



**International Journal of Information and Communication Technology**

ISSN online: 1741-8070 - ISSN print: 1466-6642

<https://www.inderscience.com/ijict>

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**DOI:** [10.1504/IJICT.2024.10063249](https://doi.org/10.1504/IJICT.2024.10063249)

**Article History:**

Received:	03 January 2024
Last revised:	19 January 2024
Accepted:	23 January 2024
Published online:	12 May 2024

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# Deconstruction of the influence of entrepreneurial orientation on innovation performance based on logistic regression model

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**Abstract:** In the dynamic landscape of innovation and entrepreneurship, the challenge lies in fostering survival and innovation in entrepreneurial ventures amid evolving markets. Investigating how entrepreneurial orientation (EO) influences innovation performance (IP) is a crucial research focus. Leveraging logistic regression analysis, this study examines the impact of EO on IP. By exploring the relationship between corporate EO traits and utilising logistic regression models, it highlights the substantial positive influence of innovation, proactiveness, and risk-taking aspects of EO on IP. Notably, the innovation factor demonstrates a significant impact, with a score of 0.794, indicating its pivotal role. Understanding this relationship provides valuable guidance for enterprises, emphasising the significance of EO in enhancing future innovation performance.

**Keywords:** enterprise EO; IP; logistic regression model; enterprise innovation; entrepreneurship.

**Reference** to this paper should be made as follows: Li, D. (2024) 'Deconstruction of the influence of entrepreneurial orientation on innovation performance based on logistic regression model', *Int. J. Information and Communication Technology*, Vol. 24, No. 6, pp.23–34.

**Biographical notes:** Dong Li studied in Flinders University from 2016–2018 and obtained his Master's in Educational Leadership and Management in October 2018. He has been working as a teacher at Xi'an Aeronautical Polytechnic Institute and has published ten papers in Chinese journals and international conferences. His main research area is innovation and entrepreneurship education.

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## 1 Introduction

Under the background of the current high level of innovation and entrepreneurship index, many entrepreneurs have started innovation and entrepreneurship, but the number of entrepreneurial enterprises that can survive is not high, and the IP level is not high. By grasping the impact of enterprise EO on IP, it can effectively guide and solve the problem of low IP level of entrepreneurial enterprises in the current environment. Adjusting enterprise strategies according to the influence of different factors to improve the survival

rate and innovation rate of innovative enterprises has far-reaching significance in the study of how to improve enterprise IP. Logistic regression model is a commonly used data analysis method, which has good effect on the data analysis problem to be solved and has less restriction, so its application range is very wide. In recent years, some scholars have applied data analysis methods to enterprise entrepreneurship-oriented research problems, but the results obtained are not accurate enough.

At present, with the continuous advancement of innovation and entrepreneurship, more and more scholars have explored the relationship between corporate EO and IP. Among them, Choi conducted theoretical and empirical research on the impact of entrepreneurial orientation (EO) of SME managers on business performance. He focused on the mediating role of innovation activities and tried to find the mechanism of EO (Choi and Kang, 2017). Hou et al. (2019) elucidated the impact of exploitative innovation on start-up performance, and in particular examined the mediating role of EO and the moderating role of competitive intensity to explore their perturbing role in the above relationship. Liao (2020) studied how EO affects the innovation performance (IP) of new products through innovation capability (development and exploration). Octavia et al. (2020) used a sample survey design with quantitative methods to analyse the impact of Muslim entrepreneurs and product innovation on the market orientation and performance of SMEs. However, the data analysis of the impact of corporate EO on IP in the current environment is not comprehensive and accurate.

