**Reconciling Conflicts between Knowledge Creation and Knowledge Utilization at Entrepreneurial Universities: The Pasteurian Orientation Perspective**

**Abstract**

This paper develops the concept of Pasteurian orientation (PO), which reflects university departments' reform on organizational strategies and structures to achieve both knowledge creation and knowledge utilization simultaneously in the new era of entrepreneurial universities. Furthermore, we elaborate on a model that consists of four major hypotheses and developing PO as a mediator between organizational antecedents and collective efficacy. The paper collects a dataset of 634 department administrators and non-administrative faculty members from 99 departments among six Taiwanese universities via a postal questionnaire survey. The regression results indicate that organizational munificence and organizational flexibility as the contextual antecedents are positively associated with PO development in departments. Knowledge creation is a significant contributor to develop knowledge utilization. PO development is positively associated with departmental collective efficacy. Also, balancing knowledge creation and knowledge utilization with PO development has a positive mediating effect on the relationship between contextual antecedents and collective efficacy. This paper concludes that developing PO of university departments acts as a crucial factor in facilitating departments toward the transformation of entrepreneurial universities. Policy and managerial and implications are also suggested.

**Keywords**: Entrepreneurial universities, Pasteurian orientation, knowledge creation, knowledge utilization, Collective efficacy

**1. Introduction**

The increase of entrepreneurial universities in the past few decades has stimulated investigation in fields of the new economics of science (Merton, 1968; Partha & David, 1994; Stokes, 1997), the university-industry linkage (D’Este & Patel, 2007; Stankiewicz, 1986), the triple helix model (Etzkowitz & Leydesdorff, 2000), and academic entrepreneurship (Etzkowitz, 2003; Shane, 2004). Along with reforms in science and technology policy, universities have gradually developed multiple infrastructures with closer and more productive relationships with industry in order to provide a fundamental economic and social contribution to society (Etzkowitz, 1998).

When universities are encouraged to nurture entrepreneurial habits, they still face severe problems of balancing between old and new missions, knowledge creation and knowledge utilization, and traditional and new sources of support (Clark, 2004; Van Looy et al., 2011). Although the tensions impede traditional universities transforming into more entrepreneurial, many universities have attempted to create favorable contexts for reconciling these dual activities by providing new organizational changes such as university’s leadership, climate, formal incentives, technology transfer office’s support, and promoting faculty’s engagement (Klofsten et al., 2019; Perkmann et al., 2013).

Stokes (1997) proposed the use-inspired basic research or Pasteur’s quadrant research to encourage academia to develop a balancing work on knowledge creation for exploring our understanding and knowledge utilization for exploiting practical use. However, the Pasteur’s quadrant provides little insights into how organizational structures, strategies, and processes to develop both knowledge creation and knowledge utilization in universities simultaneously. On the organizational development, prior research argued that an organization could establish an ambidextrous structure to coordinate the dual activities, such as exploration and exploitation (He & Wong, 2004; Lavie, Stettner, & Tushman, 2010), research publication and research commercialization (Chang, Yang, Martin, Chi, & Tsai-Lin, 2016) , or alignment and adaptability (Gibson & Birkinshaw, 2004; Raisch & Birkinshaw, 2008; Tushman & O'Reilly, 1996). For the universities, they could develop a *Pasteurian orientation (PO)* for balance between knowledge creation and knowledge utilization to respond to the rise of entrepreneurial universities, which is inspired by the concept of Pasteur’s quadrant and organizational ambidexterity. Moreover, the universities with the new organizational practice for entrepreneurial universities could facilitate collective actions by building the efficacy belief to convince faculty members of the universities engaging in (Aschhoff & Grimpe, 2014; Jain, George, & Maltarich, 2009).

