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# Exploring the impact of R&D intensity, human capital, patents, and brand value on business performance in small and medium enterprises (SMEs)

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**ABSTRACT**

The study of business performance has a substantial impact on improving the internal management and economic performance of companies. By analysing the previous literature, this paper chooses to measure the factors affecting business performance at four levels, including R&D investment intensity, human capital, patents, and brand value. The purpose of the study is to find out whether these selected factors work equally well for small and medium-sized enterprises. The sample size was 846 Chinese small and medium enterprises from different industries. The firm performance indicators were ROA and ROE. The data has been collected through National Equities Exchange and Quotations platforms based on updated annual reports in 2019. Finally, a stepwise descriptive analysis and multiple linear regression were conducted and predicted the tendency of business performance. The analysis provided the linear combination of four independent variables (R&D, human capital, patents, and brand value) which are significantly related to the dependent variable (business performance). In conclusion, we found that there is a positive impact of patents and brand value on business performance. In detail, we concluded that only production and highly educated personnel show a positive influence. For R&D intensity, there is no strong connection could be observed. In practical terms, this paper allows SME firms to appreciate the importance of human capital, patents, and brand value.

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## 1. Introduction

Exploring business performance in today's competitive market is a serious issue for researchers and managers because business performance satisfies the desires of the managers and stakeholders. So, it must be assessed to measure to organisation's achievements, especially for small and medium enterprises (SMEs). Many senior executives believe that implementing project management in an enterprise can help improve performance by improving the management model of the enterprise (Du et al., 2021).

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The theoretical system of the project includes many aspects, such as R&D investment, human capital allocation, and intellectual property system construction.

And among them is the top priority in R&D project management (Pan et al., 2020; Zhou et al., 2021). R&D activities are generally an extension and innovation of knowledge, technology, methods, and means. It refers to the various costs incurred in the research and development process of products, technologies, materials, and standards. Medium and large enterprises will place more emphasis on basic R&D projects as the basis for their technological reserves and long-term strategies. SMEs place more emphasis on product R&D projects and process research projects, which are also more likely to see results and translate into business performance. Process R&D refers to the invention or modification of new product production or manufacturing processes to maximise cost savings and increase productivity. Formally, the wide range of factors encompassed in R&D investment leads to uncertainty in the returns to R&D. This paper selects a sample of Chinese listed SMEs to explore the relationship between the intensity of their R&D investment and corporate performance.

In addition, the human capital allocation of enterprises should not be neglected. Andreeva and Garanina (2016) state that the impact of highly skilled workers on firm performance is unquestionable. In addition to emphasising the importance of technical staff, the production staff is also considered to be the direct creators of value for the company (Boselie et al., 2005). Furthermore, management competencies cannot be ignored when it comes to improving the success of a business (Zhou et al., 2023). To analyse the relationship between human capital and firm performance, this paper breaks down human capital into technical staff, production staff, managers, highly educated staff, and R&D staff.

The construction of an intellectual property system mainly refers to a company's patent work, and the number of patents is an important indicator of a company's technological strength. The number of patent applications or grants can be used as a demonstration of the results of a company's investment in R&D, or as a component of the overall investment in R&D projects (Liu & Sun, 2021). In addition, patents are the most important source of primary competitiveness. Patent registration allows firms to limit competitors by prohibiting them from copying product designs, thus generating considerable economic benefits, particularly in terms of introducing projects while retaining exclusivity and customer appeal. With the increasing frequency and closeness of trade between the country and developed countries, the country has become deeply integrated into the world IP system, which has forced SMEs in the country to focus on patents. In addition, the increasingly robust legal system in the country is also a reason for companies to attach importance to patenting. Therefore, the relationship between the two factors, the number of patent applications and the performance of enterprises, is also the focus of this paper.

The last important factor is 'branding', which serves to differentiate goods and services. Generally, branding refers to the name, image, word, icon, or design used to identify and promote the goods and services of a manufacturer or seller (Kotler & Armstrong, 2012). It can describe the value and function of an organisation and is an important part of its competitiveness (Urde et al., 2013). Therefore, brand value is also a very important non-financial indicator of business performance.

