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The Application of Business English in Communication for Real Estate Investment Projects in Emerging Markets

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Abstract To explore the core value of business English application in cross-cultural real estate investment projects and address the issue of low investment efficiency in some enterprises, this paper selects the CCR model and BCC model from the data envelopment analysis method to analyze the investment efficiency of real estate investment projects from a static perspective. Additionally, the Malmquist productivity index, which calculates the input-output index using the distance function ratio, is introduced to dynamically monitor the investment efficiency of real estate investment projects. Panel data from 30 provinces, municipalities, and autonomous regions in China from 2012 to 2023 were selected to construct a panel regression model examining the impact of business English application on the investment efficiency of real estate investment projects. The results show that teams with high levels of business English proficiency can enhance project investment efficiency. The cultural difference coefficient at the national level is -0.065, indicating that cultural differences significantly reduce real estate investment efficiency. Therefore, it can be concluded that improving business English proficiency is an effective path to optimizing the investment efficiency of real estate investment projects in emerging markets.

Index Terms Data Envelopment Analysis (DEA) method, Malmquist Productivity Index, panel regression model, real estate project investment efficiency

I. Introduction

As society continues to develop and globalization deepens, the ability to obtain effective information and the speed at which information is obtained have become critical factors in the success or failure of any endeavor. Communication enables both parties to convey information, exchange ideas, and collaborate, thereby promoting productivity and driving the completion of numerous great human projects [1]. On one hand, throughout the entire project management process, its essence lies in human activities. Given the inherent characteristics of humans, the importance of mutual communication is self-evident [2], [3]. On the other hand, communication management is a consensus that runs throughout the entire project management process and holds a significant position during project operations [4], [5].

In recent years, China's real estate projects have been booming, with project investors increasingly focusing their attention on this sector, leading to intensified competition within the industry. However, stringent policy controls and tightened credit conditions have left real estate investors or developers with strained cash flows, shifting the industry from a high-return phase to a low-margin phase. Therefore, real estate projects must further enhance project management efficiency and improve engineering project effectiveness [6]-[9]. Additionally, real estate project construction is closely intertwined with various sectors of society, involving numerous stakeholders. Different stakeholders involved in real estate project construction often face conflicts and communication breakdowns due to the need to protect their own objectives and interests, which can delay project progress and waste human and financial resources [10]-[12]. Furthermore, if these stakeholders cannot effectively participate in project decision-making and management processes, it may lead to conflicts and resistance during project execution, thereby affecting project progress and outcomes [13]-[15]. Therefore, communication and coordination are undoubtedly the core issues for enhancing the efficiency of real estate projects. A well-established communication management mechanism in real estate construction projects can effectively facilitate coordination among all stakeholders, avoid conflicts and obstacles, and ensure the smooth progress of real estate project development.

Business English, as a typical applied interdisciplinary field, encompasses multiple disciplines such as linguistics, economics, management, law, and sociology [16]. It focuses on training students' business knowledge, skills, and practical operational capabilities in an English-language environment [17]. Integrating Business English into the construction of real estate project communication mechanisms not only facilitates the rapid development of real

estate economics and transactions but also promotes new growth and breakthroughs in English-related disciplines, holding significant importance [18], [19].

Addressing the efficiency loss risks caused by cultural differences in some real estate investment projects in emerging markets, this study employs Data Envelopment Analysis (DEA) to explore the mitigation mechanisms of Business English application for this issue. First, the CCR model is used to measure the overall efficiency of real estate investment project decision-making units. Then, the BCC model is further applied to calculate technical efficiency, deriving the relationships between pure technical efficiency, scale efficiency, and technical efficiency. Subsequently, the Malmquist index analysis method is employed to conduct a dynamic analysis of the investment efficiency of 36 real estate development companies from 2017 to 2020. Empirical analysis is used to explore the specific pathways through which the application of business English influences the investment efficiency of real estate investment projects.

II. Exploring the efficiency of business English in real estate investment project communication applications

II. A. Data Envelopment Analysis Method

Data Envelopment Analysis (DEA)[20] is a non-parametric statistical method proposed by American operations researchers to evaluate the relative efficiency of decision-making units (DMUs) with multiple inputs and outputs. The DEA model uses mathematical programming methods to assess the relative efficiency of DMUs. If a DMU is located on the production frontier, it is considered efficient. In summary, DEA is a non-parametric statistical method that uses input-output data to construct a DEA model for economic analysis. It also provides management information to support improvements in management levels. Therefore, DEA is increasingly widely applied across various fields. The basic DEA models are the CCR model [21] and the BCC model [22].

II. A. 1) CRR model

The CCR model is one of the basic models in data envelopment analysis (DEA), derived under the assumption of constant returns to scale (CRS) to measure investment efficiency. This model includes two dimensions: input-oriented and output-oriented. This paper primarily focuses on the input-oriented model.

There are n real estate firms (DMUs) to be evaluated (j = 1, 2, ..., n). Each of these n real estate firms has m input factors (representing the DMU's consumption of “resources”) and s output factors (representing the “effectiveness” of the DMU's resource consumption).

