2017).

H2: Staff training has a positive impact on innovation

After external knowledge is acquired and assimilated, the process for its internalization begins to exploit this knowledge. This process refers to realized absorptive capacity, which is aligned with the post-adoption phase (phase 3) of the innovation adoption process, that is, when the organization transforms and adapts itself to benefit from the adopted innovation (Hameed et al., 2012). Although a company may have the capacities to acquire and assimilate external knowledge, if it does not have the capacities to transform and exploit this knowledge, the company will not be able to create business value and innovate (Leal-Rodríguez et al., 2014). Based on this fact, internal R&D is a widely used measure of this dimension of absorptive capacity (transform and exploit), with evidence of a positive effect on innovation (Clausen, 2013; Cohen and Levinthal, 1990; Heredia Pérez et al., 2019; Un, 2017). Internal R&D reflects companies' ability to integrate external knowledge with its own production processes (Cohen and Levinthal, 1990). In fact, external knowledge must be combined with internal knowledge to obtain the associated benefits (Arbussa and Coenders, 2007; Lau and Lo, 2015). The combination of external and internal knowledge encourages the generation of innovation (Kostopoulos et al., 2011). Considering that absorptive capacity is cumulative, by using these capacities continuously, companies are strengthened, which is decisive in generating innovation competitive advantages (Todorova and Durisin, 2007).

H3: Internal R&D has a positive impact on innovation

3.2. Impact of Technology-Transfer-Oriented Subsidies

It is pertinent to assess the impact of technology-transfer-oriented subsidies on innovation, which may have implications for the innovation policy. Public innovation grants (i.e., technology-transfer-oriented subsidies) have the goal of sharing the risks and costs associated with innovation, and thus encouraging more companies to innovate (Yao et al., 2015). The relationship between public innovation grants and higher levels of innovation is explained by the fact that factors such as the knowledge being a public good, information asymmetries, and coordination deficiencies can lead to market failures (Crespi and Castillo, 2020). Indeed, governments intervene to correct said market failures (Guo et al., 2016). Hence, prior research suggests a positive relationship between the

fact that a company had been a beneficiary of a public grant and its innovation activities (Hall et al., 2009). For example, in a study based in China, it was found that beneficiaries of public grants innovate more than non-beneficiaries, and innovate even more after receiving the grant than they did before (Guo et al., 2016). Similar results were found in a study evaluating public innovation grants in Mexico, where it was found that beneficiaries have higher levels of productivity and employment than non-beneficiaries (López-Acevedo and Tinajero-Bravo, 2013). Similarly, this study proposes:

H4: Public innovation grant has a positive impact on innovation

3.3. Control Variables

Finally, three control variables were added to the model: company size, age, and economic sector. The first variable is included because Lau and Lo (2015) found there is a positive relationship between company size and innovation levels. The second variable was included because Jansen et al. (2005) found that the more time companies are in the market, the more accumulated experience they have, which is translated into high levels of absorptive capacity and innovation. The third control variable was included because innovation differs from sector to sector (Lau and Lo, 2015).

Ⅳ. Methodology

4.1. Measurement Instrument

Innovation was measured on a five-point Likert scale. This variable measures managers' perception of business innovation as a result of the technological mission. The use of a scale-based variable to measure innovation is validated in the literature (Fores and Camison, 2011; Lau and Lo, 2019; Liao et al., 2007; Solis et al., 2017). In the case of the independent variables, for external knowledge acquisition (acquisition dimension), the participants were asked to specify the degree of external knowledge acquired during the technological mission on a five-point Likert scale. This variable measures managers' perceptions of their entrepreneurial capacity to value, identify, and acquire external knowledge, which has been validated in literature (Fores and Camison, 2011; Lau and Lo, 2019; Scuotto et al., 2017; Solis et al., 2017). Staff training (assimilation dimension), on the other hand, was conceptualized as a dichotomous variable, which measures whether or not the company conducted these activities. This variable is a widely accepted measure of absorptive capacity (Bittencourt and Giglio, 2013; Clausen, 2013; Kostopoulos et al., 2011; Olea-Miranda et al., 2016). In terms of internal R&D (transform and exploit dimensions), this variable was also conceptualized as a dichotomous variable, which measures whether or not the company conducted this type of activities. The operationalization of this concept as a dichotomous variable can be found in prior studies (Bittencourt and Giglio, 2013; Clausen, 2013; De Zubielqui et al., 2016; Kostopoulos et al., 2011; Un, 2017). In the case of the technology-transfer-oriented subsidy, this variable was conceptualized through the variable public innovation grant, which uses a five-point Likert scale aiming to capture managers' perception of the economic resources received for the technological missions.

