A Study of Policies for Improving the Technological Innovation Capacity of Small and Medium-Sized Enterprises

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Abstract **– Taiwan's "government innovation policy resources" help enterprises expand innovation capacity by providing financial rewards, tax deductions, personnel training, and polities and facilities that encourage innovation. The results of this study show that "government innovation policy resources" is significantly and positively correlated with "technological innovation capacity" and "firm operating performance," while the latter two are also positively correlated. Among the "government innovation policy resources," financial rewards and personnel training have the most influence on expanding innovation capacity, which in turn benefits the enterprises' ability to develop better products and have a positive effect on its operating performance and profitability.**

Keywords **– Government innovation policy resources, technological innovation capacity, firm operating performance**

1. Research background and motivations

Among all economic activities, firms are affected by factors related to national economic policies, industrial structures, and cultural backgrounds. Small and medium-sized enterprises (SMEs) in the Taiwan region account to 97.63% of all enterprises, 29.64% of the total sales volume, and provide 77.85% of employment [1]. Clearly, SMEs are key to Taiwan's economic development. As a result, Taiwan's government published the Small and Medium Enterprises Development Act, which proposes many policies and measures to counsel SMEs.

Taiwan is an island economy, and its survival depends on economic development. The question of how to maintain competitiveness in the global market and avoid marginalization poses a serious challenge to Taiwan. Currently, Taiwan faces the serious threat of weakening economic growth momentum. Whether firms can survive in a fiercely competitive environment and seek further opportunities for development depends largely on whether these firms have good innovative capacities. As such, the question of how to improve firms' innovative capacities has become a key factor in helping firms attain competitive advantages.

In the face of such a critical moment, the question of how to break through these predicaments and establish policies regarding firm technological innovation to guide firms in improving technological innovation is of clear importance. Only by actively investing in innovative policy thinking, extending the existing core strengths, and creating additional growth forces is it possible to create a new paradigm. Through the three main dimensions of "industrial transformation, breakthrough innovation," "market opening, facing the world," and "investment promotion, innovative entrepreneurship," Taiwan can strengthen its economic growth momentum, improve its overall competitiveness, and its global economic position.

In 2010, the Taiwanese Government issued the Industrial Innovation Act, which uses tax incentives to promote industrial research momentum. In reality, this lacks innovative thinking. In the era of the knowledge economy, innovation is unquestionably important for sustaining industrial competitiveness and increasing products' added value. However, the government hopes that through the Industrial Innovation Act, it can promote orientations for

DOI: 10.18421/TEM72-05
https://dx.doi.org/10.18421/TEM72-05

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Received: 29 September 2017.
Accepted: 15 March 2018.
Published: 25 May 2018.

industrial innovation. It is debatable whether this will allow industries to continuously innovate and allow the economy to sustain competitive advantages. We must first ask what is the extent of the effects of the tax incentives on R&D? Can the tax income generated out of the effects of industrial innovation compensate for or offset the losses suffered by the national treasury from giving out these tax incentives? Currently, the fairness of the Industrial Innovation Act has also been questioned, because most beneficiaries are large firms, while SMEs have relatively low eligibility for incentives. Because SMEs lack official R&D departments, and sometimes, even lack official financial reports, they cannot apply for R&D offset funds. SMEs are the driving force of Taiwan's economy. SMEs require capital injections or technology transfers to carry out R&D activities. Are government policies aimed at improving SME innovation in line with the needs of the SMEs? Further, it is important to consider whether these policies are actually applied at the level of the SMEs. All these questions are worth exploring.

The Taiwanese Government has already promoted industrial upgrade and economic development. In Section 9 of the Industrial Innovation Act, the Ministry of Economic Affairs (MOEA) states that "The government shall use subsidies or counselling to assist the industry, academic institutions, and research institutions in innovative activities to promote industrial innovation, improve industrial environments, and raise industrial competitiveness." Taiwan's MOEA has used research institutions, universities, or intermediary institutions (e.g., juridical-person research institutes) as intermediary agents or tools for policy implementation. As a result, universities and research organizations not only play the role of knowledge providers, personnel trainers, and enterprise incubators but also promote local innovation development and provide many intermediary services and functions, such as communication linkages, coordination, reorganization, and advisory service platforms for local innovation activities.

According to the above analysis and discussion of the research background and motivations, this study will assume the perspective of the policy tools employed by the government addressed towards SME innovation and will thereby explore the effect of the relationship between SME innovation capacity and operating performance. Moreover, this paper conducts a literature review to further its analysis and hopes to achieve the following four research objectives:

1. What are the implications of government policy tools aimed at SME innovation?
2. What is the efficacy and pathway of the effect of government innovation policies on firm innovation capacity and operating performance?
3. In response to changes in cross-straits circumstances, how should policies promoting SME innovation be adjusted?
4. With synchronous improvements to cross-straits global economic patterns, how should policies regarding value-chain labour division and innovative economic cooperation models be employed?