This research is based on two big questions: does business performance affected by R&D, human capital, patent, and brand value? And what is the intensity of these factors on business performance? The first objective is that test the impact of R&D intensity, human capital, patent, and brand value on business performance in SMEs; then, give some possible recommendations for improving R&D activities, human capital, patent, and brand value; lastly, share generally the methods for getting implementing R&D actives, human capital, patent, and brand value sharply.

The innovation of this paper mainly includes two aspects. For theory development: (1) previous literature has mainly chosen large or medium-sized Chinese firms as the subject of study. This paper bridges the gap between the empirical analyses of Chinese SMEs; (2) comparing with previous studies which focus on a specific indicator, this paper also analyses R&D intensity, human capital, number of patents and brand value. In practice, the findings can help Chinese SMEs recognise the importance of improving their brand value and the number of patents they hold in maintaining business growth. It also looks at how to use the human resources of the enterprise fully and rationally for the development of the enterprise. Further, companies should consider why internal R&D investment activities are not contributing positively to business performance and making timely improvements.

The remaining part of the article is as follows: Section 2 keeps the full-length review of previous literature based on the impact of R&D intensity, human capital, patents, and brand value on business performance. Section 3 has a conceptual framework and hypothesis development. Section 4 includes research methodology, analysis, and discussion of results. And then Section 5 shows the conclusion, limitations, and practical implementation of this research for industries.

## 2. Literature review

The term "performance" is defined as the ability of a business to respond to investments. Investments can be in the form of land, labour, capital, and entrepreneurship. By reading previous literature we must find out how to measure firm performance. And what it drivers are? These factors have a great relationship with business performance. Every factor is described as a relationship of business performance by previous scholars.

### *2.1. R&D intensity and business performance*

Based on the neo-classical growth theory's assumption of the exogenous nature of technological progress and economic growth, Romer (2020) proposed that new growth theory, which states that technological progress and economic growth are endogenous. Zeng (1997) further divided the new growth theory into capital-based growth theory and idea-based growth theory, in which innovation growth theory focuses on R&D investment and innovation growth theory. Of course, the new technologies acquired through innovation and R&D can be transformed into productivity, which in turn can be used to launch new products into the market and improve the

competitiveness of the enterprise, thus helping the enterprise to achieve better business performance.

As we know, the expanded form of R&D is research and development. And we got some concepts about R&D from previous papers. R&D is often seen as an entire business process that includes all planning and development involving new products or packaging (Davcik et al., 2021). Alternatively, R&D activities can be used as a strategy for knowledge acquisition and learning (Chen & Wu, 2020; Meyer & Berger, 2014). To get the competitive edge and topline performance in business and industry must increase their R&D. Regarding the literature researching R&D intensity and business performance, there are various points of contention.

Bae and Kim (2003) claim that R&D spending has a significant positive effect on market value and variability of stock returns in the United States, Germany, and Japan. Jaisinghani (2016) examined the association between R&D intensity, long-term profitability, and commercial success of 55 publicly traded pharmaceutical companies in India. He identified a link between R&D intensity and business performance. Recently, Nunes et al. (2019) and Narayan and Hungund (2021) have reached similar conclusions in studies of Portuguese and Indian firms, respectively.

Nonetheless, the opposition should not be ignored or dismissed. According to recognised researchers, R&D intensity hurts firm performance. Vithessonthi and Racela (2016) revealed a negative correlation between R&D intensity and business performance when assessing non-financial organisations listed on the US stock market. Busru and Shanmugasundaram (2017) reported similar findings in a survey of Indian businesses. In a study of micro and small enterprises in Taiwan, Chen et al. (2019) also found that business investment in research and development negatively impacts business performance. The phenomenon is widespread within the Chinese manufacturing sector.

### 2.2. Human capital and business performance

Human capital plays a critical role in promoting economic development in the face of fierce global competition. Human capital was defined by Wu and Wu (2019), it is a group of knowledge and skills that individuals create, maintains, and use. Similarly, Barão et al. (2017) propose that human capital is the resources that a firm's employees possess to solve problems and add value. In other words, human capital is defined as the unique competitiveness that employees within a firm can give to the firm through their combined skills, intelligence, and expertise. Finally, we got that the analysis of human capital relies on two main underpinning theories. One is the resource-based theory and the other is the core competence theory. The resource-based theory argues that the more resources an enterprise accumulates within itself and the deeper its degree of differentiation from other enterprises, the greater its advantage in the competitive process. In addition, the core competency theory considers that the main competencies of an enterprise are. Relating human capital to business performance, we got much knowledge from previous literature.