As the focal unit of a university, university department plays an influential role in not only a performing unit in knowledge creation and knowledge utilization but also an illustrated organizational cognition to reshape the behaviors in the group or the individual(Gustafsson & Autio, 2011). Therefore, this study aims to explore the relations among the university’s context, the PO development, and collective efficacy at university department level. This paper is organized as follows. After the introduction, the theoretical framework between organizational antecedents, PO construct, and collective efficacy is proposed. Thirdly, the data, variables, and data analysis are illustrated. The descriptive statistics, correlations, and regression models are shown. Finally, the empirical research results compared to previous studies are discussed. Conclusions and implications are presented.

**2. Theoretical Model**

**2.1 The rise and conflicts in creating entrepreneurial universities**

On the initiative of developing the entrepreneurial university, *the new economics of science approach* argues that university research could not only contribute to knowledge creation but also supports the development of the knowledge application with economic benefits (Nelson, 2004; Partha & David, 1994; Stokes, 1997). Moreover, *the triple-helix approach* emphasizes that developing an entrepreneurial university could promote effective interactions between academia, industry, and government which forms a better regional and national innovation systems to support industrial innovation (Etzkowitz, 2003; Shane, 2004). In other words, the rise of entrepreneurial universities means that the universities should transit to new organizational trajectories for embracing the third mission, and coordinate the teaching, research, and commercialize works that could meet the expectation for promoting social and economic impacts (Chang et al., 2016; Clark, 1998; Etzkowitz, 2017).

However, in the developing entrepreneurial universities, it may induce some tensions with the traditional goals and norms of science (Ambos, Mäkelä, Birkinshaw, & D'Este, 2008; Haas & Park, 2010; Jain et al., 2009; Philpott, Dooley, O'Reilly, & Lupton, 2011). The critical problem is the inherent conflicts between traditional academic (e.g., talent training, publishing academic results, and pursuing academic reputation) and industrial or entrepreneurial paradigms (e.g., consulting, contract research, patenting and licensing the research results, spin-off formation, and pursuing economic and societal returns). From the organizational development perspective, those two have different organizational settings as the two ends of a spectrum of scientist’s work (Philpott et al., 2011; Sauermann & Stephan, 2013). Academic logics tend to focus on basic and curiosity-oriented research (Ambos et al., 2008). Industrial logics relatively undertake less risk and direct commercial research. Second, they have different norms of knowledge dissemination (Kalar & Antoncic, 2015). Academic logics tend to encourage open disclosure and the contribution to scientific commons. On the other hand, industrial logics seeks beneficial ownership and privatization of intellectual property. These organizational conflicts may impede universities from transforming towards more entrepreneurial orientation, and many efforts can be found to encourage universities to engage in research commercialization (Bercovitz & Feldman, 2008; Haas & Park, 2010; Jain et al., 2009).

**2.2 Pasteurian orientation: Combining Pasteur’s quadrant and organizational ambidexterity**

In creating entrepreneurial universities, coordinating the conflicts in an organizational setting between academic and industrial logics are critical work. Stokes (1997) proposed the framework of Pasteur’s quadrant to transform the spectrum of the strategic direction of scientific research into a quadrant model. Stokes (1997) folded the two ends of the line model into two axes of the quadrant model. One is knowledge creation, which means enhancing the understanding of the knowledge frontier of human beings. Another one is knowledge utilization, which means resolving specific technical or social problems and realizing the market potential of innovation (Figure 1).

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Expressly, the upper-left cell referred to as *Bohr’s quadrant* focuses on basic research with little consideration of the practical application. The lower-right cell, called *Edison’s quadrant*, concentrates on research directed towards technology development, which seeks more efficient knowledge utilization. Moreover, for the lower-left quadrant, Stokes (1997) cited Peterson’s quadrant to indicate research that contains neither the creation nor the use of knowledge. Finally, Stokes (1997) proposed the concept of *Pasteur’s quadrant*, which focuses on the use-inspired basic research to encourage that academic scientists search them both to explore the understanding of scientific knowledge and to exploit the technologies for meeting practical needs.