First, define X_{ij} as the input quantity of the jth real estate enterprise DMU for the ith input, where $X_{ij} > 0$; Y_{rj} as the output quantity of the jth DMU for the r th output, where $Y_{rj} > 0$; Then, assign weights to the efficiency indicators: v_i is the weight for the i-th input; u_r is the weight for the r -th output. Here, i = 1, 2, ..., m; r = 1, 2, ..., s; j = 1, 2, ..., n. This can be expressed as:

$$\begin{aligned} X_j &= (x_{1j}, x_{2j}, ..., x_{nj})^T, j = 1, ..., n \\ Y_j &= (y_{1j}, y_{2j}, ..., y_{sj})^T, j = 1, ..., n \\ v &= (v_1, v_2, ..., v_m)^T \\ u &= (u_1, u_2, ..., u_s)^T \end{aligned} \tag{1}$$

where X_j and Y_j are the input vectors and output vectors of the selected real estate enterprise DMU_j, respectively, which are known quantities. v and u are the weight vectors of m inputs and s outputs, which are variables. Then the comprehensive value of DMU_j input is $v^T X_j$, and the comprehensive value of output is $u^T Y_j$, then the comprehensive efficiency evaluation index h_j of the real estate enterprise DMU_j is:

$$h_j = \frac{u^T Y_j}{v^T X_j}, j = 1, 2, ..., n \tag{2}$$

From the above equation, it can be seen that for any n real estate companies, appropriate weighting coefficients v and u vectors can be selected such that $h_i \le 1 (j = 1, 2, ..., n)$. Based on the above analysis, a relative efficiency evaluation model for the joth real estate company is constructed with the efficiency index of the selected real estate companies as constraints, as shown in formula (3):

$$\begin{aligned} &\max h_j = \frac{u^T Y_{j_0}}{v^T X_{j_0}} \\ &v,u \geq 0 \\ &\frac{u^T Y_{j_0}}{v^T X_{j_0}} \leq 1, j = 1,2,...,n \end{aligned} \tag{3}$$

The above fractional programming model can be further solved. Simplify it into a linear programming model, let:

$$\begin{aligned} &t = \frac{1}{v^T X_j} \\ &u = tu \\ &w = tv \end{aligned} \tag{4}$$

The model is converted to:

$$\begin{aligned} &\max h_{j_0} = u^T Y_{j_0} \\ &w^T X_j - u^T Y_J \geq 0, j = 1,2,...,n \\ &u,w \geq 0 \\ &w^T X_{j_0} = 1 \end{aligned} \tag{5}$$

Introducing the non-Archimedean infinitesimal ε, the dual programming model is transformed as follows:

$$\begin{aligned} &\min[\theta - \varepsilon(\hat{e}^T S^- + \hat{e}^T S^+)] \\ &\sum_{j=1}^{n} X_i \lambda_j + S^- = \theta X_{j_0} \\ &\sum_{j=1}^{n} Y_j \lambda_j - S^+ = Y_{j_0} \\ &S^+ \geq 0, S^- \geq 0, \lambda_j \geq 0, j = 1,2,...,n \end{aligned} \tag{6}$$

In the equation, θ represents the technical efficiency value of DMU_{j0}, with a range of $0 \leq \theta \leq 1$. When $\theta = 1$, it indicates that the DMU is on the efficiency frontier and is efficient. θ can be understood as the actual required input ratio. S^+ represents the output shortfall, and S^- represents the input surplus. The effectiveness of DEA is judged based on θ, S^+, and S^-. For the results of the formula, we have:

① If DEA is efficient, then $\theta = 1, s^+ = 0, s^- = 0$;
② If DEA is weakly efficient, then $\theta = 1, s^+, s^-$ are not all zero;
③ If the DEA is not effective, then $0 < \theta < 1$.

II. A. 2) BCC model

The BCC model is also one of the basic models of data envelopment analysis. It is based on the CCR model and derives investment efficiency (VRS) under the assumption of variable returns to scale. The model includes two orientations: input and output. This paper mainly studies the input-oriented model.

In the CCR model, the following constraints are added:

$$\sum_{j=1}^{n} \lambda_j = 1 \tag{7}$$

The BBC model was constructed. That is:

$$\begin{aligned}
&\min[\theta-\varepsilon(\hat{e}^T S^- + \hat{e}^T S^+)] \\
&\sum_{j=1}^{n} X_i \lambda_j + S^- = \theta X_{j_0} \\
&\sum_{j=1}^{n} Y_j \lambda_j - S^+ = Y_{j_0} \\
&S^+ \geq 0, S^- \geq 0, \lambda_j \geq 0, j = 1,2,...,n \\
&\sum_{j=1}^{n} \lambda_j = 1
\end{aligned} \tag{8}$$

Assuming variable returns to scale, the calculation results of the above formula are efficiency values excluding scale, yielding pure technical efficiency. In the formula, θ is the efficiency value without considering the impact of scale, i.e., pure technical efficiency. If $\theta_{BCC}=1$, then the DMU is pure technically efficient. If $\theta_{BCC}<1$, then pure technical efficiency is ineffective.

