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Geographical Locations and Technology Capacities of Petrochemical Companies

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Highlights

- Measuring technology capacities in petrochemical companies;
- Investigating the effect of geographical locations on technology capacities in petrochemical companies;
- Providing practical suggestions for developing the technological capabilities of petrochemical companies.

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Abstract

Technological orientation is one of the competitive functions in the capital market, which can be considered a basis for evaluating the advantages of companies in achieving strategic goals. This study aims to investigate the effect of geographical location on technology capabilities. It uses a resource-based view (RBV) to develop the research hypothesis. The research hypothesis was first tested using the data envelopment analysis (DEA) method to measure the technology capacities of companies and then by considering that the research dependent variable was measured as 0 and 1, based on logistic regression. The result of testing the research hypothesis was that the significance level of the coefficient of variable geographical distance (DIS) negatively and significantly affects the technical efficiency vector (TEV). Based on the test of the resource reliance theory, this result indicates that a geographical distance from the center can affect companies' access to competitive resources and, in this situation, reduce the capabilities of their core technology compared to competitors. This study is one of the few studies that examine the effect of technology capability on the geographical distance of petrochemical companies. Its results can help strengthen companies' strategic decisions. Therefore, this study can be considered innovative because it helps develop theoretical literature and strategic decision-making implications.

Keywords: Data Envelopment Analysis (DEA), Geographical Locations, Technology Capacities.

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1. Introduction

Changes in the market under the turmoil of today's economy have limited the possibility of predicting future market conditions and technological needs of companies. Thus, evaluation and capacity assessment to use the capabilities of technology can lead to a competitive advantage for companies, and

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make the need to develop competitive strategies more urgent than ever (Ciborowski and Skrodzka, 2020). Despite many risk factors influencing such strategic decisions, focusing on the geographical location of companies can be considered an important factor in achieving a competitive advantage. Because companies are in situations in economic areas that are due to social influences, economic and environmental conditions limit the access of companies to resources (Fakhari and Naqdi Mashhadikolii, 2019), which is one of the most important risks that companies face in today's market conditions to use the technology capacity. In other words, although the role of industry and market nature of companies cannot be ignored, the distance of the company geographically from the center of distribution of resources and power in the market is always considered one of the most important limitations of companies in this area (Forte and Sa, 2021).

The use of GIS as one of the position assessment techniques dates back to the late 1970s, which, due to the impact on the competitive performance of companies, is of particular importance at the market level for obtaining unimaginable resources (Hassanpour and Giti Nejad, 2021). This feasibility study helps companies absorb new knowledge and technologies, compete in the market, and have more technological capabilities. Technology capabilities in the market are not easily accessible; this issue can lead to a lack of growth and development of industries in the long run (Hosinzadeh et al., 2021). Nevertheless, in the micro dimension, the market share and the lack of balanced access of companies to knowledge and technology, which can be rooted in the geographical distances of companies in different parts of the country, cause technological capabilities as a competitive resource to bridge the gap between companies in an industry (Salisu and Abu Bakar, 2019). Although climate and the environment should not be overlooked as technological functions in the production of products, geographical locations play an important role in creating a colony of technological knowledge in any industry.

It should be noted, however, that there is no clear relationship between companies' geographical locations and technological capacities based on past research. However, references to studies such as Zhou et al. (2005) on strategic orientations with corporate technologies indicate that knowledge-based companies have far higher innovative capacities (He et al., 2020). On the other hand, reviewing the research literature related to the geographical locations of capital market companies such as Li et al. (2014), Li and Zhao (2016), and Chen et al. (2010) shows the proximity of companies in terms of geographical distance to major investors such as mutual funds, cover boxes, investment banks, and financial analysts can be effective in attracting more up-to-date knowledge and technologies to companies due to increased access to resources. However, it can also depend on the company's other capabilities regarding transparency and financial reporting.