2. Literature review

2.1 Technological innovation capacity

The main axis of Taiwanese economic growth has already expanded from technological innovation to include all aspects of innovation. The Organization for Economic Co-operation and Development (OECD) [2,3] pointed out that innovation is an effective and important source of economic growth and can be used to respond to new challenges. Innovation is the process used by organizations to create new products, services, or processes and new uses for them, their introduction to the market, or their commercialization [4]. Taiwan's economic rise, given the critical mass of financial resources, management, and R&D capacity, has become a source of technological and non-technological innovation [5]. Baldridge and Burnham defined "innovative capacity" as technological products purchased externally or produced internally by an organization, or the innovative breadth and depth facilitated by the organization's management measures within the past three years. An organization's innovative breadth includes its equipment, systems, policies, solutions, processes, products, services, etc. Innovative depth, on the other hand, is the critical influence on management or long-term profitability that innovation brings to the organization [6]. In his findings, Higgins stated that innovation is the most valuable asset of an organization of the 21st century. Innovation, according to Higgins, is the process of inventing something new, which brings great value to individuals, a collective, an organization, an industry or even the whole society [7]. Oslo Manual states that the "technological product and process" (TPP) include adopting completely new or vastly improved products and processes. When TPP is executed, it means that the new products have reached the market and the new processes have been applied [8]. Damanpour classifies innovation into process innovation, product innovation, market innovation and management innovation. The former two are based on an organization's internal technical

foundation, so they can be grouped under "technological innovation"; while the latter two concern the improvement of an organization's management efforts, so they can be grouped under "management innovation" [9].

For firm operators, the development of completely new products, significant improvements to existing product functions, new production processes, and significant improvements to existing production processes are all technological innovation capability activities.

In summary of our definitions and connotations of technological innovation, the technological innovation capability activities include production process, product, or technological innovation and relevant supporting activities. As such, technological innovation capabilities are defined as follows:

Technologically new product: A product whose new technological characteristics or uses are clearly distinct from those of existing products.

Technologically improved product: A product that, based on the existing products, uses highly efficient materials or components to greatly improve technological characteristics or that which improves certain product systems to produce significant technological improvements.

Technological Process Innovation: This refers to the use of new or greatly improved production methods, including new methods of delivering products. These methods may involve changes to production equipment or production frameworks or may be the result of applying new knowledge.

2.2 Firm operating performance

In researching the economic benefits of innovation, this study adopts two methods. First, this study utilizes financial data to review the economic benefits that investments in innovation bring to enterprises [10,11]. Firms use operating performance measurement assessments to understand the efficacy of their operations management; performance measurements are necessary indices [12]. Looking at such performance index as productivity, sales revenue, profit and return of investment. Second, combining financial and market data to investigate the values and influences of innovation, specifically in terms of the market value of the enterprise and stock returns [13,14].

Venkatraman and Ramanujam proposed three metrics for measuring firm performance [15]:

1. Financial performance: It refers to a firm's operating objectives such as sales growth, profitability, and stock earnings per share.
2. Business performance: Apart from financial performance, this includes market share, product quality, and marketing effectiveness.
3. Organization performance: Apart from the above two metrics, this metric includes elements such as employee morale and customer satisfaction.

Based on the cumulative discussion of researchers on firm operating performance indices, after exploring research in fields related to human resources, this study adopts the perspective that includes two elements, the human resources performance and the financial performance. "Human resources performance" includes employee morale, employee productivity, job satisfaction, employee turnover rate, and employee resignation rate. "Financial performance" includes the company's overall performance, profit growth rate, return on investment, operating turnover growth rate, sales profits, and market share. The four indices of profitability, sales growth, customer satisfaction, and product quality are used as research dimensions in this study.

2.3 Policies and related supporting measures for the development of Taiwanese SMEs

During the process of industrial development, governments provide policy incentives and support to provide firms with necessary resources and create a supportive environment for industrial development. Innovation policy is an action taken by governments to influence innovation development and diffusion [16]. Traditional industries have limited resources, and therefore, innovation policies must acknowledge industrial advantages to help operators introduce, expand, or make full use of applicable conditions and to generate cutting-edge and sustained innovation [17]. Innovative policies like tax incentives, reward subsidies in research investments, reward subsidies in transnational technical cooperation, etc. [18,19], are key in aiding enterprises in making high-risk investments in research and innovation activities [19]. According to the 2017 White Paper on Small and Medium Enterprises in Taiwan, the programs offered by the Taiwanese government to provide resource assistance to SMEs include the four following strategic measures and supporting measures.