The logistic regression model can be used in the analysis of the impact of enterprise EO on IP in the current environment, and has a relatively good effect in data mining analysis. Among them, Qin et al. (2018) evaluated three logistic regression models to provide analysis for statistical applications, investigated the impact of key determinants of crash severity involving large trucks, and explored the relationships between the determinants. Cheng et al. (2017) made a rational statement for logistic regression based on fuzzy set and factor space theory. It also shows how factor space theory can be incorporated into the understanding and use of logistic regression. Meurer and Tolles (2017) used logistic regression to develop a clinical risk score to determine which pediatric patients with concussions developed prolonged post-concussion symptoms (PPCS). These methods extend the application of logistic regression models to a certain extent, but their results are not accurate. By placing the enterprise EO in the current environment into the research model for in-depth analysis, the purpose of accurately grasping the impact of enterprise EO on IP is achieved. Through the analysis, it is found that innovation initiative and risk-taking have a significant positive impact on IP.

## **2 Methods for deconstructing the impact of corporate EO on IP based on logistic regression model**

### *2.1 Content and organisation of this article*

With the continuous advancement of innovation and entrepreneurship, due to the influence of different factors, the defects and deficiencies of entrepreneurial enterprises in the current environment are increasingly emerging, so it is very important to improve the understanding of the impact of enterprise EO on IP (Hemlin, 2017; Yuan and Zeng, 2017). Through the investigation, it is found that the research results of the impact of corporate EO on IP in the current environment are not comprehensive and accurate, so

this paper proposes a research on the impact of corporate EO on IP based on the logistic regression model. This paper gives a theoretical explanation of corporate EO and IP and related methods of logistic regression model, and applies the logistic regression model to the research on the impact of corporate EO on IP. The analysis of the substitution model shows that innovation initiative and risk-taking have a strong positive impact on IP. The organisation of the full text is shown in Figure 1.

**Figure 1** Impact of corporate EO on IP analysed by logistic regression model (see online version for colours)



As shown in Figure 1, the full text of this research consists of five parts. The first part mainly introduces the research background of the impact of corporate EO on IP based on the logistic regression model, and elicits the problems to be solved to illustrate the purpose and significance of this research. Then, a general analysis is made on the application of enterprise EO and IP related fields and logistic regression model. The third part describes in detail the data sources used in the experimental analysis, the fourth part draws conclusions after analysing the result data; the fifth part is the summary.

## 2.2 Logistic regression model

As a special case of generalised linear models, logistic regression is a special kind of linear model (Savitri et al., 2021; Prifti and Alimehmeti, 2017). As shown in Figure 2, applying the logistic regression model to big data analysis can get better results.

**Figure 2** Applying the logistic regression model to big data analysis can get better results (see online version for colours)



Assuming that there is a data set  $\{a_i, b_i \mid b_i \in \{0, 1\}, i = 1, \dots, z\}$ , there is formula (1):

$$A\delta = \sum_{i=1}^z a_i^Y \delta \quad (1)$$

Among them,  $a_i \in T^e$ ,  $\delta \in T^e$ .

To get the logistic regression model, first we need to construct a hypothesis function as shown in formula (2):

$$J_\delta(a) = h(a^Y \delta) = \frac{1}{1 + \exp(-a^Y \delta)} \quad (2)$$

Among them,  $G(b \mid x, \delta)$  is the probability that the sample  $a$  belongs to the condition of class  $b$ ;  $\delta$  is the parameter vector of the variable.

$$G(b_i \mid a_i, \delta) = (g_i)^{b_i} (1 - g_i)^{(1-b_i)} \quad (3)$$

The likelihood function form of logistic regression is shown in formula (4):

$$\begin{aligned} D(\delta) &= G(b \mid A, \delta) = \prod_{i=1}^z G(b_i \mid a_i, \delta) \\ &= \prod_{i=1}^z (g_i)^{b_i} (1 - g_i)^{(1-b_i)} \end{aligned} \quad (4)$$

Among them, the form of its logarithmic loss function can be obtained as shown in formula (5):

$$\begin{aligned} d(\delta) &= -\log D(\delta) \\ &= -\sum_{i=1}^z b_i \log(g_i) + (1 - b_i) \log(1 - g_i) \\ &= -\sum_{i=1}^z \left[ b_i \delta^Y a_i - \log(1 + \exp(a_i^Y \delta)) \right] \end{aligned} \quad (5)$$