The resource-based view theory, as one of the theories that facilitate technology capacities in the competitive functions of companies, can be considered in this regard. According to this theory, companies with a higher ability to attract unique resources and assets can create more value in the market that these values cannot be purchased or copied and can help maintain firm stability in the competitive market (Roshani et al., 2018). Therefore, based on dynamics in research and development, this theory helps companies always look to achieve technological capabilities to react more effectively to market changes, external threats, internal weaknesses, opportunities, and strengths for becoming a competitive advantage. Therefore, although the geographical distance of companies can be considered a threatening factor in attracting technological knowledge to companies, focusing on the resource-oriented perspective can provide deeper competitive opportunities for companies. By avoiding the role of technology-based functions in attracting competitive knowledge and resources in the Iranian market, it can be seen that the technology cycle required for the optimal entry of investors into the capital market is worn out (Sepehrdoust and Sadri, 2017). Further, there is a lack of instructions and regulations related

to the use of technology capabilities such as using trading algorithms, providing information tools from the field of big data, and consolidating and targeting it to create a high knowledge-based solution in the capital market, so companies cannot take advantage of the opportunities in this area.

Therefore, this study focuses on the resource-based view (RBV) perspective to seek the effectiveness of the strategic role of the technology-centric capacity of the geographical location of companies operating in different industries of the capital market. Accordingly, the focus of companies on technological development capacities by stimulating the dynamics of research and development in a competitive market can pave the way for the use of higher technical returns to increase the effectiveness and efficiency of sustainable investments of the company. Therefore, the present study tries to examine the role of knowledge acquisition and functional resources in the technology field by drawing on the current literature on the distance between companies due to the vastness of geography. Examining such a relationship, on the one hand, leads to the theoretical development of the knowledge-based rule to describe the effectiveness of new technologies in achieving competitive resources of companies with geographical dispersion. On the other hand, it evaluates the efficiency and effectiveness of research and development at the level of such companies, which can help formulate more coherent strategies in the field of greater market share by these companies. Therefore, this study seeks to answer the question of whether geographical locations significantly impact the capabilities of technology.

2. Literature review

2.1. Geographical location

The dispersion of companies in terms of geographical coordinates is a basis that has been considered in accounting research in the last decade due to the importance of resource distribution in a competitive market (Gao and Topuz, 2020). However, it should be noted that many companies expand their operations beyond their area of activity to the geographical assets of each region, including a capable workforce, more considerable customer reference, proximity to natural resources, and benefit from tax exemptions. However, the need to pay attention to a company's geographical location can help formulate the company's future visions and strategies. With this approach, the company's geographical location in terms of dispersion can reduce the competitive functions of the company. Numerous factors and variables can be influential in this regard. According to the approach of Maté-Sánchez-Val and Harris (2018), these variables can be strategically effective in geographical positioning.

As can be seen, at three levels of criteria affecting the strategic positioning of companies in terms of three structural foundations, the needs and prices of the region are differentiated. Depending on the type of industry and its activity, each company must pay attention to gaining more market share to advance its plans and projects. Mate-Sanchez-Val et al. (2018) sought to facilitate companies' strategic positioning functions in terms of utilizing competitive capacity in the immediate environment by providing these dimensions. This goes back to Y. Combinator's[†] private programs in the United States which, by evaluating different geographical locations, help companies to select areas to operate in the industry in question, which is a more specific period to return the initial capital, help establish strategic connections, and gain more market share among competitors.

[1] Y. Combinator is an accelerator growth center established in 2005 to evaluate the selection of strategic investment opportunities.

Table 1

Criteria affecting the strategic positioning of companies

	Company building structures	Company needs	Price levels in the region
First level	Access to basic infrastructure	Face-to-face communication with customers and distribution channels	Land prices and commercial/office rents and taxes
	Market access and customer service	The level of information technology	Characteristics of the selected space (social, economic, and cultural)
	Existence of manufacturing companies	Assessing the company's services to stakeholders	Company policies and goals
Second level	Ability to access specialized workforce	Firm size	Use of municipal/local services
	Economies of scale	The distance from the customer business development (CBD)	Access to research and development opportunities
	Market/customer demand	Year of operation	Firm size and manufacturer (customer)
Third level	Proximity or distance from other competitors	Source of investment of the company	Being the center or being a branch of the company (primary/subsidiary)
	Competitive power and reputation of the company	Urban laws and regulations	Organizational and structural changes in the size and type of work of companies

2.2. Capacities of technology based on the resource-based view

Today, technology transfer has become a higher mechanism than cooperation between companies. Technology transfer requires the active participation of all partners and companies to increase their learning and absorption capacity together (Anwar, 2018). Natalicchio et al. (2022) provided the following framework for the effectiveness of corporate learning in developing technology capacities in a competitive market.

