Innovative Capability and its Dynamics: Evidence from the Life Insurance Industry in Taiwan

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Abstract. Drawing on RBV, dynamic capability and innovation theory, we suggest innovative capabilities may evolve within a hierarchy. Therefore, the effect of different orders of innovative capabilities on market performance should be discussed separately. Using a novel panel TAR (Threshold Auto-Regression Model) approach, we investigate different associations between innovative capabilities and market performance. This study includes 10 years (1999-2008) of longitudinal data on Taiwan's life insurance industry. Our results show that there is one threshold between innovative capabilities and market performance, the suggestion of innovative capabilities evolve within hierarchy is verified.

Introduction

In general, scholars of the resource-based view, capability theory and dynamic capability theory suggest that the innovative capability of a firm can be a source of sustainable competitive advantage. [1,2,3,4,5,6]. However, RBV and capability theory don't explain specifically the degree to which innovative capabilities adjust, and how innovative capabilities lead to varied performance [7]. Thus, dynamic capability theory has been developed to overcome the mentioned question [8].

In particular, scholars [7,9,10,11,12,13] have recently proposed that capabilities adapt in response to environmental dynamism and may evolve within a hierarchy. We applied this definition to innovative capability and suggest that according to the rate at which innovative capabilities change, there will be higher-order innovative capabilities existing. Moreover, the knowledge learning modes of innovative capabilities which are in different orders should also be various [14]. Therefore, the relationships between hierarchical innovative capabilities and performance may be discussed respectively [7,9,13]. Although there are a few empirical studies that have focused on the antecedents of higher order-capabilities [11,15], direct empirical research showing a relationship between dynamic innovative capabilities and performance is still scarce. This is the principal research goal and contribution of this study.

In testing the hypotheses, we choose life insurance firms in Taiwan as the subject for three reasons. Firstly because prior research related to innovative capability has focused mostly on manufacturing sectors, thus measurement of innovative capability chiefly follows R&D activity, such as quality and quantity of patents [16] or density of R&D expenses [17]. However, the nature of manufacturing and service sector activities is totally different [18]. By building an argument and testing it on life insurance firms, we seek to contribute new knowledge to the innovation area of the financial services industry. Second, new product introductions are technologically simple, strategic moves which are clearly meaningful and observable in this industry. Third, the life insurance market was opened up by Taiwan's government due to economic liberalization from 1979 onwards. While new entrants introduced new products and new technology and marketing concepts the incumbents also changed their structure and operations to maintain their market share. Finally the innovative activities of the life insurance industry have kept the industry prosperous in Taiwan in recent years. Therefore, the development and evolution of innovative capability in the life insurance industry are appropriate subjects of this study.

Methodologically, we develop empirical panel data and employ panel TAR (Threshold Auto-Regression) model to examine the dynamics of innovative capability. We utilize panel TAR model to (1) verify the non-linear relationship between innovative capabilities and performance, (2) investigate the possible numbers of inflection points, and where they occur. Compared with the approach in previous capability literature such as linear regression model, we use a novel approach (panel TAR model) to examine the relationship of innovative capabilities and performance with more precision [19]. It may help researchers looking for empirical validations.

The rest of this paper is organized as follows. Firstly, by synthesizing RBV and dynamic capability theory, we suggest that innovative capabilities evolve within hierarchy. Next, we use panel TAR model to verify the possible presence of inflection points (thresholds) between the relationship of innovative capabilities and market performance. Finally, we discuss the empirical results and provide recommendations.

Theory and hypotheses development

Innovative capability

Technological innovation is a critical element driving organizational adaptation [20]. Successful technological innovation needs integration of multiple asset portfolios and represents a subset of organizational learning activities [21]. Besides, capabilities represent a firm's ability to deploy its resources so as to achieve specific results [22]. Building on the discussion above, this study defines innovative capability as "an organization engages in innovating activities, and learns how to coordinate production technologies dispersed throughout different locations and how to integrate diverse technologies; all the process is the cumulative results of an organization's overall learning." Through theory building, we limit the extent of innovative capabilities which focus on how firms commercialize new and current technological knowledge into new products.

Resource-based view (RBV)

The RBV asserts that when the resources possessed by a firm are valuable, rare, inimitable, and non-substitutable, the firm can employ an optimal value creation strategy to obtain a sustainable competitive advantage that competitors cannot duplicate [1,6]. Because of this, a firm that is able to effectively utilize its unique resources and capabilities will be able to create and enhance a competitive advantage, and thereby achieve success [23].