The CCR model yields the comprehensive technical efficiency θ_{CCR}, while the BCC model yields pure technical efficiency $\theta_{BCC}=1$. Dividing the two yields scale efficiency θ_s. If $\theta_s=1$, it indicates that the DMU is at optimal scale, and thus scale-efficient; if $\theta_s<1$, it indicates that the DMU is not at optimal scale, possibly due to being too large or too small.

II. B. Malmquist Index Principle

The Malmquist productivity index [23] is calculated using the ratio of distance functions to measure input-output indices. It was first applied to production theory in 1982 to calculate productivity indices. Research promoting this method combines nonparametric linear programming with data envelopment analysis (DEA) theory and further modifies the expression formula of the Malmquist index so that it can be used to represent total factor productivity indices. The specific mathematical expression is as follows:

$$M_o^t = D_o^t(x^{t+1}, y^{t+1}) / D_o^t(x^t, y^t) \tag{9}$$

Let $x=(x_1, x_2 \cdots x_i)$ be the input vector and $y=(y_1, y_2 \cdots y_i)$ be the output vector. The subscript o denotes the distance function based on output. $D_o^{'}$ is the distance function for period t, using the technology $T^{'}$ at period t as a reference. It measures the change in technical efficiency from period t to period t+1 under the technical conditions of period t. Similarly, the Malmquist productivity index for period t+1, using the technology T^{t+1} as a reference, can be expressed as:

$$M_o^{t+1} = D_o^{t+1}(x^{t+1}, y^{t+1}) / D_o^{t+1}(x^t, y^t) \tag{10}$$

The calculation of the Malmquist productivity index is prone to bias due to the arbitrary selection of periods. The approach taken in this paper is to use the average value as a substitute. If the Malmquist index is greater than 1, it indicates that total factor productivity is increasing during that period, meaning that the overall productivity level is high. If it is less than 1, it indicates that productivity is deteriorating. When a specific change ratio within the index is greater than 1, that ratio is the cause of the increase in productivity levels. Conversely, it is the root cause of the decline in productivity levels.

$$\begin{aligned}
M_o(x^{t+1}, y^{t+1}, x^t, y^t) &= \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)}\right]^{\frac{1}{2}} \\
&= \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)}\right] \\
&= EFFCH \times TECHCH \\
&= PECH \times SECH \times TECHCH
\end{aligned} \tag{11}$$

The above equation represents the mathematical derivation process for decomposing the Malmquist index, which shows that the Malmquist index can ultimately be decomposed into two main levels. The first level can be decomposed into efficiency change (EFFCH) and technological change (TECHCH), while the second level can further decompose the first level, with efficiency change (EFFCH) being decomposed into pure efficiency change (PECH) and scale efficiency change (SECH). The specific criteria for evaluation are to observe whether the values

of PECH, SECH, and TECH efficiency changes are greater than 1. If all are greater than 1, it indicates that management improvements have enhanced efficiency, the scale expansion path is optimal, and technology is advancing.

III. Empirical analysis of the application of business English in real estate investment project communication

III. A. Investment Efficiency Analysis

Based on theories related to investment efficiency, this paper uses data envelopment analysis to compare and analyze the overall investment efficiency of 20 projects undertaken by Company No. 1. Among these projects, some focused on improving the application of business English in real estate investment projects, specifically projects C, D, and F. Since investment efficiency (ITE) directly reflects the distance between the production frontier and the DMU, when the DMU is in a state of the production frontier, the calculated result is 1, indicating that the pure technical efficiency and enterprise scale efficiency of Company B also tend toward 1, with all three being in an efficient state. Conversely, when the DMU is not in a state of the production frontier, the corresponding calculation result is less than 1, indicating that the pure technical efficiency and scale efficiency of B Investment Company are also less than 1 at this time, with all three being in an inefficient state. As such, for B Investment Company, the pure technical investment efficiency of the enterprise can influence the distance between the DMU and the production frontier, while the investment scale efficiency of the enterprise also affects the distance between the DMU and the production frontier. After conducting the relevant calculations using DEAP software, the overall investment efficiency levels of B Investment Company during the 2017-2020 period can be fully explained. The investment efficiency values of B Investment Company from 2017 to 2020 are shown in Table 1.

Based on the data in Table 1, the 20 projects of B Investment Company exhibit a relatively high average overall investment efficiency, with an average of 0.977, and all years from 2017 to 2020 are above 0.9, with 2019 being the highest. After a series of calculations, the average overall investment efficiency for the four-year period was 0.977, reflecting a certain degree of fluctuation. In terms of pure technical efficiency and scale efficiency, the value for 2018 was the highest compared to other years, fully reflecting the differences in investment efficiency of B Investment Company in recent years.