Table 1. strategic measures and supporting measures

Four Strategic Measures	Four Supporting Measures
Improve financial services and promote investment: provide all kinds of financial advice, diagnoses, and counseling; coordinate with financial organizations to provide financial assistance, and help establish sound financial accounting systems, train financial management talent, and improve financial management capabilities.	Assist SMEs with counseling funds: *The Act for Development of Small and Medium Enterprises* clearly provides for the allocation of a fixed budget to help cover costs such as SME counseling funding, government procurement, and government-funded loans for SME projects.
Promote industrial transformation and upgrade and improve R&D capabilities: The government provides innovative R&D counseling and funding assistance to promote active innovation, transformation, and upgrade to increase the pace of overall industrial upgrade.	Improve the SME legal environment: Establishing technological governance operation measures to provide timely assistance and prospective planning management to SMEs through the use of legal system amendments, regulatory adjustments, and R&D policy establishment.
Construct mechanisms for incubating and accelerating innovation and entrepreneurship: Actively promote entrepreneurial service engines, optimize the entrepreneurial environment, establish creative and innovative entrepreneurial ecosystems, actively implement entrepreneurial incubation projects, and accelerate the establishment of global linkages for forward-looking enterprises.	Participate in global SME affairs and activities: Strengthen international learning and transfer, expand substantive exchanges with the international community, improve international visibility, and actively host and participate in affairs and activities for SMEs.
Thoroughly develop local industry and develop an understanding of market opportunities: Government assistance in the specialized development of local industry, providing manufacturers with opportunities for reengineering, coordinating with the introduction of local business district management and civil participation mechanisms, and the utilization of cooperative efficiency innovation activities to improve the competitiveness of local business districts.	Reward excellent operating models: Conduct award activities such as the National Award for Outstanding SMEs, the Rising Star Award, the Innovation Research Award, and the Business Startup Award to improve product sales and corporate images of award-winning firms.

2.4 Linkages between government innovation policy resources, technological innovation capacity, and operating performance

The rise of the knowledge economy, R&D, and innovation have become important factors for improving national competitiveness. Nurturing R&D capabilities, promoting innovation capacity, government planning guidance for SMEs with limited resources, and incentivizing subsidies for making innovation resources accessible play a key role in this process.

Grabowski and Mueller conducted a study of 86 listed companies in the United States, spread across nine different industries, between 1979 and 1985, considering the relation between research and development capital and return of asset. The research found that more investment in R&D gives the enterprise more earning power [20].

Rosenberg and Frischtak also found out that the innovative capacity of an enterprise is gained by long-term experience in design, production and problem solving. Data collection and archiving is also key to good performance in technological innovation and business performance [21].

Youssef states that technological innovation can improve enterprise quality (product, supply chain, design and engineering), lower costs (quality control, product development, sourcing, labor and indirect costs), increase flexibility and response capability (faster new product development and production, faster response to new market needs), which all improve operational performance [22].

In their study on the banking industry, Subramanian and Nilakanta state that technological innovation enables an organization to become more proficient, specifically in terms of market share, revenue and overall performance [23].

In their study on the influence of innovation on the Australian manufacturing industry, Yamin, Gunasekaran and Mavondo combined management innovation, technological innovation and product innovation into an innovation index. They evaluated the relation between innovation and performance through marketing effectiveness, asset management, operational efficiency and financial performance. According to the research, technological innovation can improve process innovation, lower costs, boost performance, and have positive effects on work productivity and overall performance [24].

A questionnaire study by Calantone et al. involving 400 American R&D vice presidents indicates that if firms actively search for new ways of improving work systems and consistently introduce new ways of thinking to work systems, firms will experience significant increases to overall profitability and sales returns [25].

Hall and Bagchi-Sen conducted a study in which 74 Canadian biotech companies were taken as research objects and explored the relationship between innovation capacity and performance. Their results revealed that the development of new products and the introduction of new production processes could improve the firms' overall revenue growth and product sales growth, thereby improving firm profit growth [26]. For firms' internal departments, any innovation activity regarding products or production processes improves firms' basic competitive advantages and operating performance [27,28]. Thus, both product- and process-related technological innovations have positive and significant effects on firms' operating turnover and profitability.

After a review of literature related to technological innovation, this paper posits that technological innovation effectively, significantly, and positively affects firm operating performance.

2.5 Summary

Combining the content of each level of technological innovation policy, the White Paper on Small and Medium Enterprises in Taiwan and the Handbook of Government Assistance Resource to SMEs indicate the following categories of government resources that can be provided to SMEs for assistance:

1. Tax Incentive Policy Measures

When companies invest a certain level in technological R&D and equipment, these costs will be deducted from the income tax of profit-making industries within a defined rate. In addition, strategic industry tax incentives provide tax relief for accelerated depreciation, invention awards, and tax incentives and exemption from import duties for the new establishment of operating headquarters.

2. Financial Incentive Policy Measures

R&D subsidies, financing, funds investment, etc.

3. Personnel Training Policy Measures

R&D personnel training and recruitment, introduction of military personnel to the industry, industrial technology personnel training, high-tech industrial personnel training, establishment of key industry institutes to train technical personnel

4. Establishing an Innovative Environment and Setting Policy Measures

Here, the government promotes industrial technology information-service systems while strengthening cooperation between the industry, government, academia, and research institutions. It also establishes technological standards and carries out public procurement to encourage businesses to invest in R&D, develop science and technology zones, strengthen intellectual property rights, and accelerate the effects of entrepreneurial incubation. This is done through policies that promote innovation and accelerate the development of regional R&D centers in Taiwan.