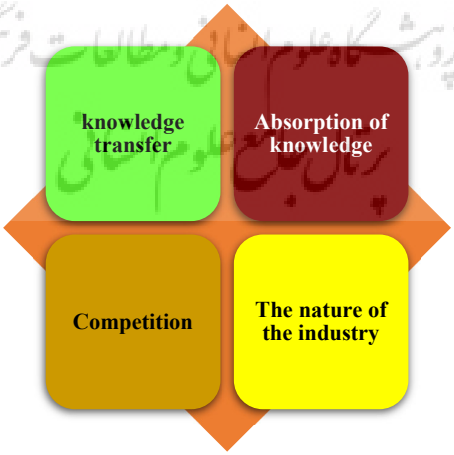

Figure 1

The framework of technology capacities (Natalicchio et al., 2022)

The resource-based approach is a competitive performance model focusing on firm-controlled resources and capabilities as a source of competitive advantage. One of its dimensions is the capabilities of

technology. Empirical evidence consistently shows that industry structure or external factors are not the sole determinants of competitive strategy and performance (Salisu and Abu Bakar, 2019). For this reason, a group of theorists in this field, such as Maiti et al. (2020) and Fahy (2000), stated that having distinct gifts of strategic resources is the ultimate determinant of strategy and performance that can be achieved for companies as follows.

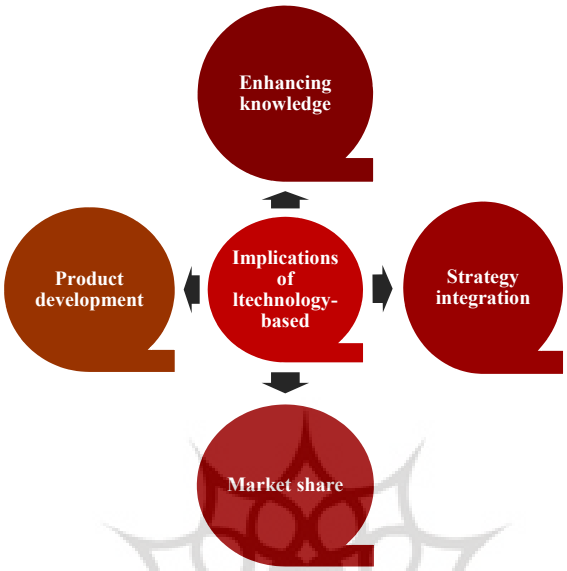

Figure 2

Consequences of using technology capacities (Maiti et al., 2020)

This attitude is precisely in line with the phenomenon of knowledge-based competition. Such competitions cause a company's long-term success to depend on what it knows and understands. Therefore, competitors look at capabilities and competencies as a key to success against their competitors (Younesi et al., 2016).

2.3. Hypothesis development

Reviewing studies such as Coval and Moskowitz (2001), Boubaker et al. (2014), and Wang et al. (2016) demonstrates that the geographical location of companies plays a vital role in the decisions of external users because financial resources do not surround the company; technically and humanely, the geographical distance from the center can obscure the future of such companies. Nevertheless, an issue that is often overlooked in corporate financial decision-making is the long-term consequences of corporate expansion, which puts the effectiveness of knowledge acquisition and the increasing development of information and communication technology in a haze of ambiguity and will lead to a gap between the company and shareholders from the perspective of agency theory. Accordingly, it is expected that there is a relationship between the geographical location of the company and the core technology of companies, and agency costs will enable the company to achieve higher technical efficiency among competitors through research and development. This will lead to an increase in the company's access to the financial resources needed to advance plans and projects. Liu and Jiang (2016) stated that a resource-based approach will help increase competitive advantage by combining capabilities and technology. Technological capabilities based on the source-oriented perspective were proposed by Teece et al. (1997). This capability includes the strategic area of companies' competitive functions, which helps create and develop valuable resources (Mobini Dehkordi et al., 2017). Jaffe et