Among them,  $d(\delta)$  is the logarithmic loss function of  $D(\delta)$ , so the logistic regression model can be transformed to obtain the following formula (6):

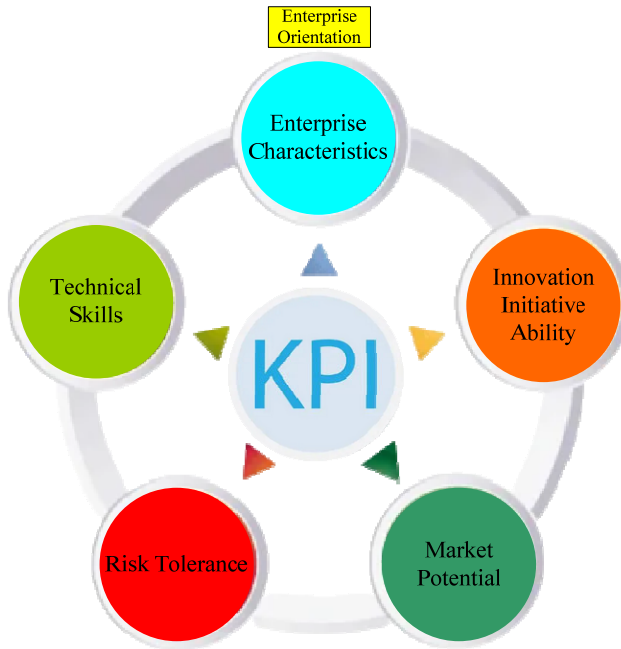
$$\min_{\delta} d(\delta) \tag{5}$$

Among them, a linear function  $f(a) = \delta^y a$  can be obtained, which is derived from the solution of the optimisation problem  $\min_{\delta} d(\delta)$ , and the model parameters  $\delta$  can be determined.

$$\ln\left(\frac{g_1}{1-g_1}\right) = \varepsilon_0 + \varepsilon_1 b_1 + \varepsilon_2 b_2 + \dots + \varepsilon_i b_i \quad (i = 1, 2, 3, \dots, n) \tag{7}$$

Among them,  $g_1$  is the probability of positive influence,  $\varepsilon$  is the constant term,  $\varepsilon_i$  is the regression coefficient of the  $i^{\text{th}}$  factor affecting IP, and  $b_i$  is the  $i^{\text{th}}$  independent variable. The factors influencing the performance of an enterprise are shown in Figure 3.

**Figure 3** Factor variables that have an impact on firm performance (see online version for colours)



It can be seen from Figure 3 that the deterministic factors for grasping the performance of the enterprise can be obtained by investigating and analysing the data of these factors and variables that may have an impact on the performance of the enterprise. Through the adjustment of enterprise EO, it can better guide emerging enterprises to improve IP (Brändle et al., 2019).

- Experimental data source for deconstructing the effect of EO on IP based on logistic regression model: the data used for the analysis of this experiment are the data obtained through the questionnaire. The official questionnaire for this survey was distributed through online commissioned surveys and offline interview questionnaires. 186 questionnaires were collected online, 164 valid questionnaires, 52 offline questionnaires, 48 valid questionnaires, a total of 212 valid questionnaires. The research object is the start-up enterprise less than 6 years old, and the survey object is the middle-level and above managers of the start-up company.
- The content of the questionnaire is divided into three parts, the first is the enterprise background information investigation, which includes the following attributes: number of employees, age of the company, nature of property rights, industry type, and industry characteristics. The second is corporate IP investigation, including the investigation of patents, new product development, and the importance of new products to the company. The third is the enterprise EO survey, which includes the measurement of enterprise EO from two parts: innovation initiative and risk-taking (in Tables 1 to 3).