Logics of dynamic capability

However, a firm's competitive environment changes as the external environment evolves. Consequently the internally-oriented RBV fails to explain how resources should be developed and deployed, and does not take into consideration the impact of a changing environment [8]. This has led to the emergence of the dynamic capability theory, which asserts that organizational capabilities should be linked to changes in the external environment [2,5]. Dynamic capability theory proposes that not only markets are dynamic, but capabilities are also inherently dynamic and flexible [8].

More recently, some scholars of dynamic capability theory have proposed that capabilities may evolve in hierarchy or orders. Before going further this study explores those related literatures as follows. [9] first suggested that there are might be distinct levels of capability. [9] points to the existence of higher-order capabilities which can go on 'ad infinitum'. There is always a higher-order capability to renew the current capability that renewed the original capability… and so on. The higher-order capability develops a capability that innovates faster or better. Thus [9] explicitly indicated that higher-order (dynamic) capabilities govern the rate of change of lower-order (ordinary) capabilities.

[10] developed [9]'s idea, and then verified the antecedents of second-order competencies in his empirical study [11]. [10] proposed two competency types: first-order competence and second-order competence. First-order competence is the ability to perform a particular task; and second-order competence is the ability to renew itself by building new first-order competence. Compared to first-order competence, second-order competence which sits at a higher level is much more important for a firm's continued prosperity in a changing environment.

[13] further adopted [9]'s proposition of capability hierarchy and particularly indicated that hierarchy begins with zero-order (ordinary) capabilities which were associated with "how firms earn a living in the present". While the next level in the hierarchy involves first-order capability change - the capacity allow firms to extend, modify or create ordinary capabilities. Such change includes product, production process, scale, or customers (market) served. This definition is more explicit and beneficial to identify sources of performance heterogeneity [7].

In late research, [7] and [24] both mentioned the idea of a capability hierarchy which emerged from [13]. [7] employed the definition of dynamic capabilities as first-order capabilities change, and emphasized this definition may enhance the possibility of empirical investigation. [24] suggested that there are three levels of dynamic capabilities which are related with managers' perceptions of environmental dynamism. However, most previous papers focus on discussing the notion of capability hierarchy, few of these studies progress in empirical analysis except [11].

Based on dynamic theory and the foregoing discussion, we adopt the concept of a capability hierarchy of rates of change. Not only is this definition more specific regarding how capabilities can be measured, but it also allows for empirical verification across firms [7]. Consequently, we apply the idea of capability hierarchy to explain the development and evolution of innovative capabilities, and the relationship between innovative capabilities and performance.

The dynamics of innovative capabilities

Drawing on dynamic capability theory, the critical difference between ordinary capability and dynamic capability is the "rate of change" [13,14,25]. Also, dynamic capability suggests that innovative capability may evolve within a hierarchy, and develop dynamically. A firm which has dynamic capabilities may expand, create or reconfigure innovative capabilities more rapidly and efficiently than its competitors; thus its capability will sit at a higher level [11]. While those firms which have higher-order innovative capability particularly change the game rules in a way that "takes the competitive scope to a higher level", the other firms may be forced to lag behind for lack of higher-order innovative capabilities. For those backward firms, their performance may be dampened by falling way behind the circle of winners in the long run [9,10]. Since there are hierarchies existing in innovative capabilities, the inputs of lower-order and higher-order innovative capabilities may all have different impact on performance heterogeneity [7]. Therefore, as suggested by dynamic capability theory, there may be other possibilities for the relationship between innovative capabilities and performance in addition to the traditional linear pattern. Accordingly:

H1: The relationship between innovative capabilities and market performance will be non-linear.

Research Design

Data

The empirical research was conducted within the life insurance industry in Taiwan. We investigated new product introduction patterns for every life insurance firm from 1999 to 2008 and the primary data source came from two official institutes. One was the Life Insurance Association of Taiwan which provides every firm's new policy name lists and financial and operational indicators. The other was the Taiwan Insurance Institute which contains new life insurance policy introduction dates and specifications of the whole life insurance industry. Also this study supplemented the primary archival data by searching the official Market Observation Post System in Taiwan, life insurance company web sites, annual reports, and reports in professional insurance magazines. To observe the adaptation of innovative capabilities in life insurance firms, we assembled empirical data which consisted of a panel of observations on firm-months. Overall, there were 21 life insurance firms in the sample, during periods of 120 months, with totally 2,520 observations.