Studies on businesses conducted in a variety of countries and regions have concluded that human capital has a significant positive effect on business performance,

including British Petroleum (Chahal et al., 2016), Korean enterprises (Sung & Choi, 2014), Russian manufacturing enterprises (Andreeva & Garanina, 2016) and American enterprises (Jogaratnam, 2017). Bontis et al. (2015) discovered that human capital positively impacted business performance when analysing 34 Serbian hotels. Likewise, when the gross margin is taken as a metric for performance, human capital positively affects corporate success (Haris et al., 2019; Xu & Wang, 2018).

On the other hand, other researchers contend that human capital has a negligible influence on business performance. Costa et al. (2014) also provided evidence in favour of this notion via research conducted in the Portuguese Republic. Using data from agricultural enterprises throughout the world, Scafarto et al. (2016) concluded that human capital had no direct connection with business performance. In a similar vein, Afrazeh et al. (2018) reported similar conclusions. Moreover, Nabi et al. (2020) also identified there is no meaningful association.

### 2.3. Patents and business performance

Patent is an exclusive right granted by a specialised department for an invention, which can help companies gain an advantage over their peers and competition, ultimately contributing to better business performance (Altinn, 2020). It is mainly attributed to the fact that patents can help companies to explore the exclusive right to commercialise an invention, which can prevent competitors from producing or selling patented technology as a way of creating a unique creative competitive advantage and attracting more customers (Bache & Spilde, 2021). Patent registration allows firms to limit competitors by prohibiting them from copying product designs. So, it is often regarded as the most important source of primary competitiveness.

Scholars believe that patents can effectively increase the value of a firm and that an increase in patent applications for inventions can improve business performance. Recent studies conducted in Korea have shown that patents held by corporations illustrate a positive moderating effect on the business performance (Jin & Kim, 2021). Similarly, Yun et al. (2016) got a similar result when they studied Korean companies. Lee (2018) indicated that patents have a significant positive effect on firm value.

In comparison, the survey of companies in Latin America revealed that patents have a negative impact when performance is measured by turnover (Paula & Silva Rocha, 2021). Moreover, it is worth noting that Artz et al. (2010) found a negative correlation between patent registrations and sales success, mainly when the influence on asset profitability has been included. Benassi et al. (2022) found no significant relationship between a company's profitability and patents. The findings of Hall et al. (2013) demonstrate that there also is no correlation between firm development and patent ownership.

### 2.4. Brand value and business performance

The very last factor is brand value. "Brand" generally refers to the name, concept, word, icon, or design used to distinguish and promote the goods and services of a manufacturer or seller (Kotler & Armstrong, 2012). Brand valuation is the key activity of any business. It is the most difficult decision that managers take about what brand

should be introduced to the market. It is a long process as well; Although, brand values are much important and play a vital role in business performance. Especially in SMEs brand value works as a backbone. Brand performance is the brand's achievements across the market, considering several components such as brand awareness, brand image, reputation, and loyalty. Also, research conducted in Hungary and Finland indicates that when businesses have a strong brand with consumers, their sales, profitability, and market share increase (Wong & Merrilees, 2008).

Previous scholars have also shown in their research that brand value is highly positively connected with specific financial indicators of some businesses (Kumar et al., 2020; Wong & Merrilees, 2008). Gromark and Melin (2011) also provide additional evidence for a positive association between the brand and business performance. On the other hand, Sadalia and Marlina (2018) noted that brand value has no meaningful association with an enterprise's financial performance. Hence, to measure if the value of the brand has a significant impact on the performance of Chinese SMEs.

Summing up all literature, we found that a lot of work has been done on business performance. Researchers proposed different factors that can impact positively or negatively on business performance, and some of them showed that R&D has a negative relationship with SMEs Industries. It is because of the high cost. Human capital, patent, and brand value are also proposed as important factors in many papers. Scholars used big samples and targeted specific markets in their studies. And some of the researchers worked on only one factor, patent. Fewer studies combine R&D intensity, human capital, patent, and brand value. So, we got that there is a big gap in this area. We've proposed a hypothesis in response to the literature to cover this gap. Which is "the impact of R&D intensity, human capital, patent and brand value on business performance". In addition, the choice of the research subject is also the key to the conduct of this study. Through the study of previous literature, it is easy to find that most of the studies conducted are from developed countries in the UK, US, and Europe, and there are very few studies on Chinese SMEs. Therefore, this study can also provide more empirical evidence for the study of Chinese enterprises. Hypotheses and the conceptual framework are explained in the next part.