In terms of scale efficiency, B Investment Company had the highest number of scale-efficient projects in 2018, with 18 projects, accounting for 90% of the total sample. These companies operated by enhancing the reasonable application of business English in real estate investment projects under economic conditions, thereby maintaining investment efficiency at a relatively high level. For B Investment Company, which has maintained a gradually increasing trend in scale efficiency over the past four years, the number of projects has remained stable at 3-5, unless the company's scale efficiency remains unchanged. However, for most companies, scale efficiency cannot remain unchanged and generally shows a stable downward trend. This indicates that companies actively improve the application of business English in project communication, effectively overcoming language and cultural barriers in cross-border investments, facilitating accurate information transmission, effective risk management, and the smooth establishment of cooperative relationships. This significantly supports efficient project operations, enabling investment efficiency to be maintained at a high level, thereby maximizing output and achieving stable and sustainable development. This highlights that in real estate investments in emerging markets, enhancing professional business English communication skills is an important practical approach to optimizing investment efficiency and achieving economies of scale.

Table 1: Investment efficiency of b investment company in 2017 and 2020

Year	Efficiency mean			Scale benefit		
	Overall investment efficiency	Investment in pure technical efficiency	Investment scale efficiency	Increasing	Invariant	Diminishing
2017	0.975	0.984	0.954	3	10	7
2018	0.963	1	0.974	5	13	2
2019	1	0.971	1	4	10	6
2020	0.968	0.984	1	5	11	4
Mean	0.977	0.985	0.982			

After a series of data processing, this paper clearly defines the investment efficiency values of each decision-making unit for the years 2017-2020. The investment efficiency values of Investment Company B are shown in Table 2.

Based on the annual investment efficiency, the distribution ratio of effective and ineffective investments can be further clarified. Among them, Projects C, D, and F show effective investment, with efficiency values reaching 1, accounting for 15% of all decision-making units. One of the key elements of their successful operations lies in effectively overcoming cross-border communication barriers. These projects place high importance on and proficiently utilize business English, ensuring precise information transmission in the complex environment of emerging markets. This supports the scientific nature of their investment decisions and the efficiency of their operations, maintaining investment efficiency at the highest level.

Other projects exhibit ineffective investment, with Project I having the lowest overall investment efficiency. The number of companies with efficiency values below 0.6 was highest in 2020, with two such projects—Project N and Project I—reflecting the significant efficiency losses that can result from inadequate communication in emerging markets. Projects like C, D, and F, which are well-invested, technologically advanced, appropriately scaled, and scientifically managed, have consistently maintained a leading position in the industry during their development and operations. They have maintained a stable investment trend for investment projects, ensuring that the company's investments and outputs are proportional. This is because the company's behavior in daily operations directly impacts subsequent investment efficiency. It is evident that the success of this company's projects provides valuable insights for other business managers, helping corporate investors improve investment management and enhance investment efficiency. Drawing on the experiences of high-efficiency projects, systematically enhancing the team's business English communication skills is crucial for further integrating and refining the company's resources and operational supply chain, thereby continuously improving management standards.

Table 2: B investment efficiency value

DMU	2017	2018	2019	2020
A	0.917	0.974	-	-
B	-	0.848	-	-
C	-	1	0.856	-
D	-	1	0.933	-
E	-	0.979	0.917	0.929
F	-	-	1	1
G	-	-	0.901	0.853
H	-	-	0.916	0.921
I	-	-	0.915	0.471
J	-	-	0.911	0.931
K	-	-	0.912	0.855
L	-	-	0.865	0.839
M	-	-	0.875	0.841
N	-	-	0.874	0.579
O	-	-	0.927	0.931
P	-	-	0.932	0.829
Q	-	-	0.873	0.847
R	-	-	0.884	0.818
S	-	-	0.823	0.871
T	-	-	0.861	0.896

III. B. Malmquist index analysis

By rerunning the DEAP program and utilizing standardized raw data, a dynamic analysis of the investment efficiency of 36 real estate development companies from 2017 to 2020 was conducted, yielding the Malmquist indices and their component changes for each period. To facilitate a more intuitive analysis, a chart illustrating the changes in the Malmquist efficiency index was created, as shown in Figure 1.

Using 2017 as the base year in the time series, the Malmquist index for that year is equal to 1. The Malmquist indices for the subsequent three time periods are 0.571, 1.174, and 0.782, respectively, with an average value of 0.842. This indicates that the investment efficiency of real estate development companies declined significantly in 2017-2018, then rose sharply, and then declined again in 2019-2020. The overall investment efficiency of companies has not reached an optimal level, and there have been significant fluctuations over the years. The stability of corporate investment behavior and development is poor, posing a challenge to the healthy growth of the real estate emerging market.