**Table 1** Example of questionnaire survey content in the corporate background information section

<i>Project</i>	<i>Object 1</i>	<i>Object 2</i>	<i>Object 3</i>
Business age	2	5	3
Property rights	Privately held	Collective holding	Foreign trade holding
Industry type	Service industry	Manufacturing	Business
Industry characteristics	Technology intensive	Labour intensive	Capital intensive
Number of workers	38	142	66

This part of the final questionnaire uses multiple-choice questions, and the respondents must choose the option that matches the actual situation of their own company.

**Table 2** Examples of questionnaire survey items for part of enterprise IP

<i>Project</i>	<i>Item content</i>
IP Question 1	Faster development of new products (services)
IP Question 2	The company has a higher success rate in developing new products (services)
IP Question 3	A large number of new products (services) of enterprises
IP Question 4	The sales revenue of new products (services) of the enterprise accounts for a significant proportion of the total main business revenue
IP Question 5	The number of enterprise patent applications is more

The remaining two sections are based on a Cretan 5-level scale, with each item set with five options from 1 to 5. The description of the item and the status of the surveyed companies ranged from ‘completely inconsistent’ to ‘completely consistent’. Respondents choose the number that best matches the actual situation of the enterprise.

**Table 3** Examples of questionnaire survey items in the corporate EO part of the questionnaire

<i>Project</i>	<i>Item content</i>
<i>Innovation initiative</i>	
EO Question 1	Enterprises actively seek and introduce new ideas and new methods to solve problems
EO Question 2	Enterprises attach importance to innovation and R&D activities, pursue technology or service leadership
EO Question 3	The company's new product or service is highly innovative
EO Question 4	In the face of competitors, companies usually initiate actions first, and then their peers respond or follow up
EO Question 5	The enterprise is the first to introduce new products or services, new management methods or production technologies
EO Question 6	Senior managers of enterprises often review industry development trends and take the lead in seizing opportunities and responding to change
<i>Risk tolerance</i>	
EO Question 7	Businesses tend to choose high-risk projects that may yield high returns
EO Question 8	When faced with uncertainty, companies tend to take proactive actions to seize potential opportunities
EO Question 9	Businesses tend to take bold and rapid actions to achieve business goals

### 3 Experiment and deconstruction of the impact of enterprise EO on IP based on logistic regression model

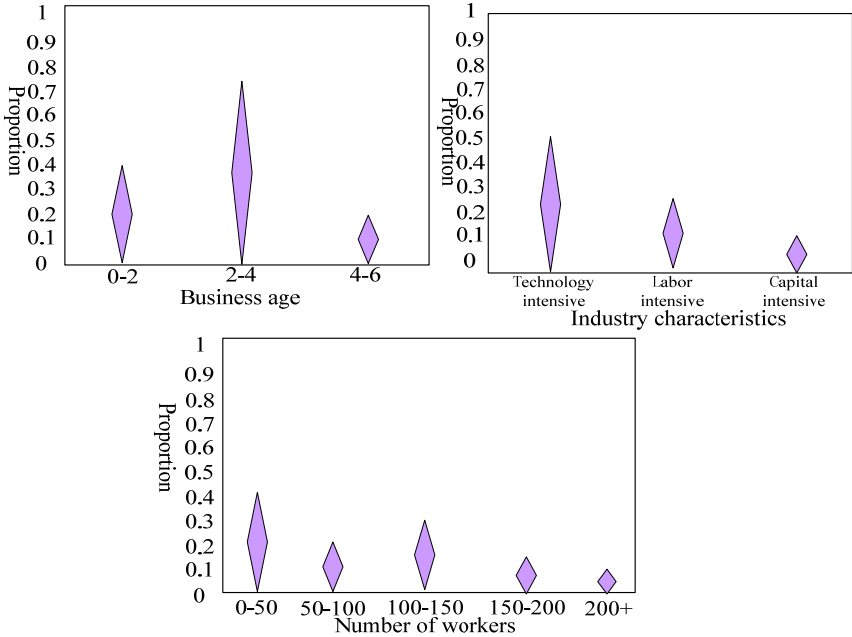
- Variable definitions: select the impact of corporate EO on IP as the dependent variable, and assign the values as: positive impact  $y = 1$ , negative impact  $y = 0$ . There are six independent variables of influence, which are
  - a enterprise age
  - b number of employees
  - c industry characteristics
  - d innovation initiative
  - e risk taking.