## 3. Conceptual framework and research hypotheses

### *3.1. Conceptual framework*

After reading the relevant literature from the previous several years, we have selected four notable non-financial indicators to evaluate their relevance to business performance. R&D intensity, human capital, patent, and brand value are independent variables and business performance is a dependent variable. In the hypothesis section, some alternative words have been used for independent variables. The concept of these terms is the same (Figure 1).

### *3.2. Hypothesis*

Four main hypotheses have been developed for this study. In which the first hypothesis H1 is to determine the relationship between the intensity of R&D investment and the

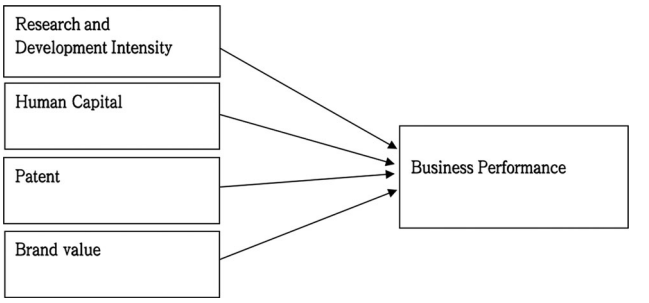


**Figure 1.** Conceptual framework.
Source: designed by myself.

previous performance of Chinese SMEs. H2 is to analyse whether human capital has a significant impact on company performance within Chinese SMEs. In search of Chinese academics in related fields, Feng and Jiao (2004) believe that personal knowledge, experience, and technical level can generally reflect human capital. In addition, Wang and Liu (2016) highlighted that employees' innovation and technical capacity are also factors that must not be overlooked. Some Chinese academics have also noted the importance of employee education and believe that highly educated talent can create more value for organisations (Xiao, 2016). Based on these statements, the paper develops the following five sub-hypotheses. The third is H3, to test whether the number of patents owned by a firm has a significant impact on firm performance. Finally, the H4 tests whether there is a strong relationship between brand value and business performance. All hypotheses are as follows which are further discussed in separate sections:

H1: R&D intensity has a positive impact on business performance within Chinese SMEs
H2: Human capital has a positive impact on business performance within SMEs
H2a: Technological personnel have a positive impact on business performance.
H2b: Production personnel have a positive impact on business performance.
H2c: Management personnel have a positive impact on business performance.
H2d: Highly educated personnel have a positive impact on business performance.
H2e: R&D personnel have a positive impact on business performance.
H3: Patents have a positive impact on business performance.
H4: Brand value has a positive impact on business performance.

## 4. Research design

This section details the study design to examine the hypothesises. First, the research data sources are presented, along with their strengths and limitation. Then comes the choice of study variables. Following are descriptive analysis and multiple linear regression analysis of the survey variables. Next the hypotheses are summarised and analysed. At last, we discuss the whole research.

### *4.1. Data sources*

All data of samples are gathered through the National Equities Exchange and Quotations (NEEXQ) platforms. Furthermore, data were collected from these industries

in October 2021 and then analysed in March 2022. We deleted companies with missing, anomalous, or incomplete financial data and organisations that were suspended in the sample selection procedure. The main advantage of the samples selected here is that the cross-sectional comparison between enterprises is more intuitive. Data are all from the annual financial statements of each company in 2019, which facilitates cross-sectional comparisons between different companies. Secondly, the samples from 18 different sectors presented in this paper are more generalisable. But there are some limitations, such as sample size. Due to the limitation of search time and the principle of business confidentiality, only the raw data from 864 firms were obtained in this research.

### 4.2. Study variables

We selected the dependent variables return on asset (the ratio of net income to total assets) or return on equity (the ratio of net income to equity). Nandy (2020) used ROA and ROE as potential earning performance for business. According to him, it's a great tool for assessing an organisation's performance.