In terms of control variables, company size was measured as micro, small, or medium. The current study operationalized this variable with two dummy

variables: Dmedian and Dsmall. As for age, it is a continuous variable, which was measured as the number of years the company has been present in the market. In the case of sector, this study used primary sector (agriculture), secondary sector (manufacturing), and tertiary sector (services). Accordingly, this variable was operationalized with two dummy variables: Dprimary and Dsecondary. <Table 1> gives a summary of all the variables.

4.2. Data Collection

Data were collected from *Innovate Peru*, specifically from the technological mission database. The data are from MSMEs that were beneficiaries of this program between 2014 and 2016, and thus it is an adequate sample to meet the objectives of the present study. Innovation literature recommends a period of at the least three years to observe the effects of innovation activities on business performance (OECD and Eurostat, 2018). Hence, the selected timeframe is adequate because the survey was conducted in 2019. During this period of time (2014 to 2016), 72 technology missions were launched with a total of 419 MSMEs involved. From this population, data were collected from 88 MSMEs. However, information is incomplete for three of them, so the final sample size is 85 MSMEs. It should be noted that the sample responds to a proportional stratified sampling technique, with a confidence level of 95%,

<Table 1> Measurement Instrument

Variable	Description	Measure
Dependent Variable		
Innovation	Degree of Business Innovation	Likert (1 to 5)
Independent Variables		
Acquisition of External Knowledge	Perception of Acquired External Knowledge	Likert (1 to 5)
Staff Training	Staff Training Activities	0 = No / 1 = Yes
Internal R&D	Internal R&D Development	0 = No / 1 = Yes
Public Innovation Grant	Perception of Economic Resources Received	Likert (1 to 5)
Control Variables		
Size	Size of the Company (micro, small and medium)	Micro: Dmedium = 0, Dsmall = 0 Small: Dmedium = 0, Dsmall = 1 Medium: Dmedium = 1, Dsmall = 0
Age	Years of Operation of the Company	Continuous
Sector	Economic Sector of the Company (Agriculture, Manufacturing, Services)	Primary sector: Dprimary = 1, Dsecondary = 0 Secondary sector: Dprimary = 0, Dsecondary = 1 Third sector: Dprimary = 0, Dsecondary = 0

and a maximum permissible error of 5% (Ministry of Production, 2019). The sample includes companies at the national level and is representative of the described population (Ministry of Production, 2019).

The sample size is similar to samples used in related studies. For example, Tseng et al. (2011) used a sample of 88 Taiwanese companies in the services sector in their study about the impact of absorptive capacity on innovative performance. Similarly, Solis-Vásquez et al. (2017) conducted a study on the effect of absorptive capacity on innovation in petrochemical companies in Mexico, using a sample of 96 companies. In addition, this study employed G*Power software (Faul et al., 2009), to confirm the adequacy of sample size. Considering that the model has four independent variables, the minimum number of respondents was estimated to be 85, which was obtained with the settings of 0.15 for f2 effect size and 0.05 for error Type I to further achieve 80% of statistical power.

The sample is composed mainly of micro (47.73%) and small (37.50%) companies, with medium-sized companies constituting a smaller proportion (14.77%). In terms of the economic sector, most of the sample is represented by MSMEs from the manufacturing sector (54.55%), followed by services (25%) and agriculture (20.45%). Regarding companies' geographical location, the sample is concentrated in Lima (59.09%), with the remaining 40% representing companies in different parts of Peru: 21.59% in the south, 9.09% in the north, 5.68% in the east, and 4.55% in the center. Finally, most of these missions visited Europe (44.71%), followed by Asia and Oceania (22.35%), then South America (17.65%), and finally North America (15.29%).

4.3. Data Analysis

This study used multiple lineal regression. To apply this technique, a number of assumptions must be met: 1) errors should approximately have a normal distribution, 2) the variation of the dependent variable with respect to each of the independent variables must be linear, 3) the expected average value of errors should be zero (exogeneity), 4) the variance of errors should be constant (homoscedasticity), and 5) independent variables should not be highly correlated (multicollinearity).