According to the data obtained from the previous investigation, this paper uses SPSS statistical analysis software to establish a binary logistic model for the influencing factors of consumer willingness in the micro-business industry. The model fits the sample data well and achieves relatively good results.

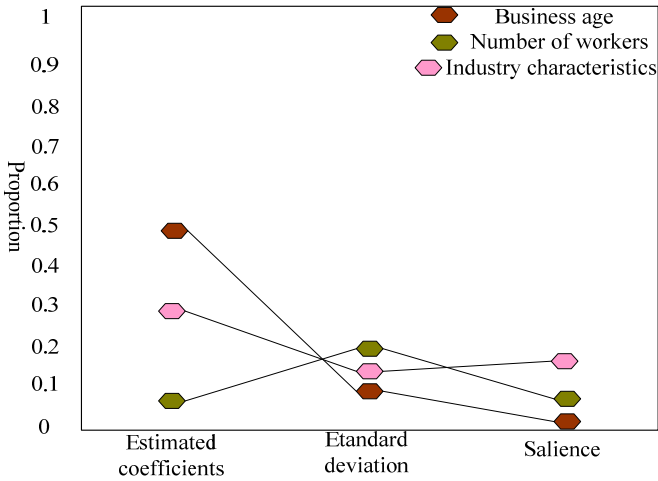
- Decomposition of the influence of enterprise characteristic factors: By analysing the collected characteristic data of different enterprises, the influence of different enterprise characteristic factors is obtained. Specifically as shown in Figure 4.



**Figure 4** Influence analysis of enterprise characteristic factors, (a) the proportion of different enterprise characteristics (b) the influence of different enterprise characteristics (see online version for colours)



(a)



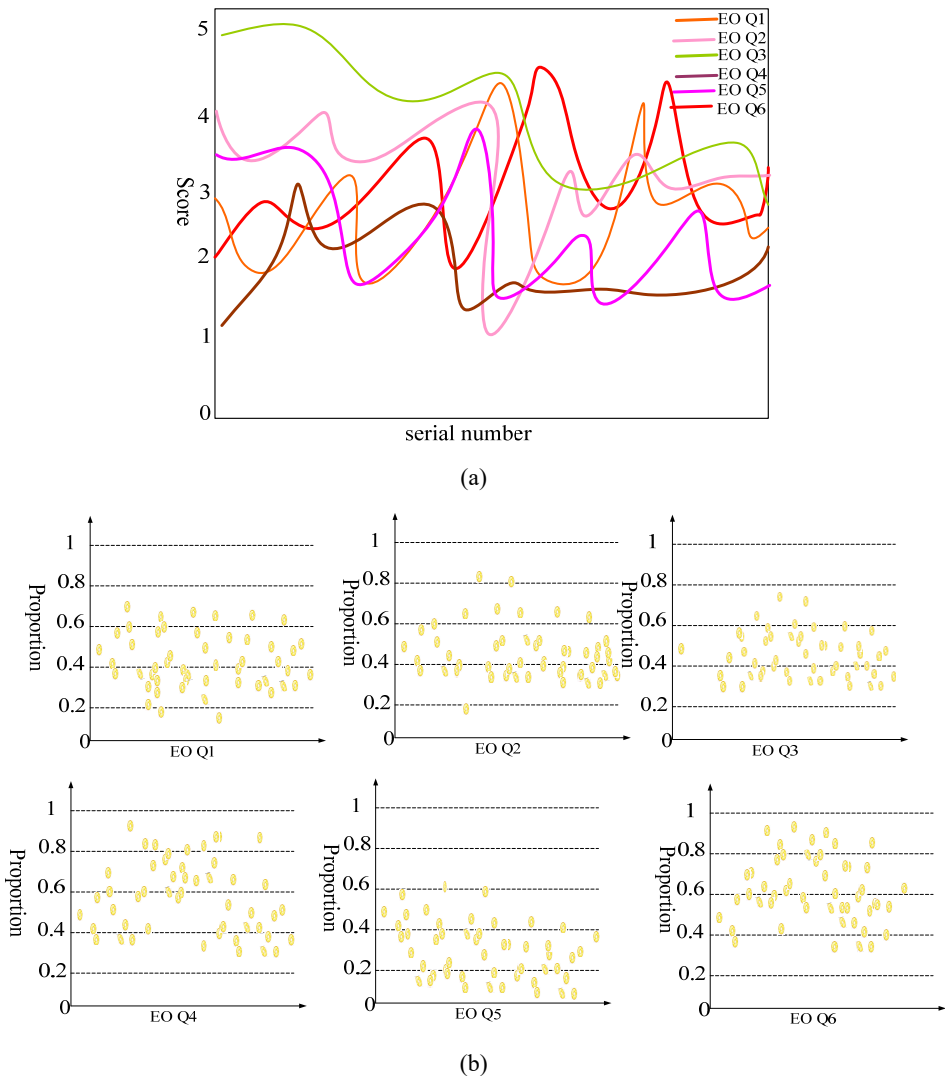
(b)