Regarding the control variable: (1) business age (A_b) demonstrates its ability to survive and develop (Delmar et al., 2013). In this study, we use the number of years the business has been in existence until 2019 as the business age; (2) business size (S_ta) is another variable that generally refers to the size of a firm's operations. With the approach adopted by many researchers, we also represent business size by the logarithm of assets (Xu & Jin, 2016).

The independent variables are picked based on the hypotheses we discussed previously. (1) R&D intensity is defined as the ratio between a firm's R&D investment and the firm's revenue (H. Park et al., 2021). According to Ravšelj and Aristovnik (2020), this ratio provides comparability among the different enterprises. Consequently, we choose R&D intensity (RD_i) as the first independent variable to measure business performance. (2) We adopted the ratio of R&D personnel (RD_r), production personnel (PP_r), technical personnel (TP_r), management personnel (MP_r), and highly educated personnel (HeP_r) to all staff to assess business performance (Xu & Jin, 2016; Zhao & Yu, 2021; Zhou et al., 2023). (3) We choose to use the number of patents (N_p) the company held in 2019 to analyse the relationship between patents and business performance. (4) The last one is brand value (BV_ratio). For a company, brand value is a collection of active and passive assets that depend on the brand name and symbols (Gerekan et al., 2019). We select the brand value from the company's annual report as an independent variable.

### 4.3. Descriptive statistics

SPSS Statistics 26 is used for data analysis in this paper. Descriptive statistics of variables are shown in Table 1.

### 4.4. Multiple linear regression analysis (step backward)

In reviewing previous publications, we found that many researchers have chosen the multiple linear regression analysis to investigate the relationship between each independent

**Table 1.** Descriptive statistics.

| Code | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| ROE | 845 | −176.060 | 872.000 | 13.908 | 49.024 |
| ROA | 846 | −157.928 | 601.306 | 7.306 | 26.606 |
| A_b | 663 | 2.000 | 41.000 | 16.790 | 5.184 |
| S_ta | 845 | 2.458 | 6.665 | 4.523 | 0.609 |
| RD_i | 845 | 0.000 | 379.000 | 6.702 | 14.255 |
| RP_r | 846 | 0.000 | 146.667 | 30.496 | 21.989 |
| TP_r | 846 | 0.000 | 672.973 | 34.893 | 32.716 |
| PP_r | 846 | 0.000 | 94.983 | 29.462 | 26.015 |
| MP_r | 846 | 0.000 | 72.727 | 12.667 | 7.845 |
| HeP_r | 846 | 0.000 | 56.232 | 5.391 | 7.056 |
| N_p | 290 | 0.000 | 300.000 | 23.830 | 40.629 |
| BV_ratio | 845 | 0.000 | 139.013 | 2.535 | 8.910 |

Source: Own elaboration.

**Table 2.** Result of ROA.

| | Unstandardised Coefficients | | Standardised Coefficients | | |
|---|---|---|---|---|---|
| Code | B | Std. Error | Beta | t | Sig. |
| **(Constant)** | 65.222 | 6.563 | | 9.937 | 0.000 |
| N_p | 0.094 | 0.035 | 0.084 | 2.721 | 0.007 |
| PP_r | 0.159 | 0.035 | 0.155 | 4.570 | 0.000 |
| HeP_r | 0.406 | 0.125 | 0.108 | 3.248 | 0.001 |
| BV_ratio | 1.238 | 0.097 | 0.414 | 12.761 | 0.000 |

Source: Own elaboration. The variables included are age of business, Size of business, R&D intensity, Research personnel rate, N° patents, Technological personnel rate, Production personnel rate, Management personnel rate, Highly-educated personnel rate, and Brand value rate.

**Table 3.** Result of ROE.

| | Unstandardised Coefficients | | Standardised Coefficients | | |
|---|---|---|---|---|---|
| Code | B | Std. Error | Beta | t | Sig. |
| **(Constant)** | 78.064 | 13.062 | | 5.976 | 0.000 |
| N_p | 0.113 | 0.068 | 0.055 | 1.660 | 0.097 |
| TP_r | −0.124 | 0.058 | −0.083 | −2.121 | 0.034 |
| PP_r | 0.289 | 0.078 | 0.154 | 3.707 | 0.000 |
| HeP_r | 0.529 | 0.246 | 0.076 | 2.153 | 0.032 |
| BV_ratio | 1.474 | 0.191 | 0.268 | 7.730 | 0.000 |

Source: Own elaboration. The variables included are age of business, Size of business, R&D intensity, Research personnel rate, N° patents, Technological personnel rate, Production personnel rate, Management personnel rate, Highly-educated personnel rate, and Brand value rate.

variable and business performance (Ravšelj & Aristovnik, 2020; Xu & Wang, 2018). However, an economic phenomenon is frequently related to several factors. In fact, an economic phenomenon is frequently associated with multiple factors, and it is more efficient and practical to estimate the dependent variable using multiple independent variables. Therefore, we choose a multiple linear regression in the survey on Chinese SMEs.