al. (1993) and Keller (2002) stated the importance of knowledge's role in companies' geographical location. Companies located in a geographical location close to resources use the competitive potential of knowledge overflow, leading to increased technological capabilities for companies because they can achieve innovation in competitive functions in the industry through the combination or integration of knowledge (Sobanke et al., 2014). On the other hand, researchers such as Teece et al. (1997) and Tsai (2004) considered the role of companies in geographical locations in a region as a factor in transferring technology from developed countries to companies in developing countries; reviewing such facts in countries such as China (Hey et al., 2020), Russia (Väätänen et al., 2009), Mexico, India, and Brazil (Chittor and Ray, 2007; Dechezleprêtre et al., 2009) can be considered a confirmation of this claim. Emphasizing the focus on tacit knowledge for companies to innovate in a competitive market, Juarez et al. (2021) stated that the choice of geographical location as a strategic basis is dominated by formal and non-toxic streams of knowledge that companies should not be unaware of. On the other hand, Whitefield et al. (2020) considered the ratio of input to output knowledge a factor for exploiting pure expertise in companies and stated that the choice of geographical locations for companies depended on industry-specific factors in the equal distribution of knowledge and technology. Therefore, by reviewing the theoretical foundations and empirical support of the research, the research hypothesis can be expressed as follows:

Hypothesis: Geographical locations have a significant effect on the technology capacities of petrochemical companies.

3. Research Methodology

The present study is applied in terms of purpose and data collection method, and it is a semi-experimental and post-event research in positive accounting research. It uses data envelopment analysis and logit regression to measure variables and test the research hypothesis. The statistical population studied in this study consists of petrochemical companies listed on the Tehran Stock Exchange from 2017 to 2021, and the selected sample of the research is knowledge-based companies that have the following conditions:

- Companies whose admission date in the stock exchange organization is before 2017 and are on the list of petrochemical companies in the stock exchange until the end of 2021.
- Their fiscal year shall end at the end of March, and they have not changed their activity or fiscal year during the mentioned years.
- They are not part of investment and financial intermediation companies; investment companies are not included in the statistical community due to their different activities.
- The interruption of transactions in these companies should not exceed three months during the mentioned period.

After applying the above restrictions, 75 companies were selected as the research sample. The reason for choosing a statistical sample is the existence of research and development criteria in measuring the variables of technology capacities as a basis for technical efficiency. The data of the present study were extracted from the compact discs of the statistical and video archives of the Tehran Stock Exchange, the website of the Tehran Stock Exchange, and other related databases. The final analysis of the collected data was performed using Eviews software. Considering that the cost of R&D, as one of the variables calculated in technology capability based on the model of Dutta et al. (1999) and Li et al. (2010), is of interest, is usually disclosed voluntarily, and is not disclosed by many companies, this study used companies related to petrochemicals.

3.1. Research variables

3.1.1. Independent variable

This research uses the following three criteria to measure the geographical location variable.

3.1.1.1. The first criterion: the logarithm of the distance from the center

Following El Ghoul et al. (2012) and Loughran and Schultz (2006), this study uses the logarithm of distance. The logarithm examines the distance ratio of the geographical location of companies to the capital. Relying on the theoretical underpinnings of Moskowitz (2001) on the competitiveness of companies close to the center to engage with financial institutions and banks' investment funds, this study uses the following equation to measure the distance between points A and B:

$$DIS_iA - B = arc\ cos[Cos(lat\ A) \times Cos(Long\ A) \times Cos(Lat\ B) \times Cos(Long\ B) + Cos \times Lat\ A) \times Sin\ (Long \times Cos(Lat\ B) \times Sin(Long\ B) + Sin(Lat\ A) \times Sin(Late\ B)] \times (2JIr)/360 \quad (1)$$

where *Lat* and *Long* are the latitude and longitude of the geographical location of the company to the capital, i.e., Tehran, which can be calculated based on reputable sites such as the Iranian Astronomy site (Fakhari and Naqdi Mashhadkolaii, 2019). In this research, the logarithm of this relationship will be used to calculate the company's geographical location accurately.

3.1.1.2. The second criterion: the large scale of the province

In this criterion, following the research of Yao et al. (2019), the two-dimensional variables 0 and 1 are used. In this way, if a company is located in seven big cities in terms of geography and population according to the geographical division of provinces, it will be assigned 1; otherwise, it will be assigned 0.

3.1.1.3. Third criterion: logarithm of road distance

Following the honorary and critical research of Fakhari and Naqdi Mashhadikolaii (2019), the two-dimensional variables 0 and 1 are used to measure this criterion. Thus, 1 will be assigned to a company outside the capital and 0 to a company inside the capital.