Variables

Dependent variable We used sales growth to gauge market performance [26]. Sales growth takes into account the effectiveness of a firm's innovative activities and hence reflects a firm's market performance.

The sales growth is (new business premium income in month t minus new business premium income in month t-1) / new business premium income in month t-1. *Independent variable* A firm's innovative capability can be inferred from new product portfolios since successful new product introduction may be accomplished by either developing new innovative capability or enhancing and improving extant innovative capability [27]. Thus we chose new product introductions as the primary data source to measure innovative capability.

In line with the innovation defined by [28], we used (1) the number of new product introductions (product frequency) and (2) the innovativeness of these introductions (product innovativeness) to estimate innovative capabilities. The product frequency reflects the adapting speed; while the product innovativeness indicates the changing amount.

(1).Product frequency We adopted new personal life and annuity policies except for new health, accident and group insurance policies as the sample observation. We measured product frequency as the number of new insurance policies introduced by each sample firm each month.

(2).Product innovativeness Drawing on the literature of [10], we divided the new policies into three groups according to their innovativeness. The first is pure exploration policies. We define pure exploration policies as the first ones to be registered with the authority. Before the announcement of a new policy, there is none of the same kind in the market. When a firm develops a pure exploration policy successfully, it must own the entire new knowledge which is new to the industry [29]. Pure exploration policy is the most innovative product. We surveyed the archival data of our two primary data sources to confirm the pure exploration policy.

The second policy group is leverage policies. A leverage policy means that a firm registers a new policy for a kind of new product that has never been developed by the firm before. Since there are no patents for life insurance products, a firm can leverage the knowledge which emerges from pure exploration policies in the industry [29]. To identify a leverage policy, we first confirmed each pure exploration policy. Then each new policy which not only imitated any one kind of pure exploration policy but also was the first one of the same kind of new policy to be introduced by a firm was classified as a leverage policy.

The third type is pure exploitation policies. Pure exploitation policies are described as when a firm registers a new policy, and that kind of new product has been developed by the firm before. It means that a firm uses or improves the existing knowledge and capabilities to successfully introduce a pure exploitation policy [29]. Therefore, pure exploitation policies are the least innovative products. All new policies except pure exploration policies and leverage policies were all categorized as pure exploitation policies.

In addition, the degree of innovativeness is continuous, rather than dichotomous [10]. Different degrees of innovativeness which need varied organizational factors such as resources input, process, and framework design may lead to performance heterogeneity. Thus we suggest that new policies of different innovativeness deserve qualified weighting.

To construct weighting for product innovativeness, we categorized all new policies according to innovativeness and obtained 1,471 new policies including 1,248 pure exploitation policies, 211 leverage policies and only 12 pure exploration policies. Therefore, leverage policies have six times the development time of pure exploitation policies. It indicates that the successful development of a leverage policy may averagely precede a pure exploitation policy by six months for new business. The innovativeness of a pure exploration policy is the greatest, however the technology and knowledge of each exploration policy is diverse. Consequently, the propensity of a firm to imitate an exploration policy depends on the degree of difficulty of the entire new policy and the lead in periods of each exploration policy will be different. To assemble the weighting of 12 pure exploration policies, we first calculated the summation of the time difference in months between the approval date of each exploration policy and the following leverage policies respectively. Secondly we summed the time difference divided by the number of followers of each pure exploration policy. We got 12 weights between 6.15 and 35.41 average months. The weightings indicated that each pure exploration policy does precede followers various periods.

Together, since the innovativeness of the exploitation policy is the least, its weighting is 1. Leverage policies lead exploitation policies by an average of six months, so its weighting is 6. The weighting of pure exploration policies depends on the average preceding months of each policy. The measures are noted below: *Product innovativeness* = the number of pure exploitation policies×1+ the number of leverage policies×6 + the number of pure exploration policies × average lag months of followers. *Innovative capability* = product frequency + product innovativeness.