3. Research framework and hypotheses

3.1 Research framework

The Delphi method questionnaire is used to collect expert opinions. Because the questionnaire content was amended, deleted, and supplemented by expert academics, it has good reliability; the questionnaire content underwent a second round of consistency testing, and therefore, the questionnaire has good test-retest reliability. Further, we have established an index framework for policies aimed at improving the innovation capacity of Taiwanese SMEs. According to the research objectives of this study and in reference to the empirical studies in the above literature, after using the Delphi method questionnaire to survey the opinions of experts, we derive a basic research framework.

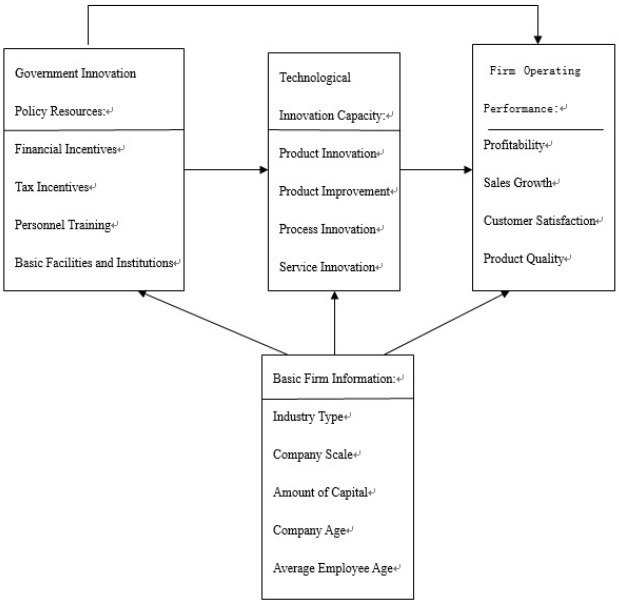

Figure 1. Research Framework

3.2 Research hypotheses

H1: The effects of government innovation policy resources on different kinds of firms vary significantly.

H2: Different kinds of firms have significantly different technological innovation capacities.

H3: Different kinds of firms have significantly different operating performances.

H4: Government innovation policy resources have a significant effect on technological innovation capacity.

H5: Government innovation policy resources have a significant effect on firm's operating performance.

H6: Technological innovation capacity has a significant effect on firm's operating performance.

3.3 Questionnaire surveying

This study uses the second-round results of the Delphi method questionnaire and consults the literature and research objectives to form an official questionnaire. The questionnaire is addressed to the Taiwanese SMEs that have practical cross-straits trade experience, such as those SMEs that have won the MOEA Innovation Research Award, have innovative ideas concerning industrial operation, have invested in factories in mainland China or conducted cross-straits trade. A total of 1,250 questionnaires were distributed, and 281 valid questionnaires were returned at a rate of 22.5%. After collecting, coding, and registering the questionnaires, the SPSS software was used as an analytical tool.

4. Research results and analysis

4.1 Basic data analysis

Here, we analyze the firm's basic information. With regard to industry types, "Other" was the most common, comprising 24.9% of the firms; the next most common type was "Agricultural Food Products Manufacturing and Processing," at 16.7%. With regard to company scale, most companies had 50 or fewer employees, accounting for 58.7% of the total; the next most common company scale was between 51–100 employees, accounting for 19.2% of the firms. With regard to company capital, the most common capital volume was between NT$10,010,000–NT$50,000,000 at 30.6%, followed by capital volumes greater than NT$80 million. With regard to company age, the most common company age was greater than 31 years, comprising 32.0% of the total, followed by companies aged between 11–20 years.

4.2 Analysis of government innovation policy resources, technological innovation capacity, and firm operating performance

Here, we analyze the effect of government innovation policy resources on firm innovation capacity. After the analysis, the question item "This company has been able to improve its innovative capacity because it received capital subsidies, financing, or funding investments from the government" (M = 3.66) ranked as the primary government innovation incentive, followed by "Active government training of innovation personnel can help this company innovate" (M = 3.61).

Here, we analyze the effect of improved technological innovation resulting from government innovation policy resources on firms. Following the analysis, the question item "Technological innovation capacity stimulates this company's development of new products" (M = 4.06) ranks as the most important item for technological innovation capacity, followed by "Technological innovation capacity can improve the quality of this company's existing products" (M = 4.03).

Here, we analyze the effect of improved innovation capacity resulting from government innovation policy resources on firm's operating performance. Following the analysis, the question item "Innovation capacity can improve this company's profitability (M = 3.98) ranks as the most important item with regard to technological innovation capacity, followed by "Innovation capacity can improve this company's product quality" (M = 3.95).

4.3 Correlation analysis for government innovation policy resources, technological innovation capacity, and firm operating performance

In analyzing Taiwanese SMEs' utilization of financial incentives, personnel training, tax incentives, and environmental infrastructure, this study has found that "financial incentive" is significantly and positively correlated to "personnel training," "tax incentive," and "environmental infrastructure." Namely, the more resources the government invests in "financial incentives", the higher the level of "personnel training resources," "tax incentive," and "environmental infrastructure." "Personnel training" is positively and significantly correlated with "tax incentive" and "environmental infrastructure," meaning that when the "personnel training" element of government innovation policy resources is higher, "tax incentive" and "environmental infrastructure" are also higher. "Tax incentive" is positively and significantly correlated with "environmental infrastructure;" this means that when the "tax incentive" element of government innovation policy resources is higher, "environmental infrastructure" will also be increased.