Considering that each of the above criteria alone may disrupt the measurement of geographical location variable, the present study measures this variable from a competitive index based on the mean decimal rank of the three criteria for observations (year-company), following the research of Chen et al. (2018) and Noravesh et al. (2016). For this purpose, companies are first classified into 10 categories (deciles) based on each of these three criteria of geographical location each year. Thus, the companies with the lowest geographical position are in the first decile, and those with the highest are in the last decile. Then, the total number of decile ranks obtained from each of the above criteria for each company in each year is divided by 3 (the number of criteria for measuring the geographical location) to obtain a comprehensive index of the geographical location of each company. This composite index ranges from –10 to 10, so larger (smaller) values indicate more (less) geographical distance of the company. This comprehensive index reduces the skewness caused by the virtual application of each geographical location criteria and provides a more accurate criterion for testing (Gaio and Raposo, 2010).

3.1.2. Dependent variable

3.1.2.1. Technology capacities

Technological competitiveness will provide a competitive advantage in terms of the company's technical efficiency in transforming its internal resources into product resources because such capabilities, embodied in in-company processes, are not transferable or imitative. Following this discussion, Dutta et al. (1999) measured the competitiveness of technology (as the firm's technical

efficiency in converting input to output) relative to competitors. This study follows the research of Dutta et al. (1999) and Li et al. (2010) about the resource-based view (RBV), corporate technological competitiveness as the relative technical efficiency of a company through which it turns R&D resources into an innovative product. Following the study by Griliches (1984), the cumulative R&D resources of company *i* in year *t*, defined as $RND_{i,t}$, are redefined as follows:

$$RND_{i,t} = Ln\left[RDE_{i,t} + \sum_{1}^{\tau}(1-\gamma)^{\tau}\, RDE_{i,t-\tau}\right] \quad (2)$$

where $RDE_{i,t}$ is the research and development costs of firm *i* in year τ‡, and γ indicates the investment rate in research and development[§].

Following the research of Namazi and Moghimi (2019) and Hajiha and Kharatzadeh (2015), the basis of technical innovation will be used to extract investment data in research and development. Since data envelopment analysis (DEA) will be used to measure this variable, the inputs of this analysis are based on the symbol $RDE_{i,t}$ which is a cumulative measure, the ratio of the training costs to total salary costs, the number of professional staff, and research and development costs; the output is the profitability of companies. In this study, data envelopment analysis was used to examine the capabilities of each company's core technology in terms of its technical efficiency compared to other competitors in converting cumulative R&D resources in the form of symbol to $PAT_{i,t}$ profitability. In other words, data envelopment analysis outputs are a proportion of the impact of research and development on profitability. According to Schumpeter (1963), research and development are effective in profitability (Batabyal and Beladi, 2016). According to this approach, firms with higher monopoly power can achieve risk reduction by creating innovation by increasing research and development costs; thus, profitability under the influence of research and development increases by maintaining more monopoly power, which is the basis for measuring change in the impact of research and development on the performance of companies in a competitive environment. Hence, the data envelopment analysis performance metrics are as follows:

$$SE_{i,t} \rightarrow TEV_{i,t} = AD/AC \quad (3)$$

where $SE_{i,t}$ is the computational basis of data envelopment analysis based on decoding, which leads to $TEV_{i,t}$, the technical efficiency of companies' technology capacities. These performance metrics have the following characteristics:

- Their values are between 0 and 1;
- They measure returns against "best performance" among the companies surveyed;
- $\frac{1}{TEV_{i,t}} - 1$ multiplied by the proportional increase in core technology outputs $PAT_{i,t}$ without increasing the input of corporate technology capacities, $RND_{i,t}$; this occurs if the company maximize your technical efficiency in moving from point D to point C.

Based on this, the calculation of this variable will be $TEV_{i,t}$, i.e., technical efficiency. The companies were ranked in the first decile to the last decile according to the input variables (the ratio of training costs to total salary costs, the number of professional staff, and research and development costs) and the output (profitability) using data envelopment analysis and decile. Thus, if the technical returns

‡ The letter τ is a Greek word that refers to *t* years in company data reviews.
§ In order to measure the values of γ and τ, Griliches (1984) assumed a constant value of 0.4 for γ and 5 for the time period *τ*.

obtained according to the companies' deciles are equal to or greater than $TEV_{i,t} \geq 1$, the core technology capacities of the companies based on technical returns are essentially unimaginable; this indicates the existence of technology-centric capacities of companies, so 1 is assigned to the companies. However, suppose the technical efficiency obtained according to the decile of companies is less than ($TEV_{i,t} < 1$), then it indicates the low technical efficiency of the companies under review. This means that companies in this decile do not have core technology capacities or have low technologies, so they are assigned the number 0.