Control Variable According to the prior studies, we controlled three variables which may influence our model. First, we controlled for firm size and used the market share as a measure. Market share is the proportion of total premium income of a firm to total premium income of the industry. We also controlled the business quality and measured by the proportion of benefit payments to total premium income. The benefit payments of an insurance firm represent the loyalty, quality of its customers and products. If the benefit payments of a firm are too high, there may be some problems existing in the quality control policy or practice. Furthermore, according to the learning curve, the marketing skills of marketing distribution can be improved by practicing and training. The refinement of marketing skills may influence the speed and innovativeness of the development of new products. Thus marketing skills were controlled and measured as the monthly growth rate of the average face amount per new policy. And the face amount per new policy is the total face amount of new policies divided by the numbers of new policies. Moreover, we expect that the effects of size and marketing skills are positive, while the impact of business quality is negative.

Statistical Model

We employed a panel TAR [30], where individual observations can be objectively separated into classes based on the some observed variable. Therefore, we can investigate where the possible inflection points occur, and estimate slope parameters for the different regimes.

The analysis of the panel TAR involves a test for the presence of a threshold against the null hypothesis of no threshold. If we cannot reject null hypothesis, threshold effect does not exist. However, the threshold value is not identified under the null hypothesis which would generate the nuisance problem [31,32]. The existence of nuisance problem means the test statistics follow a nonstandard distribution, and that would overly reject the null hypothesis. To overcome the above question, [30] provides a bootstrap procedure for calculating the first order asymptotic distribution of test statistics and verifying the significance of threshold effect. Because the Ordinary Least Square (OLS) method is not easy to estimate in a non-linear model, [30] suggested a two-stage OLS method to test panel TAR. In the first stage, for any given threshold (γ), the sum of squared errors (SSE) is calculated respectively. In the second stage, utilizing the figures computed in the first stage, the estimation of (γˆ) is attained by minimizing the sum of the squares. After the value of threshold is determined, it can be used to estimate the slope parameters of each regime. Accordingly, we used the hypothesis test procedure proposed by [30] in our analysis.

We construct our threshold model of innovative capability as follows:

$$y_{it} = \mu_i + \theta' Z_{it} + \beta_1 x_{it} \mathrm{I}(D_{it} \le \gamma) + \beta_2 x_{it} \mathrm{I}(D_{it} > \gamma) + \varepsilon_{it} \tag{1}$$

$$Z_{it} : \begin{bmatrix} Z_{1it} & Z_{2it} & Z_{3it} \end{bmatrix}$$

where y_{it}, the market performance is dependent variable; x_{it}, innovative capability , is the independent variable; D_{it} represents threshold variable; and γ : is the specific estimated threshold value. (Z_{it}), control variables are Z_{1it}: size; Z_{2it}: business quality; Z_{3it}:marketing skills respectively. $\mathrm{I}(\bullet)$ is the indicator function.

Empirical analysis

The time period of our data is 1999 to 2008. The resulting data sample is a "balanced panel" containing 21 firms, 2,520 observations during 120 months. Table 1 provides descriptive statistics of and correlation between variables.

If time series regression is non-stationary, there might be spurious regression [33], and the results of OLS are essentially meaningless. Testing for unit roots is one procedure to find whether the dataset is stationary or not. Therefore, before the analysis of TAR, all variables in the model should be tested with the unit root hypothesis. If the null hypothesis of a unit root is rejected, it means the dataset is stationary.

Thus we can proceed with the estimate of TAR. We used four panel-based unit tests that are t-statistic of Breitung [34], IPS [35], and χ^2-statistic of Augmented Dickey-Fuller (ADF) [36] and Phillips-Perron (PP) test [37,38]. The results of unit root test are reported in Table 2. The results showed that all five variables are stationary, thus they all can be put in the analysis of TAR model.

Table1. Descriptive statistics and correlations of the variables

Variables	Mean	SD	1	2	3	4	5
1.Market performance	0.032	0.19	1				
2.Innovative capability	1.65	1.72	.023	1			
3.Size	0.05	0.069	.027	.26**	1		
4.Business quality	0.02	0.199	-.186**	-.033	-.051*	1	
5.Marketing skills	0.007	15.99	.583**	-.044*	.007	-.141**	1