The underlying cause is that the technical efficiency progress index (TC) and technical efficiency change (EC) have constrained healthy development. The technical progress curve aligns closely with the Malmquist index curve. During the period of significant efficiency improvement from 2018 to 2019, the technical progress value reached 1.242. Effective cross-border communication, particularly the application of business English, played a potential positive role. Analyzing the growth structure of investment efficiency, the technical progress index has had a significant impact on dynamic outcomes, starting with modest growth and then continuously declining, leading to an overall annual decrease. However, it should be noted that the technical progress in 2018 offset the decline in relative technical efficiency. Additionally, when further decomposing changes in technical efficiency, this declining trend is primarily influenced by two factors. First, the Pure Technical Efficiency Change (PEC) index values for both the 2017–2018 and 2019–2020 periods were greater than 1, indicating that changes in technical efficiency had minimal impact on corporate investment. This suggests that corporate internal operations remained relatively stable, and the use of business English for more precise internal communication and cross-cultural team collaboration helped maintain this efficiency. Second, scale efficiency changes (SEC), whose indicator values are roughly the same as those of technical efficiency changes, have shown a consistent downward trend. The overall average of scale efficiency changes is even lower than that of technical efficiency changes, making it the primary cause of the deterioration in technical efficiency changes and a key factor influencing the decline in investment efficiency. Additionally, this is an area where business English communication plays a critical role. By improving communication efficiency with overseas partners, international financial institutions, local governments, and supply chains, it can significantly reduce scale inefficiencies caused by cultural misunderstandings, thereby optimizing scale efficiency.

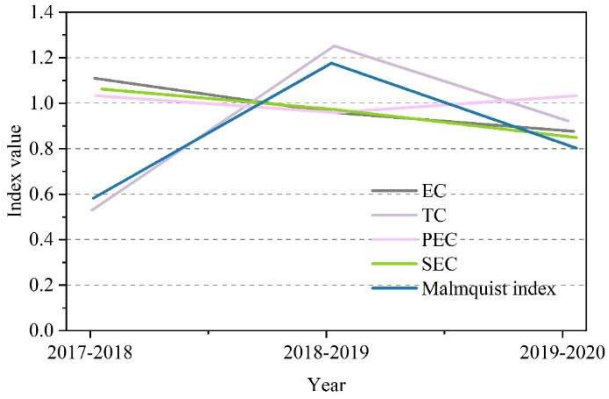

Figure 1: The malmquist efficiency index changes

The following analysis examines the Malmquist indices of various real estate development companies from 2017 to 2020, providing insights into the changes in total factor productivity and its component indicators. The results are presented in Table 3.

Considering the characteristics of the industry and referencing previous studies, if the Malmquist index falls within the range [0, 0.950], it indicates a significant downward trend. If it falls within the range [1.050, +∞], it indicates a significant upward trend. If it falls within the range [0.950, 1.050], it indicates that the Malmquist index maintains a relatively stable trend. According to this theory, from 2017 to 2020, the TFP of the four real estate development companies—No. 2, No. 7, No. 8, and No. 34—showed a very obvious upward trend, with No. 2 ranking first with an increase of 83.1%. The primary reason for the significant difference from other companies lies in the substantial increase in the technical efficiency change index driven by the scale efficiency change index. Efficient business English communication skills are a key element of their success, ensuring that the company can accurately convey strategic intentions, effectively adjust strategic resources, and quickly respond to localized demands during large-scale cross-border investment projects and negotiations with international partners, thereby driving the rise in the Malmquist index.

However, nearly 75% of real estate development companies exhibit a pronounced downward trend in total factor productivity, with Companies 13 and 17 being the most notable examples, declining by 74.5% and 58.6%, respectively. This highlights the bottlenecks they face due to insufficient technological progress and deficiencies in business English proficiency. Companies 1, 5, 9, 11, 21, and 24 exhibit relatively stable changes and are all located in economically developed first-tier cities and the Jiangsu-Zhejiang region, where the international business environment is more mature, reflecting significant regional economic disparities.

By decomposing total factor productivity, we can further explore the trends in changes. Among all the sample real estate development companies, 11 companies had a technological progress index greater than 1, contributing significantly to the Malmquist efficiency index. The remaining 25 companies had a technological progress index below 1, with Nos. 13, 17, and 36 ranking at the bottom. These companies particularly need to introduce innovative technologies and recruit high-quality technical personnel to achieve technological progress in investment and operations. Proficient business English communication skills serve as a bridge for absorbing cutting-edge technologies and are the core drivers for improving the technological progress index. The companies with the highest technical efficiency change indices are No. 2 (1.909), No. 34 (1.051), No. 24 (1.032), and No. 14 (1.031), while those with the lowest indices are No. 15 (0.695) and No. 4 (0.797). This often stems from communication breakdowns in cross-border projects, leading to information distortion, decision-making delays, and resource misallocation and integration failures. Company No. 2 benefited from the improvement in the business English communication skills of its project team, which drove the company's investment and development, demonstrating a positive promotional effect on the Malmquist index; Company No. 15, on the other hand, was hindered in its investment and development due to insufficient business English communication skills, demonstrating a negative inhibitory effect on the Malmquist index.