Regarding the evaluation of the statistical model, the determination coefficient (R^2) will be used, which is a measure of the variability of the dependent variable that is explained by the independent variables (Hair et al., 2014).

Ⅴ. Results

<Table 2> shows the descriptive statistics and correlations between all variables. This study checked for the assumptions of multiple linear regression. First, the value of the Durbin-Watson test is close to 2 (2.313), which suggests there is no correlation between errors (Field, 2009). Second, the absence of multicollinearity was guaranteed by checking that VIF values were under the threshold of 5 – the highest VIF value was 2.082 for the dummy variable of primary sector (Field, 2009). Third, the linear relationship between each of the independent variables and the dependent variable were all assessed by visual inspection (omitted for brevity), suggesting this assumption is also met. Fourth, the histogram of residuals was inspected in order to check the assumption about the normal distribution of errors. This histogram shows that distribution of errors has

<Table 2> Descriptive Statistics and Correlation Matrix among Variables

Variables	1	2	3	4	5	6	7	8	9	10
1. Innovation	1									
2. Acquisition of External Knowledge	0.639**	1								
3. Internal R&D	0.284**	0.126	1							
4. Staff Training	0.349**	0.292**	0.047	1						
5. Public Innovation Grant	0.326**	0.427**	0.030	0.131	1					
6. Dsmall	-0.050	-0.093	-0.024	-0.189*	0.088	1				
7. Dmedium	0.254**	0.175	-0.027	0.148	0.235*	-0.413**	1			
8. Age	0.065	0.061	0.009	0.163	0.196*	0.155	0.329**	1		
9. Dprimary	0.227*	0.175	0.045	0.160	0.091	-0.057	0.334**	0.272**	1	
10. Dsecondary	-0.041	0.002	-0.017	-0.037	-0.062	0.030	-0.160	-0.66	-0.639**	1
Average	4.35	4.45	N/A	N/A	4.28	N/A	N/A	20.38	N/A	N/A
Standard Deviation	1.95	1.67	N/A	N/A	2.28	N/A	N/A	38.65	N/A	N/A
Minimum	1	2	N/A	N/A	2	N/A	N/A	5	N/A	N/A
Maximum	5	5	N/A	N/A	5	N/A	N/A	64	N/A	N/A

Note: * p-value < 0.05, ** p-value < 0.01
N/A = Not applicable for nominal variables

a mean close to 0 (-4.31E-16) and a standard deviation close to 1 (0.945), which are aligned with those of a standard normal distribution. In addition, this study assessed the skewness and kurtosis of this distribution. The value of skewness is -0.492, with a standard error of 0.261, which results in a standardized skewness of 1.9. For its part, the value of kurtosis is 1.043, with a standard error of 0.517, which means a standardized kurtosis of 2.0. In both cases, the standardized values are in the range of ±2, which means that there is not an extreme violation of this assumption (Field, 2009; Lewis et al., 2012). Considering that multiple linear regression is robust even if this assumption is not met (Knief and Forstmeier, 2021; Pek et al., 2018), this study concludes that this technique is feasible. Fifth, from a visual inspection, the homoscedasticity assumption (i.e., a constant variance of the errors) is not met. Hence, a weighted least squares (WLS) technique should be used (Rosopa, 2006).

<Table 3> shows the results of WLS. The complete model has an R^2 equal to 0.523, while the model made up of only control variables (control model) has an R^2 of 0.045. This difference in R^2 values implies an $f^2 = 1.002$, which suggests a high impact of the independent variables since it is larger than the threshold of 0.35 (Cohen, 1988). From the analysis of coefficients, all the independent variables relating to absorptive capacity have a positive significant impact on innovation: acquisition of external knowledge ($\beta = 0.508$, $p < 0.01$), staff training ($\beta = 0.188$, $p < 0.05$), and internal R&D ($\beta = 0.217$, $p < 0.01$). Regarding public grant, the impact of this variable is not statistically significant ($\beta = 0.034$, $p = 0.717$), thus the relationship between technology-transfer-oriented subsidy and innovation is not verified.