** p< 0.01(2-tailed) *p<0.05 (2-tailed)

Table2: The results of panel unit root test

Variables/ Unit root test	Market performance	Innovative capability	Size	Business quality	Marketing Skills
LLC (2002)	-14.4188*** (0.000)	8.58522 (1.0000)	0.09444 (0.5376)	-9.84025*** (0.000)	-12.3219*** (0.000)
Breitung (2000) t-stat	-8.45112*** (0.000)	-6.08606*** (0.000)	-3.35733*** (0.0004)	-3.40436*** (0.0003)	-12.6795*** (0.000)
IPS (2003) W-stat	-17.0128*** (0.000)	-3.95869*** (0.000)	-2.49684*** (0.0063)	-12.9680*** (0.000)	-19.9666*** (0.000)
ADF- Fisher Chi-square	362.692*** (0.000)	80.7459*** (0.0003)	145.807*** (0.000)	281.964*** (0.000)	443.782*** (0.000)
PP - Fisher Chi-square	635.791*** (0.000)	155.413*** (0.000)	669.323*** (0.000)	736.054*** (0.000)	678.787*** (0.000)

Note1. *p*-values are given in parentheses 2.***p<0.01,**p<0.05,*p<0.1 3.The null hypothesis of panel unit root test is a unit process, while the alternative hypothesis is not.

We followed the bootstrap procedure to obtain test statistics which are shown in Table 3. The result of single threshold indicated that F test statistic is 22.11 along with the significance of 10%, 5%, and 1%, critical values were 11.6, 13.53 and 21.26. We find a threshold value of 1.167 which is significant at the 0.01 level. Thus, there is a single- threshold in this model. The non-linear relationship between innovative capability and market performance is supported, consistent with Hypothesis 1.

In empirical studies, typically the number of thresholds is not known a priori with certainty. After the determining of first threshold, we can follow the procedure of estimating single-threshold to search the second threshold. If there are double thresholds, the model is modified as:

$$y_{it} = u_i + \theta_i' \quad Z_{it} + \beta_1 x_{it} I(D_{it} < \gamma_1) + \beta_2 x_{it} I(\gamma_1 \le D_{it} < \gamma_2) \\ + \beta_3 x_{it} I(D_{it} \ge \gamma_2) + \varepsilon_{it} \tag{2}$$

Where $\gamma_1 < \gamma_2$

Table 3: Determining the number of threshold

	Estimated threshold value	F Test statistic	Bootstrap 1% , 5% critical values
Singe-threshold model	1.167	22.11	21.26 ,13.53
Two-threshold model	1.167 2.833	6.19	NA

Note: 200 times replications were used for each bootstrap test

We then test for the presence of a second threshold through estimation of equation 2. The estimated F test statistic of 6.19 is less than the χ^2 critical value at the five percent level. Therefore, there is no presence of second threshold in this model.

Conclusions and Implications

Drawing on the RBV, dynamic capability and organization theory, we assume that innovative capabilities adapt in response to environmental dynamism and may evolve within a hierarchy. We observed the development of new products of life insurance firms in Taiwan from 1999 to 2008 and then verified our argument with a novel panel TAR approach.

Our analysis verified that the relationship between innovative capability and market performance is non-linear. Our results have many important implications for theory and managers, particular in service industry. Although innovation in service has become a prominent issue, due to its nature and the lack of patents of service products, it is very difficult to explore the subjects relative to their innovation. By articulating essential features and properties of innovative capability in the life insurance industry, we believe that our study can contribute to future studies on the innovation of financial and knowledge-based service industries.

There are two important contributions to academic fields. First, we define that innovative capabilities evolve within a hierarchy proposed by dynamic capability. Our finding supports that adopting this definition is more specific and can allow for empirical testing across firms. Secondly, the framework and methods are used here with a novel approach (panel TAR) to investigate theoretical questions about innovative capability with more precision. It may provide avenues for future researchers to seek empirical validations.

We acknowledge several limitations of this study, and provide directions for future research. First, there are some factors that we do not consider in our model. For example, marketing distribution, brand, strategic partners and promotion strategies may have impacts on market performance [26]. The influences of these factors will be the subjects of future study. Second, according to the study of [28], we measure innovative capability including frequency and innovativeness. But the evidence shows that larger and older firms tend to introduce new products more frequently; while smaller and new firms pursue great innovativeness. Innovative strategies do differ between these firms. For future research, it is suggested to explore the development of frequency and innovativeness respectively. Also additional research to investigate the relationship between innovative capability and the characteristics of firms is needed. Finally, our findings confirm that innovative capability is a critical source of competitive advantage, it is suggested to explore the factors regarding how best to build and manage innovative capabilities for future research.

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