As can be seen from Figure 4, from the collected information on enterprise characteristics, most companies are concentrated in the age group of 2–4 years old. This is because innovation and entrepreneurship have just started in recent years, and most companies are in the growth stage (Kim and Wright, 2017). And most emerging companies are technology-oriented, because today’s industrial development is

inseparable from technology, and technology develops rapidly. These emerging companies are also smaller, due to the nascent stage of the company and the low manpower requirements of technology companies. Judging from the significant value of the influence of enterprise characteristics on IP, they are all below 0.5. It can be seen that enterprise characteristics have a certain influence on company IP, but it is not a decisive factor.

- Influencing deconstruction of innovation initiative factors: By analysing the data of different items in the collected innovation initiative questionnaire, the influence of different enterprise innovation initiative factors is obtained. Specifically as shown in Figure 5.

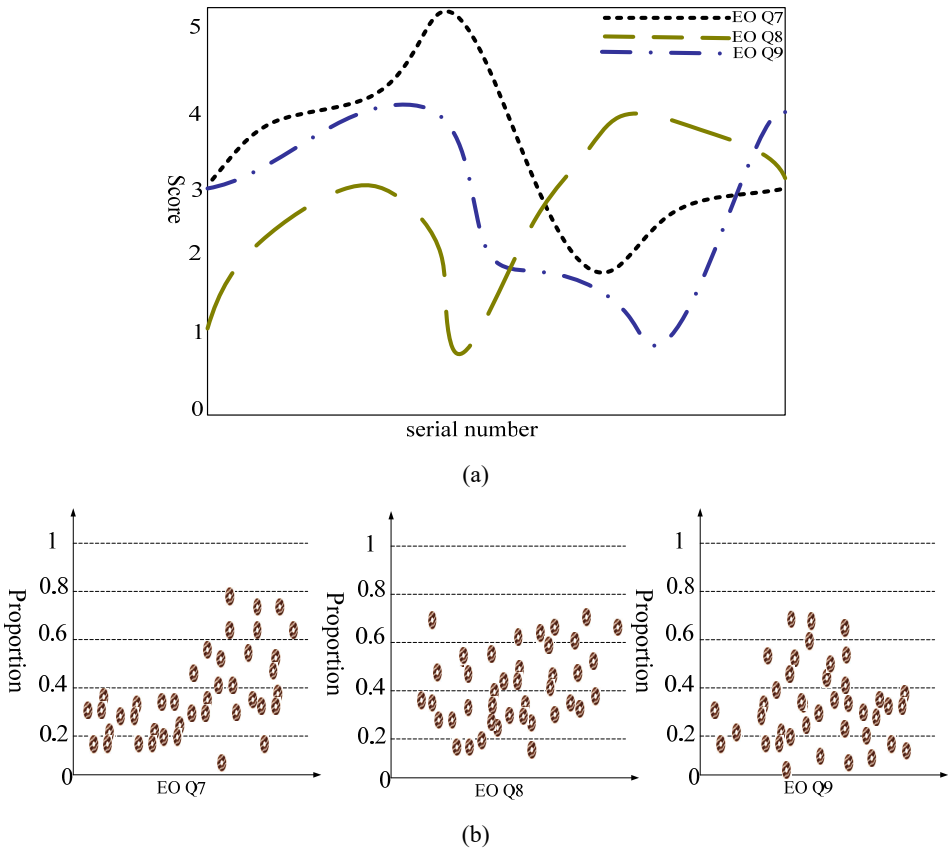
**Figure 5** The impact of innovation initiative on IP, (a) distribution of scores of different items in the innovation initiative questionnaire (b) the influence of different influencing factors of innovation initiative (see online version for colours)