3.1.3. Control variables

In determining the control variables, the variables that have the most significant impact on the geographical distance with the development of the technology were considered.

Firm size: Size is primarily based on the hypothesis that resource power affects the company's position and technological capabilities. Kim and Choi (2020) showed that larger companies have higher capabilities to provide the necessary resources to invest in technology than smaller companies due to their greater resources and economic strength.

Growth expectation: It is measured by the ratio of the book value to the market value and reflects investors' expectations for the company's future performance. Market-level companies from the center may have fewer technological capabilities than their competitors. In these circumstances, investors' low expectations of these companies can justify their lack of technology (Vitorino Filho and Moori, 2018).

Return on assets: The ratio of operating profit to total assets of the company is defined, and its higher value can be considered a basis for the existence of technology capacities of companies against competitors. Therefore, since the efficiency of corporate assets can be viewed as a competitive evaluation of companies, higher technology can lead to more effective returns on investments (Giménez et al., 2019).

Liquidity: The ratio of cash to the company's total assets is used to measure this variable. As the firm's liquidity increases, the liquidity constraints on using technology-driven capacities will decrease, which could add to the company's competitive performance (Li et al., 2018).

3.2. Research models

Given the nature of the research variables and the hypothesis, Equation 4 is used to measure the model of the research hypothesis:

$$Ln\left(\frac{TEV_{it}}{1-TEV_{it}}\right) = \varsigma_0 + \varsigma_1 DIS_{i,t} + \varsigma_2 RND_{i,t} + \varsigma_3 Size_{i,t} + \varsigma_3 ROA_{i,t} + \zeta_4 AGE + \varepsilon_{it} \quad (4)$$

where, $DIS_{i,t}$ is the geographical distance of company *i* at time *t*.

Further, for better regression analysis, in the research hypothesis model, it should be noted that, based on data envelopment analysis, if $TEV_{i,t}^{*}$ is the optimal scale ($TEV_{i,t} \geq 0$) (i.e. point P in Figure 3), R&D costs ($RND_{i,t}$) can effectively play a role in companies' core technology capacities according to Equation 4, despite their geographical distance from the center. Finally, if scale returns are potentially reproducible among firms, and it is therefore impossible to distinguish between firms with and without core technology capabilities, then ρ_1 and ρ_2 are expected to be zero. $\rho_1 \neq \rho_2$ is also possible because scale returns can be easily improved when the firm operates at a higher than optimal level instead of performing poorly.

4. Results and discussion

This section presents descriptive statistics of research variables and then inferential statistics in the form of data envelopment analysis to measure technological capacities, default models, combinations, and testing of research hypotheses.

4.1. Descriptive statistics

Familiarity with descriptive statistics related to variables is necessary to study the general characteristics of variables, model estimation, and detailed analysis. Table 2 lists the descriptive statistics of the tested variables, which include some central indicators and dispersion.

Table 2

Descriptive statistics of research variables

Variable	Symbol	Observations	Mean	Mean	Minimum	Maximum	Standard deviation
Technology capacities	TEV	375	0.293	0.000	0.000	1.000	0.455
R&D logarithm	RND	375	8.098	9.113	6.057	10.15	0.622
Geographical distance	DIS	375	4.391	4.367	2.278	6.541	1.267
Firm size	SIZE	375	13.17	12.99	10.19	17.12	1.32
Expect growth	GROW	375	0.375	0.380	0.08	0.63	0.145
Return on assets	ROA	375	0.214	0.192	–0.434	0.756	0.165
Liquidity	CASH	375	0.064	0.036	0.002	0.875	0.102