From the analysis result, we dropped the variables with p values above 0.10, which are not significant. In Table 2, brand value rate effect ROA most significantly. When the brand value rate increases by 1 unit, the ROA will increase by 1.238 units. In summary, when ROA is analysed as the business performance indicator, the number of patents, production personnel rate, highly educated personnel rate, and the ratio of brand value all positively affect corporate performance.

Table 3 shows the correlation between variables and ROE using the same methodology. After removing variables with p values above 0.10, the p-values N_p, TP_r,

**Table 4.** Research hypotheses.

| Hypotheses | Result |
|---|---|
| H1: R&D intensity has a positive impact on business performance. | No |
| H2: Human capital has a positive impact on business performance. | |
| H2a: Technological personnel has a positive impact on business performance. | Negative |
| H2b: Production personnel has a positive impact on business performance. | Positive |
| H2c: Management personnel has a positive impact on business performance. | No |
| H2d: Highly educated personnel has a positive impact on business performance. | Positive |
| H2e: R&D personnel has a positive impact on business performance. | No |
| H3: Patents have a positive impact on business performance. | Positive |
| H4: Brand value has a positive impact on business performance. | Positive |

Source: designed by myself.

PP_r, HeP_r and BV_ratio are statistically significant in the regression. In short, the number of patents, production personnel rate, high-educated personnel rate, and the ratio of brand value all display a positive correlation with the dependent variable ROE. However, the technological personnel rate illustrates a negative trend.

### 4.5. Result

Table 4 summarises the results of the hypothesis. There is no significant correlation between R&D intensity and firm performance over the same period. So, H1 is not valid, which is consistent with previous studies of Li (2012). Moreover, according to previous scholarly research, firm R&D intensity can indirectly affect firm performance by improving product quality, promoting product innovation (Xie et al., 2019), or improving employee competence (Chen et al., 2019). Therefore, we conclude that R&D intensity does not have a direct impact on firm performance. The conclusions for H2 are complex. H2b and H2d are valid. Production personnel and high-educated personnel always show a significant positive effect on both ROA and ROE, in line with the previous studies of Boselie et al. (2005), Feng and Jiao (2004), Hall et al. (2013) and Xiao (2016). Surprisingly, H2a does not hold. Unlike previous studies (Boselie et al., 2005; Haris et al., 2019; Xu & Wang, 2018), the technicians showed a negative effect. Moreover, H2c and H2e also cannot be confirmed. There is no significant correlation of managers and R&D personnel, which is against the view of Zhou et al. (2023). However, both H3 and H4 are supported. The positive correlation between the number of patents and the business performance of SMEs in China is more significant, which is supported by Yoo and Kim (2019). Additionally, brand value has the most significant positive effect on ROA, consistent with recent research of Kumar et al. (2020).

### 4.6. Discussion

While the study does not confirm that there is a direct effect of R&D investment on business performance. The cycle of R&D activities generally lasts for a long period of time and only when the successful product is performing well in the market can the R&D investment be truly financially rewarded, thus improving the performance of the company. Therefore, a company's investment in R&D is likely to have a negative impact on current corporate performance but may have a positive impact on future corporate

performance. Another noteworthy point concerns the lagged impact of R&D intensity on firms. As Ravšelj and Aristovnik (2020) mention in their study of Slovenian companies, R&D investments should not have a significant impact on current business performance but should have a positive impact on future performance. Some empirical research recently contacted in different countries, including China (Leung & Sharma,2021; Luan & Tien, 2015; Wang & Yang, 2017; Zang et al., 2019; Zhao & Yu, 2021; Zhao, 2021), Taiwan China (Chen et al., 2019; Su et al., 2020), the USA (Pourkarimi & Kam, 2022), Korea (Kim & Park, 2021; Seo & Kim, 2020), the European Union (Çiftçioğlu, 2022), Slovenia (Ravšelj & Aristovnik, 2020), Turkey (Kiraci et al., 2016), Bangladesh (Rahman & Howlader, 2022) and India (Busru & Shanmugasundaram, 2017). This is also a topic worthy of further study.