Table 3: Enterprise malmquist index and its decomposition

DMU	EC	TC	PEC	SEC	Mq	DMU	EC	TC	PEC	SEC	Mq
1	1.002	1.013	1.000	1.002	1.016	19	1.000	0.685	1.000	0.997	0.685
2	1.909	0.960	1.000	1.904	1.831	20	1.006	0.900	1.059	0.945	0.896
3	1.000	0.933	1.000	1.000	0.937	21	0.870	1.143	1.027	0.857	0.999
4	0.797	1.094	1.016	0.781	0.868	22	0.997	0.739	0.992	1.000	0.745
5	0.974	0.991	1.015	0.962	0.974	23	1.000	0.751	1.000	1.000	0.746
6	1.000	0.776	1.000	1.000	0.784	24	1.032	0.966	1.000	1.000	1.010
7	0.938	1.139	1.000	0.937	1.062	25	0.904	0.744	1.000	0.903	0.670
8	0.932	1.132	1.000	0.932	1.062	26	0.859	0.859	0.883	0.977	0.877
9	0.898	1.135	1.000	0.894	1.025	27	1.000	0.676	1.005	1.000	0.679
10	1.000	0.857	1.000	1.000	0.853	28	1.000	0.712	1.000	1.000	0.711
11	1.000	0.999	1.000	1.000	1.000	29	0.860	0.783	0.976	0.879	0.671
12	1.000	0.703	1.000	1.000	0.699	30	0.837	0.836	1.107	1.024	0.817
13	1.000	0.262	1.000	1.000	0.255	31	0.868	0.919	1.000	0.872	0.794
14	1.031	0.871	1.000	1.025	0.891	32	0.868	1.023	0.990	0.870	0.884
15	0.695	0.787	1.094	0.631	0.538	33	0.921	0.854	0.982	0.937	0.796
16	1.025	0.725	1.023	1.002	0.736	34	1.051	1.057	1.210	0.870	1.109
17	1.000	0.417	1.000	1.000	0.414	35	0.982	0.943	1.028	0.956	0.922
18	0.843	1.079	1.000	0.841	0.921	36	0.915	0.597	0.933	0.980	0.548
Mean	EC:	0.975									
	TC:	0.863									
	PEC:	1.012									
	SEC:	0.972									
	Malmquis:	0.845									

IV. Research on the Impact of Business English Application on Real Estate Investment Efficiency

IV. A. Indicator Selection and Data Sources

(1) Dependent variable: Dynamic efficiency of real estate investment (TFP). The dependent variable is selected based on the dynamic efficiency of real estate investment calculated using the DEA-Malmquist index model. It reflects both the quality and quantity of real estate industry development.

(2) Explanatory variables: The application of Business English in investment projects is represented by the cultural difference (CD) variable, while permanent population (POP), public facilities (BUS), per capita GDP (GDP), housing prices (PRI), and industrial structure (T) serve as control variables.

Additionally, due to the high volatility among the variables, an elasticity model is employed to eliminate this volatility, with all variables log-transformed.

Based on panel data from 30 provinces, municipalities, and autonomous regions in China from 2012 to 2023, a panel model incorporating real estate investment dynamic efficiency, the application level of business English, and control variables is constructed for preliminary regression analysis. The specific model specification is shown in Equation (12):

$$TFP_{it} = \alpha_1 + \alpha_2 BEAL_{it} + \alpha_3 POP_{it} + \alpha_4 BUS_{it} + \alpha_5 GDP_{it} + \alpha_6 PRI_{it} + \alpha_7 T_{it} + \mu_{it} \quad (12)$$

Among these, α_i represents the estimated parameters for each variable, where i denotes the 30 provinces, municipalities, and autonomous regions of China, and t denotes the time period from 2012 to 2023. μ_{it} represents the random error term.

Given the availability and timeliness of the data, regional panel data for the 30 provinces, municipalities, and autonomous regions of China from 2012 to 2023 were selected. The data were sourced from the China Statistical Yearbook, the China Real Estate Statistical Yearbook, the China Urban Statistical Yearbook, and the official websites of the statistics bureaus of each province, municipality, and autonomous region. Additionally, due to significant data gaps for the Tibet Autonomous Region, it could not be included in the research framework. The descriptive statistics for all variables are shown in Table 4.

From the descriptive statistics results, it can be seen that the average real estate investment efficiency is 1.012, with a minimum value of only 0.206 and a maximum value of 3.346, and a standard deviation of 0.349, indicating significant differences in real estate investment efficiency among the sample cities. The mean value of CD is 1.223%, the maximum value is 8.135, the minimum value is 0.347, and the standard deviation reaches 0.66, indicating that there are significant differences in the application level of business English in investment projects across provinces.

Table 4: Descriptive statistics

Variable name	Sample size	Mean value	Standard deviation	Minimum value	Maximum value
TFP	380	1.012	0.349	0.206	3.346
CD	380	1.223	0.662	0.347	8.135
POP	380	1.020	0.028	0.919	1.111
BUS	380	1.050	0.114	0.577	1.615
GDP	380	1.131	0.063	0.779	1.315
PRI	380	1.112	0.101	0.866	1.660
T	380	0.972	0.528	0.498	4.167

IV. B. Stability Test and Cointegration Test

First, we conduct stability tests and cointegration tests to ensure the validity of the estimates and avoid spurious regression or false regression. We use the LLC, IPS, and ADF methods in Eviews 8.0 software to test for unit roots in each variable. The test results are shown in Table 5. Based on the results of most test indicators, PRI and T are not stable. Note: ***, **, and * indicate p<1%, 5%, and 10%, respectively. The test model includes time trend terms and level trend terms, with lag periods selected based on the SIC principle.