As can be seen in Table 2, based on descriptive statistics, the mean TEV technical efficiency of the companies under study is 0.293, which indicates that the technological capacities of the companies are more significant than one, i.e. ($TEV_{i,t} \geq 1$); hence, the technologies of the companies under study are unimaginable. Still, given that they are less than half, it should be noted that the level of knowledge in this field is very low and based solely on corporate investments; the main focus on training returns is on salaries and professional staff. It was also found that the logarithm of research and development costs is equal to 8.098, which is clear that there is not much difference between the companies surveyed in these companies, according to the standard deviation below 1. The growth expectation (GROW), as a variable of one of the control variables of the research, is equal to 0.375, which indicates that the expectation of growth of companies' stock value is below 0.5 on the mean. Moreover, the liquidity variable equals 0.064, which shows that 6.4% of the total assets of the surveyed companies constitute the mean cash. According to the results obtained from the descriptive statistics of research variables, which show that the mean and median in most research variables are close, there is a good distribution in this field. Table 3 also presents the percentage and frequency indices for the technology-oriented two-dimensional variable.

Table 3

The percentage of frequency and mode

Variable	Symbol	Frequency percentage (1)	Frequency percentage (0)	Mode
Technology capacities	TEV	33.29%	67.70%	0

From the obtained result, it can be found that 29.33% of the surveyed companies have almost unimaginable technologies, and 70.67% of the surveyed companies have similar technologies, which cannot help their competitive capacities. As explained in the research model, to estimate the model of the first hypothesis based on logistic regression, the statistics of conformity or fit test and Hosmer-

Lemeshow test or the same assumption of model suitability (model adequacy) are employed. To determine the fit of the model of the first hypothesis, the Omnibus test is used, which examines the quality of the model performance. In this test, the chi-square value (χ^2) indicates whether the independent variable affects the dependent variable.

H_0: $\chi^2 = 0$ Geographical distance does not affect the technology capacities.

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Table 4

The Omnibus test

Test	χ^2	Degrees of freedom	Significance level	Test results
Omnibus	10.515	4	0.000	Rejection of H0

As can be seen, due to the significant level of chi-square value (10.515), which is less than 5%, the independent variable, company geographical distance (DIS) on the technology capabilities (TEV), is confirmed and has a good fit of the model. Therefore, the null hypothesis is rejected at a confidence level of higher than 95%, and the H1 hypothesis is accepted, that is, accepting the original hypothesis. The Hosmer-Lemeshow tests confirm the model's usefulness and indicate agreement between the observed and predicted results. This statistic tests the null hypothesis and suggests the model's suitability. If its significance level is less than 5%, the adaptation is poor, and the model is unsuitable. Since the significant level of the chi-square statistic (11.119) is greater than 5%, these results show that the data are sufficient for the model fit.

H0: The model is fit (sufficiency of data models).

H1: The model is not fit (insufficiency of data models).

Table 5

The Hosmer-Lemeshow test

Test	χ^2	Degrees of freedom	Significance level	Test result
Hosmer-Lemeshow	11.119	6	0.215	Acceptance of H0

The results of testing the research hypotheses according to the following model are presented in Table 6.

$$\mathrm{Ln}\left(\frac{\mathrm{TEV_{it}}}{1-\mathrm{TEV_{it}}}\right) = \varsigma_0 + \varsigma_1 \mathrm{DIS_{i,t}} + \varsigma_2 \mathrm{RND_{i,t}} + \varsigma_3 \mathrm{Size_{i,t}} + \varsigma_3 \mathrm{ROA_{i,t}} + \zeta_4 \mathrm{AGE} + \varepsilon_{\mathrm{it}}$$

Based on the result in Table 6, it should be stated that the values of Cox-Snell and Nagelkerke determination coefficients represent the amount of change in the dependent variable, which is explained by the model and is equivalent to the coefficient of determination (R^2) in linear regression. However, accurate R^2 is impossible in logistic regression, and it equals 10.12% and 15.4%, respectively in the fitted model. These results show a minimum of 10.12 and a maximum of 15.04 (approximately low and high), which are the percentage of predictive changes in the probability of having axial technology capacities by the components of independent and control variables explained based on logistic regression. The regression coefficients of the variables are tested to examine the research hypothesis.

DIS negatively and significantly impacts technology capabilities TEV. Expectation–prediction evaluation of binary specification has also been used to determine the percentage of model prediction accuracy.