The results of the human capital analysis are complex. For managers and R&D staff, we do not find a link between them and firm performance, which is largely because more than two-thirds of samples are in traditional manufacturing and animal husbandry, where the role of managers, particularly R&D staff, is very limited. In contrast, we found that highly educated employees and production staff all had a positive impact on firm performance. This finding supports by researches of Andreeva and Garanina (2016), Boselie et al. (2005), Lee et al. (2016), Xiao (2016) and Yun et al. (2016).

This research prefers to explain that the number of patent applications can, to some extent, reflect the strength and operation of the firm and that strong and well-run firms tend to have better financial data. One reason for this is that for smaller firms, relying on a few high-tech patents for monopoly profits makes it more likely that the firm's financial figures will increase sharply. It means that the company's new products are about to hit the market and capture the market, thus boosting the company's performance.

For brand value, it has the most significant positive on business performance. The reason why brand value has a significant positive impact on corporate performance can be analysed in two main ways. Firstly, brand value can increase the value of a company's products and services beyond their functional price, thereby boosting sales and prices and ultimately improving business performance. Secondly, good brand value can reinforce customer loyalty, which is a crucial factor in improving business performance.

## 5. Conclusion

In terms of academic research, previous literature has mainly chosen large or medium-sized Chinese firms as the subject of study. This paper bridges the gap between the empirical analyses of Chinese SMEs. In addition choosing the common R&D investment intensity or patents as variables to explore the relationship between firm performance. This paper incorporates human capital and brand value into the empirical analysis as well. The results have been derived from the collecting data of 846 Chinese SMEs through NEEXQ. When ROA and ROE are analysed as the business performance indicator, our results on R&D intensity are in line with recent studies by previous researchers (Ravšelj & Aristovnik, 2020). There is not a direct connection between R&D

intensity and business performance. The results of studies on human capital are complex. Only production personnel and highly educated personnel show a positive trend. However, the number of patents owned by a company has a significant impact on the performance of the company, and the results are significant for both ROA and ROE. This further supports the conclusion that there is a significant positive relationship between patents and business performance (Lee, 2018; Yun et al., 2016). In analysing the brand value of a company, we find that it has a more pronounced impact on ROE. This refutes the argument of Sadalia and Marlina (2018) on the relationship between brand value and corporate performance. Finally, by summarising the findings, we support the positive contribution of patents and brand value to firm performance. The driving role of technicians, production staff, and highly educated personnel is also highlighted. And it refutes the positive impact of R&D investment on current firm performance.

### 5.1. Implications of practice

The findings of the article are combined with practice. Firstly, the government should continue to support high-tech enterprises in terms of policy and promote the transformation of R&D results. Encouraging continuous growth in the number of patents owned by enterprises will help them sustain their development. Secondly, we can affirm the role of production staff and high-educated talents in driving the performance of enterprises. Exchanges and cooperation between universities, enterprises, and government research institutions should be encouraged. On the one hand, schools can provide enterprises with many high-end technical talents; while on the other hand, enterprises can provide schools with R&D projects and provide students with many internships and practice opportunities, which can be considered a win-win situation. Finally, enterprises should not neglect to build their own brand value.

### 5.2. Limitations and recommendations for further study

First, the data collected needs to be improved. All samples have disclosed information about R&D investment in their annual reports. In some companies, the R&D investment refers to the sum of the R&D investment of the parent company and the subsidiaries, while in others, only the R&D investment of the parent company is disclosed. This may also lead to differences in results and should be harmonised in future studies. Another limitation is the sample size. This study measured only 846 Chinese SMEs, which is a very small fraction. Therefore, for future studies more companies' data should be included.

In this paper, we found that the intensity of corporate R&D investment cannot affect business performance directly. However, many scholars have also mentioned the lagged effect of R&D investment. In future research, we will investigate more whether there is a lagged effect of R&D investment on the firm performance of Chinese SMEs. We will also determine the length of the lag period.

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