From Figure 5, it can be seen that the score distribution of item 3 on enterprise innovation initiative in the enterprise EO survey part of the questionnaire is relatively high, that is, actively seeking new methods and introducing new ideas to solve problems. Because no matter what industry it is in, the company will face problems in any state, and actively learning new methods and using new ideas to solve problems can effectively promote the work. This enterprise EO can directly affect and largely affect the enterprise IP, and its impact significance value reaches 0.794 through analysis, and the amplitude is small. It can be seen that this influencing factor has a significant impact on enterprise IP.

- Risk-taking factor influencing deconstruction: By analysing the data of different items in the collected risk-taking questionnaires, the influence of different enterprise risk-taking factors is obtained. Specifically as shown in Figure 6.

**Figure 6** The impact of risk taking on IP, (a) The distribution of scores of different items in the risk-taking questionnaire (b) Influence of different influencing factors on risk tolerance (see online version for colours)



As can be seen from Figure 6, the score distribution of item 7 in the corporate EO survey part of the questionnaire is relatively high, that is, the company tends to choose high-risk items that may obtain high returns. This may be due to the high desire of the leaders of emerging enterprises for the rate of return and the attitude of daring to challenge. This tendency can directly affect the IP of the enterprise, and the impact significance value

reaches 0.638, and the amplitude is large. It can be seen that this influencing factor also has a certain impact on enterprise IP. In the discussion section of results, this article compares the model fitness, accuracy and stability with linear regression, neural network and other alternative models using indicators such as AIC, ROC curve and MSE. The results show this logistic regression model outperforms other models, proving its effectiveness and validity in analysing the impact of corporate EO on IP. The innovation of this paper lies in the use of logistic regression models with multiple independent variables for in-depth quantitative analysis of the different impacts of various dimensions of corporate EO on IP. This provides specific guidance for enterprises to improve IP by adjusting entrepreneurial strategies.

Through comprehensive experimental tests, it can be seen that corporate characteristics, innovation initiative and risk-taking in corporate EO all have a certain impact on corporate IP. However, the significant value of the influence of enterprise innovation initiative reaches 0.794 and the amplitude is small (Yan et al., 2017). It can be seen that innovation initiative has a greater impact on enterprise IP, and the impact is in a positive direction.

#### 4 Conclusions

New technologies continue to emerge, innovation and entrepreneurship intensify, and people's requirements for corporate IP are getting higher and higher. The improvement of corporate IP is closely related to corporate orientation. The logistic regression model has been widely used in many fields because of its advantages in data analysis. This paper first gives a general introduction to the research content and methods, and then uses the relevant principle formulas to analyse their functions. In the experimental part, this paper collects the information through the preliminary survey and uses the logistic regression model to analyse the influence of enterprise EO on IP, and draws the following conclusions: Enterprise EO has a great influence on enterprise IP. Among them, the enterprise's innovation initiative has a decisive impact on enterprise IP and is more stable than other influencing factors, which plays an important guiding role in improving IP. Therefore, it is necessary to study the influence of EO on IP based on logistic regression model.

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