In terms of control variables, those related to age and sector were not significant. For company size,

<Table 3> Multiple Linear Regression Results

Variable	Control Model	Complete Model
Independent Variables (IV)		
Acquisition of External Knowledge		0.508***
Staff Training		0.188**
Internal R&D		0.217***
Public Innovation Grant		0.034^{ns}
Control variables		
Dsmall	0.047^{ns}	0.145^{ns}
Dmedium	0.140^{ns}	0.210**
Age	-0.115^{ns}	-0.121^{ns}
Dprimary	0.190^{ns}	0.103^{ns}
Dsecondary	0.098^{ns}	0.058^{ns}
F Test	0.742^{ns}	9.121***
R^2	0.045	0.523

Note: * p-value < 0.05, ** p-value < 0.01, ns = Non-significant

the dummy variable of medium-sized companies was significant (β = 0.210, p < 0.05), suggesting these companies are more likely to innovate than small and micro companies.

Finally, a possible outlier was detected. Hence, two multiple linear regressions were performed: one including the outlier (n = 85) and the second without it (n = 84). Not much difference was found in terms of the values and significance of the standardized coefficients of the independent variables. Likewise, the R^2 of both regressions were similar ($R^2_{n=85}$ = 0.523, $R^2_{n=84}$ = 0.559). Since there is not a plausible reason to discard this outlier, this study reports only the results of the complete sample of 85 observations.

Ⅵ. Discussion and Implications

The results support the positive effect of absorptive capacity on innovation, providing evidence for H1 to H3. For the first dimension (acquisition) of innovation, 94% of the sample reported they obtained knowledge as a result of the technological mission, while 87% reported having acquired or incorporated new technologies from these missions. Most of the technologies are related to product (78.4%) and process (78.4%) innovations, followed by commercialization (55.4%) and organizational innovations (44.6%). In the case of the second dimension (training), 75% of the sample reported they implemented training programs as a result of the technological mission, with productive techniques being the main topic of these programs (83.6%), followed by health and safety issues (62.3%), ICTs (52.5%), business management (49.2%), marketing (47.5%), and soft skills (44.3%). As for those MSMEs that have not implemented training, they reported that lack of resources, lack of supply, time limitations, and lack of knowledge about entities or training courses were among the main obstacles. Third, in terms of internal R&D, it is observed that most of the sample have increased their budget (67.1%) after technological missions,

while a lower percentage have maintained it (9.4%) or decreased it (7.1%); the remaining 16.5% did not specify.

The subsidy does not have a significant impact on innovation and thus H4 is not supported. Although this finding contradicts prior literature that found a positive relationship between public subsidies and innovation (Basit et al., 2018; Guo et al., 2016), this lack of impact has also been identified in other empirical studies. For example, Koski and Pajarinen (2013) did not find a significant relationship between subsidy and innovation activities in the case of small Finnish companies. Also, in a study of innovation grants in Sweden, it was found that there are no long-term effects between the grant and business performance (Gustafsson et al., 2016). One potential explanation is that the innovation financing structure of these companies has not changed in the three years after the technological mission. Financing from public sources has marginally increased from 7% to 10%, and is the lowest source of financing for innovation activities.

In the case of control variables, it was found that medium-sized companies are more likely to innovate than micro and small companies, which coincides with previous studies that found a significant relationship between innovation and company size (Lau and Lo, 2015; Sorensen and Stuart, 2000).

In summary, results highlight the importance of technological missions as a mechanism to increase absorptive capacity, which in turn encourages innovation in Peruvian MSMEs. These innovation efforts are expected to improve companies' performance. Indeed, 80% of the sample has reported an increase in their sales during the period of analysis. Finally, despite the fact that MSMEs have improved their levels of innovation, 41.1% of them have still reported difficulties for innovating. These difficulties include the lack of financing sources (51.4%), shortage of personnel (51.4%), and uncertainty (45.7%).

6.1. Theoretical Implications

This study identified three theoretical gaps. First, there is little knowledge (limited and inconclusive results) about absorptive capacity in companies from developing countries. Second, there is inconclusive empirical evidence of the effect of absorptive capacity in MSMEs. Finally, there is a lack of research about the impact of technology-transfer-oriented subsidies given by innovation agencies.

Regarding the first gap, this study was conducted in Peru, which is an emerging economy. Therefore, this study provides evidence of the impact of absorptive capacity on innovation in a context characterized by low innovation investments. In fact, there are still various obstacles to innovation in spite of the significant impact of absorptive capacity.