Table 2: Overall correlation analysis for government innovation policy resources, technological innovation capacity, firm operating performance, and cross-Straits trade interaction

	Financial Incentive	Personnel Training	Tax Incentive	Environmental Infrastructure
Financial Incentive	1			
Personnel Training	0.57***	1		
Tax Incentive	0.48***	0.70***	1	
Environmental Infrastructure	0.51***	0.66***	0.79***	1

*p<.05 **p<.01 ***p<.001

A correlation analysis of product innovation, product improvement, process innovation, and service innovation elements of the Taiwanese SMEs' technological innovation capacity reveal that "product innovation" is significantly and positively correlated with "product improvement," "process innovation," and "service innovation." This means that when the "product innovation" element of government innovation policy resources is higher, "product improvement," "process innovation," and "service innovation" are also higher. "Product improvement" is significantly and positively correlated with "process innovation" and "service innovation." This means that when the "process innovation" element of government innovation policy resources is higher, "process innovation," and "service innovation" also increase. "Process innovation" is significantly and positively correlated with "service innovation." This means that when the "process innovation" element of government innovation policy resources increases, "process innovation," and "service innovation" also increase.

Table 3. Correlation analysis of product innovation, product improvement, process innovation, and service innovation elements of firm technological innovation capacity

	Product Innovation	Product Improvement	Process Innovation	Service Innovation
Product Innovation	1			
Product Improvement	0.86***	1		
Process Innovation	0.82***	0.92***	1	
Service Innovation	0.79***	0.84***	0.86***	1

*p<.05 **p<.01 ***p<.001

After conducting correlation analysis of profitability, sales growth, customer satisfaction, and quality improvement elements of firm's operating performance, we find that "quality improvement" is significantly and positively correlated with "profitability," "sales growth," and "customer satisfaction;" this means that when the "quality improvement" element of government innovation policy resources is higher, "profitability," "sales growth," and "customer satisfaction" will also increase. "Customer satisfaction" is positively and significantly correlated with "profitability" and "sales growth;" this means that when the "customer satisfaction" element of government innovation policy resources is higher, "sales growth" and "profitability" will also increase. "Sales growth" is positively and significantly correlated with "profitability;" this means that when the "sales growth" element of government innovation policy resources increases, "profitability" also increases.

Table 4. Correlation analysis of profitability, sales growth, customer satisfaction, and quality improvement elements of firm operating performance

	Profitability	Sales Growth	Customer Satisfaction	Quality Improvement
Profitability	1			
Sales Growth	0.88***	1		
Customer Satisfaction	0.77***	0.82***	1	
Quality Improvement	0.78***	0.81***	0.87***	1

*p<.05 **p<.01 ***p<.001

After conducting an overall correlation analysis of the Taiwanese SMEs' utilization of government innovation policy resources, technological innovation capacity, and firm operating performance, our results reveal that "government innovation policy resources" is positively and significantly correlated with "technological innovation capacity" and "firm's operating performance." This means that when "government innovation policy resources" increases, "technological innovation capacity" and "firm's operating performance" also increase. "Technological innovation capacity" is positively and significantly correlated with "firm's operating performance;" this means that when the "technological innovation capacity" element of government innovation policy resources increases, "firm's operating performance" will also increase.

Table 5. Overall correlation analysis of government innovation policy resources, technological innovation capacity, and firm operating performance

	Government Innovation Policy Resources	Technological Innovation Capacity	Firm Operating Performance
Government Innovation Policy Resources	1		
Technological Innovation Capacity	0.66***	1	
Firm Operating Performance	0.57***	0.76***	1

*p<.05 **p<.01 ***p<.001

4.4 Variance analysis of government innovation policy resources, technological innovation capacity, and firm's operating performance for different types of firms

4.4.1. Variance analysis of government innovation policy resources for different firm types

1. Industry Type

For single factor variance analysis of government innovation policy resources for different industry types, this variation shows statistical significance for financial incentives, personnel training, tax incentives, and environmental infrastructure. Post hoc comparisons do not reveal significant variation, showing that different industry types do not vary with regard to government innovation policy resources.

2. Firm Scale

For single factor variance analysis of government innovation policy resources for different firm scales, the variation shows statistical significance for financial incentives, personnel training, tax incentives, and environmental infrastructure. A post hoc comparison does not reveal significant variation, showing that there is no variation between industry types with regard to government innovation policy resources.

3. Capital Volume

For single factor variance analysis of government innovation policy resources for different firm capital volumes, the variation shows statistical significance for financial incentives, personnel training, tax incentives, and environmental infrastructure. A post hoc comparison does not reveal significant variation, showing that there is no variation between industry types with regard to government innovation policy resources.

4. Company Age

For single factor variance analysis of government innovation policy resources for firms with different ages, the variation shows statistical significance for financial incentives, personnel training, tax incentives, and environmental infrastructure. A post hoc comparison does not reveal significant variation, showing that there is no variation between industry types with regard to government innovation policy resources.