Table 6

The test result of the first research hypothesis

Dependent variable: Technology Capacities (TEV) Period: 2016–2021 **Observation: 375 (year-company)**	**Number of companies surveyed: 75 companies**		
Variables	**Kind of relation**	**(TEV) Regression coefficient**	**Parent statistics**
Width of origin	؟	0.193	2.365
Geographical distance	–	–0.515***	–6.043
Logarithm of research and development costs	+	0.489**	5.761
Firm size	+	0.226*	3.091
Expect growth	+	0.93	1.075
Return on assets	+	0.316**	4.613
Liquidity	+	0.328*	4.437
Cox and Snell determination coefficient		10.12	
Coefficient of determination of Nagelkerke		15.04	
Proper statistics		127.253	
Percentage of accurate prediction of the potential of core technology capacities		29.33	
Percentage of accurate prediction of the probability of technology capacities		70.67	
Percentage of correct overall prediction of the research model		41.43	
Probability of technology capacities based on observations from a total of 375		110	
Impossibility of technology capacities based on observations from a total of 375		265	

Note: * Expresses statistical significance at the error level of 5%.
** Expresses statistical significance at the error level of 1%.

Conclusions

This study aimed to determine geographical locations and technology capacities based on evaluating the resource-based view theory in petrochemical companies based on data envelopment analysis. The research hypothesis test demonstrated that geographical locations had a negative and significant effect on the capabilities of the technology. In line with the resource-based view theory in the analysis of the result, it should be noted that the farther away the companies were from the center in terms of geographical coordinates, the lower the level of access to resources as an essential resource in competitive inter-firm functions was; this can reduce the level of technology capacities of petrochemical companies. The resource-based view theory states that companies must have two critical resources to achieve a competitive advantage. The first source of skills, capabilities, and resources is related to the company's innovations that make one company superior to another. The second source in this theory refers to fixed and capital resources that cannot be transferred and imitated from one company to another, at least in the short term, due to significant investments or technical knowledge. In other words, companies with the same number of different resources cannot use different competitive strategies to conclude and overtake each other. Accordingly, innovation in technical knowledge makes the operational strategies in petrochemical companies unusable to other companies. In this case, a competitive advantage is gradually created for such companies. Therefore, by accepting the assumption

that resources are usually concentrated in the center, the existence of a geographical distance from the center can affect the access of petrochemical companies to competitive resources and, in this case, reduce their technology capacity compared to competitors due to challenges such as financial constraints, unwillingness of foreign investors, and not having technical knowledge to enter that point. It should be noted that remote geographical coordinates of companies in countries with a vast territory such as ours can hit their competitors not only in the region but also in an industry in terms of access to significant resources. Gradually, the lack of transfer of newer technical knowledge into the structures of a company causes it to miss out on gaining competitive advantages over its competitors in the market. The results of personalizing the research of He et al. (2020), Whitfield et al. (2020), Liu and Jiang (2016), and Jo and Lee (2014) correspond. Based on the obtained result, it is suggested that policymakers and analysts supervising the performance of petrochemical companies in the stock market should aim at creating a balance in the market to facilitate the process of knowledge acquisition for companies by providing the required funding for development-oriented projects; sustainable companies that can help the country's economy should also do the necessary planning. In this direction, the formation of special working groups in the evaluation of development-oriented petrochemical projects can help the stability of these companies in the market and strengthen competition based on knowledge acquisition at the industry level. On the other hand, companies themselves can take the necessary steps to develop the core technology capacities of petrochemical companies through integration strategies or joining a consortium to transfer the unparalleled knowledge of other companies into their operating structures. Moreover, by keeping their capabilities in terms of internal functions, they can become a market leader in strengthening the company's strengths in attracting external knowledge.

Nomenclature

DIS_iA-B	The logarithm of the distance from the center
Firm size	total assets, total sales, and market value of equity
Growth expectation	It is measured by the ratio of the book value to the market value and reflects investors' expectations for the company's future performance.
Lat and *Long*	the latitude and longitude of the geographical location of the company to the capital Market
Liquidity	The ratio of cash to the company's total assets is used to measure this variable.
$RND_{i,t}$	the research and development costs of firm i in year t
ROA	Return on assets: the ratio of operating profit to total assets of the company
$SE_{i,t}$	the computational basis of data envelopment analysis based on decoding firm i in year t
$TEV_{i,t}$	Technical efficiency of firm i in year t
γ	indicates the investment rate in research and development

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