As for the second gap, MSMEs have been used as the unit of analysis in this study. Accordingly, these findings generate knowledge about the role of absorptive capacity in this type of companies, providing empirical evidence of its positive effect on technology adoption and innovation. In short, the results of this study contribute to clarify prior inconclusive findings about the effect of absorptive capacity on innovation.

Finally, for the third gap, according to the Literature Review section, the study by Nieto and Quevedo (2005) was the only one that used companies that received innovation grants as the unit of analysis. Therefore, this study contributes to theory by providing empirical evidence about companies subsidized by innovation agencies. The associated results, however, show that subsidies received from technological missions did not significantly affect innovation in

the Peruvian case. This finding suggests that financial support may not be the only channel to support MSMEs in their way to innovate.

6.2. Practical Implications

By understanding and validating the effect of absorptive capacity on innovation in the context of Peruvian MSMEs that received government economic support, this study will suggest recommendations for both MSMEs and the government.

First, acquisition of external knowledge has a positive impact on innovation. Prior literature has suggested that knowledge-searching strategies can be divided into two categories: breadth and depth (Kim et al., 2019). The breadth category refers to the number of sources with which companies interact to gain new knowledge (Kim et al., 2019). Accordingly, knowledge can be acquired through communication and collaboration with external actors, using various sources of knowledge such as clients, suppliers, collaborators, universities, or business networks (Marshal et al., 2020). Hence, it may be recommendable that entrepreneurs search first within their personal networks to establish alliances with external actors in order to have sources of external knowledge that are economical. On the other hand, the depth category refers to the intensity of collaboration with these various sources (Kim et al., 2019). Therefore, MSMEs should commit to establishing environments of mutual trust and informal ties with these sources. Breadth-related strategies embrace a primary knowledge creation process, while the depth-related strategies constitute a secondary knowledge creation process (Kim et al., 2019). Based on prior findings, and given that MSMEs have budget restrictions, it is recommendable that these companies engage in secondary knowledge creation processes, which are better drivers of radical innovations that are more meaningful for companies than those incremental innovations associated with primary knowledge creation processes (Kim et al., 2019).

Based on the above paragraph, in the specific case of technological missions, MSMEs should try to maintain relationships with international companies visited during these programs, and maintain them as sources of knowledge in order to be at the forefront of new technologies. In addition, it is recommendable that Peruvian MSMEs intensify their interaction with those international companies to achieve a secondary knowledge creation process that may boost their innovation capacities. Further, considering that MSMEs may be discouraged from engaging in knowledge acquisition activities if they perceive the need of high amounts of resources (Pi et al., 2018), it is recommendable that MSMEs search for public or private sources that promote knowledge absorption.

In the case of governments, they should take advantage of virtual opportunities such as launching digital events (fairs, business conferences, or similar). It would be interesting for *Innovate Peru* to establish relationships with commercial missions of developed countries in Peru in order to connect foreign suppliers with Peruvian MSMEs. For example, in Peru there are trade missions from Spain, Israel, USA, and others. These entities can search for and identify relevant foreign technology suppliers for Peruvian MSMEs, and *Innovate Peru* could act as mediator of this relationship. Actually, Angelelli et al. (2017) claimed that innovation agencies may use not only financial but also non-financial mechanisms to encourage innovation. In *Innovate Peru*, the current (and only) mechanism to promote absorptive capacity is financing (subsidizing) technological missions. However, there is still a range of non-financial mechanisms to explore, such as the provision of information

and networking services. This recommendation is aligned with other countries' best practices. For example, Finland's innovation agency provides information and market opportunities services, consulting services, company databases, and business contacts seeking to link MSMEs with external entities to facilitate the absorption of knowledge.

Second, staff training also has a positive impact on innovation. Hence, MSMEs may employ both formal and informal training activities, with informal training having the greatest impact on business performance (OECD, 2012). Informal training is the term given to the assimilated knowledge resulting from day-to-day activities related to work, such as interaction with clients, suppliers, or collaborators (OECD, 2012). This type of training is especially important for low-skilled personnel (OECD, 2012). For highly skilled workers, formal training is usually used. As a business strategy, MSMEs should establish a training plan that promotes a more innovative organizational culture and incentivize staff retention. For instance, MSMEs should map business processes in which their staff interact with external actors in order to identify situations where informal training can take place and be able to systematize this assimilated knowledge. In addition, it is important that these companies create a culture of knowledge sharing based on informal learning situations. Strategies such as mentoring can be useful in achieving this goal. Indeed, pairing new workers with experienced ones is beneficial for the knowledge assimilation process (Kaila, 2021). In addition, promoting a knowledge-sharing culture by organizing spaces (e.g., meetings, webinars, Whatsapp groups) where frontline employees can share their experience of problem-solving situations with other workers may be beneficial for the company's productivity (Kaila, 2021). Now, to motivate frontline employees to share their knowledge, it is important that managers empower and recognize them for these activities, and thus an institutional commitment should be in place to do so (Kaila, 2021).