4.4.2 Variance analysis of technological innovation capacity for different types of firms

1. Industry Type

For single factor variance analysis of technological innovation capacity for different industry types, the variation shows statistical significance for product innovation, product improvement, process innovation, and service innovation. Post hoc comparisons do not reveal significant variation, showing that different industry types do not vary with regard to government innovation policy resources.

2. Firm Scale

For single factor variance analysis of technological innovation capacity for different firm scales, the variation shows statistical significance for product innovation, product improvement, process innovation, and service innovation. Post hoc comparisons do not reveal significant variation, showing that different firm scales do not vary with regard to government innovation policy resources.

3. Capital Volume

For single factor variance analysis of technological innovation capacity for different corporate capital volumes, the variation shows statistical significance for product innovation, product improvement, process innovation, and service innovation. A post hoc comparison shows that product improvement was greater for firms with capital volumes "NT$5,000,000 or below" and "NT$80,010,000 or above" than for firms with capital volumes "NT$5,010,000–NT$10,000,000." This shows that companies with different capital volumes vary significantly with regard to technological innovation capacity. Firms with capital volumes of "NT$80,010,000 or above" showed more process innovation than those with capital volumes "NT$5,010,000–NT$10,000,000," showing that companies with different capital volumes vary significantly with regard to technological innovation capacity.

4. Company Age

For single factor variance analysis of technological innovation capacity for different company ages, the variation shows statistical significance for product innovation, product improvement, process innovation, and service innovation. Post hoc comparisons do not reveal significant variation, showing that different industry types do not vary with regard to government innovation policy resources.

4.4.3 Variance analysis of firm operating performance for different types of firms

1. Industry Type

For single factor variance analysis of firm operating performance for different industry types, the variation shows statistical significance for profitability, sales growth, customer satisfaction, and quality improvement. Post hoc comparisons do not reveal significant variation, showing that different industry types do not vary with regard to government innovation policy resources.

2. Firm Scale

For single factor variance analysis of firm operating performance for different firm scales, the variation shows statistical significance for profitability, sales growth, customer satisfaction, and quality improvement. A post hoc comparison does not reveal significant variation, showing that different industry types do not vary with regard to government innovation policy resources.

3. Capital Volume

For single factor variance analysis of firm operating performance for different corporate capital volumes, the variation shows statistical significance for profitability, sales growth, customer satisfaction, and quality improvement. A post hoc comparison shows that profitability was greater for firms with capital volumes "NT$80,010,000 or above" than for firms with capital volumes "NT$5,010,000–NT$10,000,000." This shows that companies with different capital volumes vary significantly with regard to firm operating performance. Firms with capital volumes of "NT$80,010,000 or above" showed more quality improvement than those with capital volumes "NT$5,010,000–NT$10,000,000," showing that companies with different capital volumes vary significantly with regard to firm operating performance.

4. Company Age

For single factor variance analysis of firm operating performance for different company ages, the variation reached statistical significance for profitability, sales growth, customer satisfaction, and quality improvement. Post hoc comparisons do not reveal significant variation, showing that different industry types do not vary with regard to government innovation policy resources.

4.5 Structural model and empirical analysis

This study mainly focuses on the structure of the causal relationship between government innovation policy resources for improving SME innovation capacity and the effect of technological innovation on firm's operating performance. AMOS20.0 software is used to conduct structural model analysis, to test the hypotheses of this study, and to expand the detailed discussion of estimated model parameters and goodness of fit; the final analytical results are used for discussion and analysis (hypothesis testing results can be seen in Table 5).

4.5.1 Model analysis of government innovation policy resources for improving SME innovation capacity and the effect of technological innovation capacity on firm's operating performance

This study's model representing government innovation policy resources for improving SME innovation capacity and the effect of technological innovation on firm's operating performance is analyzed using AMOS20.0 software; analytical results are shown in the figure below. The model can be divided into an exogenous latent variable and three endogenous latent variables. Here, the exogenous latent variable, "government innovation policy resources," is composed of four exogenous manifest variables. The endogenous latent variable, "technological innovation capacity," includes four exogenous manifest variables, and the endogenous latent variable, "firm's operating performance," includes four exogenous manifest variables.

The fit of this study's initial model is as follows: $\chi 2/df = 3.42$; GFI = 0.87; AGFI = 0.82; RMR = 0.06; RMSEA = 0.09; PGFI = 0.63; PCFI = 0.79; PNFI = 0.77; TLI (NNFI) = 0.94; IFI = 0.95; CFI = 0.95. This shows that the model used by this study to explore government innovation policy resources for improving SME innovation capacity and the effect of technological innovation on firm's operating performance is reliable.