Table 5: Unit root test results

	LLC	IPS	HT	Conclusion
TFP	-8.795***	-5.664***	137.345***	smoothness
CD	-8.648***	-3.074***	98.358***	smoothness
POP	-7.001***	-2.265**	88.112**	smoothness
BUS	-10.596***	-4.773***	122.763***	smoothness
GDP	-9.985***	-2.642***	100.985***	smoothness
PRI	1.203	0.165	51.952	Uneven stability
T	4.095	8.774	11.388	Uneven stability

After applying first-order differencing to the original data and re-testing, the results are shown in Table 6. All data are stationary, and it can be concluded that all data are first-order integrally stationary.

Table 6: 1st Unit root test order difference

	LLC	IPS	HT	Conclusion
TFP	-8.795***	-5.664***	137.345***	smoothness
CD	-8.648***	-3.074***	98.358***	smoothness
POP	-7.001***	-2.265**	88.112**	smoothness
BUS	-10.596***	-4.773***	122.763***	smoothness
GDP	-9.985***	-2.642***	100.985***	smoothness
PRI	1.203	0.165	51.952	Uneven stability
T	4.095	8.774	11.388	Uneven stability

Using the Kao method to test for cointegration in first-order stationary data, the Kao test results support the existence of a long-term stable relationship between the selected data at a 1% significance level. Therefore, panel regression analysis can be performed on them.

IV. C. Empirical Analysis

Using Eviews 8.0 software to perform regression analysis on the model, the F-test passed at the 1% significance level using the fixed effects model (FE), and the Hausman test also passed at the 1% significance level using the fixed effects model. Therefore, regression analysis was conducted using the fixed effects model, with the results shown in Table 7.

First, looking at the national-level regression results, the CD coefficient is -0.065, which passes the 1% significance test, indicating that an increase in cultural differences significantly reduces real estate investment efficiency, consistent with expectations. For every 1-unit increase in CD, i.e., when cultural differences double relative to the previous year, real estate investment efficiency decreases by 6.5% relative to the previous year. When examining regional differences, the regression coefficients for CD on real estate investment efficiency in the central and eastern regions are both significantly negative. The coefficient for the eastern region is -0.112, passing the 1% significance test, indicating that the impact of cultural differences on real estate investment efficiency in the eastern region is greater than the national average. The coefficient for the central region is -0.028, passing the 5% significance test, indicating that the central region also experiences a suppressing effect of cultural differences on real estate investment, but the coefficient is lower than the national average. The CD coefficient for the western region is not significant.

It can be seen that, at the national level, in the eastern region, and in the central region, cultural differences significantly reduce real estate investment efficiency. However, in the western region, cultural differences do not significantly reduce real estate investment efficiency. This confirms the importance of business English proficiency in communication during real estate investment projects.

Table 7: Regression results

	Whole country	East	Middle	West
CD	-0.065***	-0.112***	-0.028**	0.012
	-4.086	-3.455	-2.425	1.205
POP	0.385	1.266	0.375	0.011
	0.587	0.703	1.149	0.043
BUS	0.107***	0.136***	0.018	0.248***
	3.734	2.762	0.411	3.918
GDP	0.017	0.444	0.033*	0.011
	0.399	0.645	1.874	0.678
PRI	0.533***	0.978***	0.095*	0.135***
	5.228	3.815	1.936	2.922
T	-0.133***	-0.122	-0.094***	-0.158***
	-2.526	-0.945	-3.954	-4.753
Sample size	380	142	105	133
Hausman	19.562***	16.718***	12.658**	11.436**
F	21.985***	12.865***	9.624***	9.478***
Model	FE	FE	FE	FE

IV. D. Testing for mediating effects

Although this paper has examined the impact of cultural differences on real estate investment efficiency through empirical analysis in the previous section, and found that cultural differences have a significant inhibitory effect on real estate investment efficiency at the national level, in the eastern region, and in the central region, but not in the western region, further investigation is needed to explore why cultural differences do not affect real estate investment efficiency in the western region.

First, this paper argues that cultural differences can significantly increase the ratio of public/private investment. In this paper, we establish an econometric model in which cultural differences are the explanatory variables, and public/private investment is the explanatory variables, and the data of public investment and private investment are derived from the China Statistical Yearbook of the relevant years. Since the main purpose is to verify the robustness of the conclusions of the previous section, the original model is used, only the explanatory variables are replaced, and the mediation effect is tested in two steps according to the stepwise test.

To test whether cultural differences can significantly increase the scale of real estate investment, this paper establishes an econometric model with cultural differences as the explanatory variable and the scale of real estate investment as the dependent variable. Similar to the test for public investment/private investment, only the dependent variable is replaced. Using the stepwise testing method, the mediating effect is tested in two steps.