It is recommendable that *Innovate Peru* promotes technological internships, an instrument similar to technological missions which, as *Innovate Peru* itself says, aim to co-finance the expenses associated with professionals or technicians from companies or associations of producers of goods or services having internships in companies or technological entities in the country or abroad, in order to obtain knowledge regarding a specific technique or technology, which is relevant to improving the productivity of the entity for which they work (Innóvate Perú, 2020c). Through technological internships, workers from MSMEs can acquire knowledge and thus enhance companies' absorptive capacity.

Third, internal R&D was found to positively impact innovation. To promote internal R&D, MSMEs may engage in open innovation strategies with external partners such as academia, corporations, laboratories, or R&D institutes (OECD and Eurostat, 2018). With this strategy, MSMEs could reduce the associated costs of innovation, making R&D activities more accessible (OECD and Eurostat, 2018). In addition, open innovation brings benefits for the collaborating entity. For example, IESE Business School and Wayra (2020) identified around 460 joint work initiatives in 107 corporations in the region. The joint work is made up of different activities such as the challenges of open innovation, scouting, incubation or acceleration, coworking, and hackathons (IESE Business School and Wayra, 2020). Hence, it is recommendable for Peruvian MSMEs to approach higher education institutions for instance, considering that universities have incubation and acceleration initiatives for this type of companies, and that some of these institutions

organize activities such as hackathons or datathons. In addition, there are tax reduction incentives for those companies that engage in scientific research or technological innovation projects jointly with institutions such as universities, or any other authorized center for implementing these benefits. MSMEs may explore this channel to strengthen their relationships with universities (i.e., knowledge sources) to improve their internal R&D capacities at affordable cost.

In the case of governments, they may foster open innovation through the provision of subsidies (Crespi and Castillo, 2020). In Peru, this type of instrument is called collaborative innovation projects. In addition, government may invest more resources to spread the benefits of tax reduction policies for MSMEs that collaborate with authorized centers to implement technological innovation projects. The idea of this strategy is that more companies become aware of these benefits to motivate them to participate in R&D projects to improve either their production or processes.

Finally, no significant relationship was found between subsidy and innovation. These results may be explained by the nature of technological missions. The objective of theses missions is to obtain information, knowledge, practices, or productive techniques. In other words, these missions mainly focus on potential absorptive capacity without considering the next phase (i.e., realized absorptive capacity). Therefore, *Innovate Peru* may consider extending the focus of these missions as other countries of the region have done. For example, CORFO of Chile executes the Regional Technological Diffusion Program, which supports MSMEs to improve their competitiveness through the prospection, dissemination, transfer, and absorption of knowledge (CORFO, 2020). This program finances activities for the diagnosis of technological gaps, courses, workshops, and field demonstration activities, among others (CORFO, 2020). Thus, Chilean MSMEs can attend a technological mission to absorb new knowledge, conduct training, as well as internal R&D for demonstrations in the production plant, covering all the stages of absorptive capacity.

6.3. Limitations and Future Studies

The present study has limitations. First, the sample size was only 85 cases. While this is an accepted sample size, future studies may seek to use larger sample sizes to strengthen these findings. Second, the sample was only made up of Peruvian MSMEs. Through the literature review, it has been possible to verify that empirical studies on absorption capacity may have different results according to the research context. Therefore, future studies may seek to extend this study to other Latin American countries, in order to improve the external validity of these results. Third, only MSMEs that received a public grant constituted this study's unit of analysis. Thus, future studies should assess both beneficiaries and non-beneficiaries of public grants, and then evaluate differences between these two groups. Fourth, this study is centered on technological missions, which focus on potential absorption capacity. Future studies may seek to evaluate other innovation instruments granted to MSMEs by innovation agencies.

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