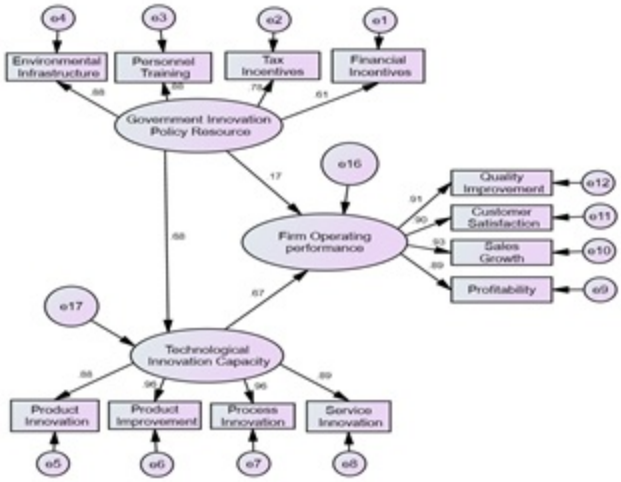

Figure 2. Pathway map of government innovation policy resources for improving SME innovation capacity and the effect of technological innovation on firm's operating performance

4.5.2 Overall model path analysis

This study's structural model is composed of three research hypotheses; the degree of fit index for each hypothesis reaches the desired value. The results of this study reveal that the path coefficient for the effect of "government innovation policy resources" on "technological innovation capacity" has a value of 0.59 (t = 9.99, p<0.001) and is positive and significant, thus supporting H4. The path coefficient for the effect of "government innovation policy resources" on "firm operating performance" is 0.16 (t = 2.03, p<0.05) and is positive and significant, thus supporting H5. The path coefficient for the effect of "technological innovation capacity" on "firm operating performance" is 0.68 (t = 9.12, p<0.001) and is positive and significant, thus supporting H6.

4.5.3 Parameter estimation for manifest variables and latent variables

With regard to estimations for parameters between manifest variables and latent variables, "government innovation policy resources" has the strongest correlation with "personnel training" (0.87) and the weakest with "financial incentives" (0.61). "Technological innovation capacity" has the strongest correlations with "product improvement" (0.96) and "process innovation" (0.96) and the weakest correlation with "product innovation" (0.90). "Firm operating performance" has the strongest correlation with "sales growth" (0.95) and the weakest with "customer satisfaction" (0.86).

Table 6. Hypothesis empirical testing results

Hypothesis Content	Significance
H1.The effects of government innovation policy resources on different kinds of firms vary significantly.	Insignificant
H2. Different kinds of firms have significantly different technological innovation capacities.	Partially Significant
H3. Different kinds of firms have significantly different operating performances.	Partially Significant
H4. Government innovation policy resources have a significant effect on technological innovation capacity.	Significant
Government innovation policy resources have a significant effect on firm's operating performance.	Significant
H5. Technological innovation capacity has a significant effect on firm's operating performance.	Significant

5. Conclusions and recommendations

5.1 Conclusions

This study has used the Delphi method to determine factors for improving the innovation capacity of the Taiwanese SMEs. These factors include three dimensions: within the dimension of "government innovation policy resources," there are four indices: "financial incentives, tax incentives, personnel training, and environmental infrastructure". Within the dimension of "technological innovation capacity," there are the four indices: "product innovation, product improvement, process innovation, and service innovation." The "firm operating performance" dimension has four indices of "profitability, sales growth, customer satisfaction, and quality improvement."

In analyzing the effect that the government's innovation policy resources has on a firm's innovation capacity, the question item "This company has been able to improve its innovative capacity because it received capital subsidies, financing, or funding investments from the government" ranked as the primary government innovation incentive. This is followed by the question item "Active government training of innovation personnel can help this company to innovate." With regard to the analysis of the effect of improved technological innovation capacities from government innovation policy resources on firms, the question item "Technological innovation capacity stimulates this company's development of new products" ranks as the most important item for technological innovation capacity, followed by "Technological innovation capacity can improve the quality of this company's existing products." With regard to the analysis of the effect of improved innovation capacity from government innovation policy resources on firm's operating performance, the question item "Innovation capacity can improve this company's profitability" is ranked as the most important item with regard to technological innovation capacity, followed by "Innovation capacity can improve this company's product quality."

The single factor variance analysis of technological innovation capacity showed that the amount of capital for different companies significantly affected the elements of product improvement and process innovation. Furthermore, the single factor variance analysis of firm operating performance showed that the amount of capital for different companies significantly affected the elements of profitability and quality improvement.

The results of this study show that "government innovation policy resources" is significantly and positively correlated with "technological innovation capacity" and "firm's operating performance" and that "technological innovation capacity" is significantly and positively correlated with "firm's operating performance." Further, "government innovation policy resources" has a positive effect on "technological innovation capacity" and "firm's operating performance," while "technological innovation capacity" has a positive effect on "firm's operating performance."

5.2 Recommendations

This study finds that government innovation policy resources are extremely important for firms' innovation capacities. As such, we recommend that relevant administrative units in the government implement more flexible deployment of innovation policy resources to allow SMEs to actually sense the government's positive encouragement of innovation.

1. The Government is the Maker of Innovation Policy

According to the World Economic Forum's (WEF) The Global Competitiveness Report 2016–2017, among 138 assessed countries, Taiwan ranks 14th. According to the International Institute for Management Development's (IMD) IMD World Competitiveness Yearbook, Taiwan ranks 14th out of 61 assessed countries.