Since the mediation effect test only requires the coefficients of the core explanatory variable and the mediating variable to determine the result, due to space constraints, only the regression results of the core explanatory variable and the mediating variable in the two test models are listed below. The regression results of Model 1 are shown in Table 8. Note: ***, **, and * indicate p < 1%, 5%, and 10%, respectively.

From the regression results of Model 1, the first step of the test shows that cultural differences at the national level and in the central region significantly affect the regression results of the public investment/private investment ratio. The coefficients of cultural differences on public investment/private investment are 0.126 and 0.583, respectively, and both sets of data pass the significance test at the 1% level. Looking at the results of the second step, the coefficient of cultural differences on the TFP value of real estate investment efficiency in the national sample group is significantly negative, with a coefficient of -0.054, indicating that the national group is an incomplete mediator. In the central region, this coefficient is not significant, indicating that it is a complete mediator in the central region. Overall, these results confirm that cultural differences indeed suppress private investment and favor public investment in both sample groups. Cultural differences distort public and private investment, which is one of the reasons for the decline in real estate investment efficiency. In the eastern region, the first step of the mediation effect test was not significant, indicating that while cultural differences suppress the overall effect of real estate investment efficiency in the eastern region, there is no mediation effect suppressing private investment. The suppression of real estate investment by cultural differences in the western region is due to other factors. In the western region, since the suppression effect of cultural differences on real estate investment efficiency is not significant, there is no need for a mediation effect test in the absence of an overall effect.

Table 8: Bivariate regression results of the model 1

	Total effect	Step1	Step2	
Explain the variable/be solved Release variable	CD/TFP	CD/P	CD/TFP	P/TFP
Whole country	-0.065***	0.126***	-0.054***	-0.175***
	-4.086	3.225	-3.884	-3.076
East	-0.112***	0.004		
	-3.455	0.223		
Middle	-0.028**	0.583***	-0.023	-0.098***
	-2.425	4.246	-0.935	-2.546
West	0.012			
	1.205			

The results of the regression analysis for Model 2 are shown in Table 9. From the results of the regression analysis for Model 2, the first step of the analysis indicates that cultural differences at the national level and in the eastern and central regions significantly influence the regression results for real estate investment scale, with coefficient values of 0.005, 0.565, and 0.2413, respectively. These three sets of data passed the significance tests at the 1%, 5%, and 1% levels, respectively. Looking at the results of the second step of the test, the coefficients for the impact of cultural differences between the national and eastern regions on the total factor productivity (TFP) value of real

estate investment are significantly negative, with coefficients of -0.056 and -0.064, respectively. This indicates that in these two sample groups, the scale of real estate investment is not a complete mediating effect. In the central region, this coefficient is not significant, indicating that in the central region, it is a complete mediating effect. This confirms that cultural differences indeed enhance the scale of real estate investment in these three sample groups. The western region does not require this mediation effect test as there is no overall effect.

Cultural differences have an inhibitory effect on real estate investment efficiency at the national level. Through verification, it was found that cultural differences inhibit real estate investment efficiency by suppressing private investment and expanding the scale of real estate investment. Therefore, the application of business English in communication for real estate investment projects in emerging markets has the potential to reduce cultural differences and enhance real estate investment efficiency.

Table 9: Bivariate regression results of the model 2

	Total effect	Step1	Step2	
Explain the variable/be solved Release variable	CD/TFP	CD/HI	CD/TFP	HI/TFP
Whole country	-0.065***	0.005***	-0.056***	-0.633***
	-4.086	2.178	-3.974	-2.135
East	-0.112***	0.565**	-0.064***	-0.135**
	-3.455	2.223	-4.118	-2.008
Middle	-0.028**	0.243***	-0.006	-0.637***
	-2.425	4.248	-0.005	-4.315
West	0.012			
	1.205			

V. Conclusion

This paper employs data envelopment analysis (DEA) and the Malmquist index analysis method to investigate the investment efficiency and its impact pathways of business English applications in real estate investment projects in emerging markets.

Successful corporate investment projects C, D, and F maintained leading positions in their industries during operations through appropriate investment strategies, advanced technology, and high-level business English proficiency, ensuring a proportional relationship between corporate inputs and outputs through stable investments. Their successful experiences hold significant implications for other enterprises in terms of investment management and enhancing investment efficiency.

The improvement in the project team's business English communication proficiency plays a crucial role in the positive development of Enterprise 2's investments, benefiting the enterprise while also positively influencing the Malmquist index. In contrast, Enterprise 15, due to the lack of business English communication proficiency, faced development obstacles, resulting in a negative impact on the Malmquist index.

National regression analysis shows that the cultural difference coefficient is -0.065 (significant at the 1% level), indicating that cultural differences significantly reduce real estate investment efficiency. For every doubling of CD, real estate investment efficiency decreases by 6.5%. Nationally, in the eastern and central regions, cultural differences significantly reduce real estate investment efficiency, primarily by suppressing private investment and expanding investment scale. However, this effect is not significant in the western region, further confirming the necessity of applying business English proficiency in communication for real estate investment projects in emerging markets.

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