Although Taiwan exhibits excellent innovative capacity, when we consider the current situation of the industrial sector, many of the key mainstream technology patents are held by advanced countries. As such, the government should commercialize innovation-related patents and shorten the commercialization process of R&D innovation for innovative outcomes to achieve mass production, to be marketed, and to create real economic benefits. This is necessary to achieve industrial competitiveness.

2. Innovative Economies Must Be Open

Innovation requires a tolerant and open environment to drive international competitiveness based on an innovative economy; however, recent developments from governments seem to run counter to the trends of innovation. The long lag in the establishment of laws and regulations allowing manufacturers to use online payments and the prohibition of Uber operations and strict fines imposed upon them are simple examples of Taiwan's failures with regard to innovation. These are not technological issues, but issues of being unable to reconcile the relationship between vested interest groups and innovation. If the government cannot produce a beneficial environment, innovators must leave. Only when governments exclude ideological interference and create an open and inclusive environment for innovation is it possible for the roots of innovation to take hold.

3. The Government is the Allocator of Innovative Resources

Taiwan's innovation policy resources are primarily composed of tax incentive tools, with non-tax incentive tools being utilized insufficiently. However, tax incentives can create tax revenue losses and are only beneficial when profits are generated from innovative R&D. Furthermore, tax incentives can lead to a distortion of fairness in the tax system. The non-tax incentives used by advanced countries, such as financial incentives and direct subsidies, do not affect the fairness of the tax system and are advantageous in the basic industrial research stage. Governments can use methods such as the provision of financial incentives, subsidies, industrial-academic cooperation, and technology transfers to reduce corporate costs.

4. Alter the Higher Education Evaluation System, Make Good Use of Academic R&D Personnel

The government only uses quantitative measures for academic evaluations, such as the Science Citation Index (SCI) and Social Science Citation Index (SCCI), to measure the number of paper publications as a means of rewarding academic departments and providing financial subsidies. This causes social, economic, and industrial research to become de-coupled from demand. The government should improve the current method, in which institutions blindly pursue SCI and SCCI evaluation criteria [29]. For example, the assessment of research influence for the UK's evaluation framework, the Research Excellence Framework (REF), includes elements such as the economy, society, public policy and service, health, environment, culture, and quality of life. Further, this framework emphasizes that research should produce groundbreaking or transformative effects and value [30]. Evaluation items should be diversified and include elements such as education, employment, globalization, the degree to which innovation supports industry, and the degree of contribution to social participation.

The innovative R&D capacity of firms is one of the most important factors determining whether a firm can sustain operational success. A good use of government innovation policy resources by firms can result in innovative technologies and abilities and an accumulation of firm's operational success. This study's recommendations for SMEs with regard to promoting innovation capacity are as follows:

1.Make Good Use of Government Innovation Policy Resources, Accumulate Innovation Capacity

Based on the restricted innovative R&D capacity of SMEs resulting from their relatively small scale and limited capital and R&D personnel, the

government has implemented many innovation policies, released a variety of innovation resources and guidance measures, and established channels for cooperation with local governments. Firms should take full advantage of government resources, such as the SBIR(Small Business Innovation Research) subsidy application, industry-academic cooperation with academic institutions or research units, and direct technology transfers with research units; firms should acquire innovative technologies and participate in innovation personnel training programs conducted by the government. Government innovation policy resources are easily attainable, have relatively low costs, and are, therefore, suitable for utilization by SMEs.

2. Innovative Entrepreneurship, Taking Advantage of Entrepreneurial Spirit

In the face of Taiwan's "low growth, low wages, low employment" state of economic stagnation, the key to Taiwan's economic growth is the combination of government, corporate, and academic resources to stimulate innovative entrepreneurship, transfer human capital from the manufacturing and Original Equipment Manufacturer (OEM) sectors, encourage innovation and entrepreneurial spirit, and stimulate Taiwan's new wave of economic energy. Successful entrepreneurs should be keenly aware of external demand and opportunities and should help those around them become better "driving forces" in their world, irrespective of generation or the "persistence" of any industry.

3. Invest in Internal R&D Innovation Strategies, Stop Being Contented with Small Scales

According to a 2016 survey report by the WEF, Taiwan's "Availability of Latest Technologies" has gradually declined year over year, with Taiwan's ranking for "innovative capacity" also falling to ninth place. This shows that Taiwan's technological R&D and technological acquisition have fallen behind the rest of the world, the primary reason for which is that Taiwanese firms are being primarily engaged in manufacturing and OEM and lacking independent brands and channels. This kind of quick-profit, shortsighted, lack of innovativeness and systematic innovative capacity has caused firms to experience problems related to weak technological innovation capacities. To break this cycle, firms should alter their innovative culture and thinking and increase their knowledge of and willingness to engage in innovation. By accumulating core OEM technologies and transforming them into quality products, own brand manufacturing, uniting brands and manufacturing processes, and providing in-depth tailored "production services" at boutique prices, the Taiwanese SMEs can acquire the most challenging and premiere customers.

Acknowledgment

Grant from the National Natural Science Foundation of China "Firm Management Quality: Attributes, Measurements, Optimization, and Evolution Research" (71171054)

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