From the underpin of organizational ambidexterity (Tushman and O’Reilly, 1996; Raisch and Birkinshaw, 2008), universities developing toward the Pasteur’s quadrant are expected to create ambidextrous structures and contexts to pursue research excellence and research commercialization simultaneously. By re-conceptualization of Pasteur’s quadrant and organizational ambidexterity, this paper argues Pasteurian Orientation (PO) includes two sub-orientations: the knowledge creation orientation (KCO) and the knowledge utilization orientation (KUO) which deploys the two dimensions represent two major distinctive activities in entrepreneurial universities. Moreover, the PO is equivalent to the knowledge creation orientation multiplied by the knowledge creation orientation and the knowledge utilization orientation, as shown in Equation 1(Gibson & Birkinshaw, 2004). Correctly, the PO could be regarded as *the organizational propensity to develop organizational strategies, processes, and structures to achieve, simultaneously, knowledge creation and knowledge utilization*.

PO= KCO\*KUO…………………………Equation 1

Furthermore, each sub-orientation consists of *organizational support* and *faculty engagement*. *Organizational support* is associated with organizational resources, incentives, and supervisor and colleague’s consensus (Bercovitz & Feldman, 2008; Datta, Mukherjee, & Jessup, 2015) to support knowledge creation and knowledge utilization. *Faculty engagement* shows the faculty members’ intention and capabilities regarding time, awareness, experience, and research portfolio engaged in their knowledge creation and knowledge utilization (Chang, Yang, & Chen, 2009; Jain et al., 2009). We can draw a figure to illustrate the composition of the PO (Figure 2).

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**2.3 Contextual antecedents**

For creating entrepreneurial universities, university departments are the meso-level unit between institutional contexts of the universities and faculty members to perform the integration and engagement in changing university paradigm (Ambos et al., 2008; Chang et al., 2016; Gibb, Haskins, & Robertson, 2013; Jain et al., 2009). Jain et al. (2009) argue that universities with appropriate environmental contexts would encourage the internal actors to respond to the transformation of the university paradigm (Perkmann et al., 2013). In organizational studies, the organizations in higher environmental munificence are more accessible to adopt new strategies and structure even stabilize the new practices in a turbulent environment (Boyne & Meier, 2009; Keats & Hitt, 1988). The level of munificence refers as the availability of resource and support in the environmental contexts which it could help the organizations adopt new practices to sustain organizational growth and changes (Dess & Beard, 1984; Goll & Rasheed, 2005; Haveman, 1993). For creating entrepreneurial universities, Clark (2004) suggests that the managerial group could provide a sustainable commitment to the new university paradigm to encourage the internal actors to build an integrated context to respond to the changes. O’Reilly and Tushman (2008) point out that senior managers could adapt, integrate, and reconfigure organizational skills and resources for orchestrating both new and existing routines to matching changing environments. Glenna, Welsh, Ervin, Lacy, and Biscotti (2011) recommends that university administrators should provide sufficient commitment on various incentive structures, funding sources, policies, and practices to invest in diverse scientific research values. Gibb et al. (2013) consider that university administrators could remove barriers and provide abundant resources and support associated with the entrepreneurial paradigm as well as carry its existing culture, mission, and strategy. Above all, the university administration should continuously create organizational munificence to encourage the internal actors to realign with the missions of universities (Andrews & Johansen, 2012; Smith, Mitchell, & Summer, 1984; Tilcsik, 2014; Wu, 2008). Therefore, this paper argues that the senior team (i.e., university administrators) have to provide sufficient organizational munificence on pursuing research excellence and commercialization, and it would influence that the departments enhance and integrate KCO and KUO simultaneously. Thus:

*Hypothesis 1：The degree of organizational munificence is positively associated with the development of Pasteurian orientation at university departments.*

*Hypothesis 1a：The degree of organizational munificence is positively associated with the sustainment of knowledge creation orientation at university departments.*

*Hypothesis 1b：The degree of organizational munificence is positively associated with the development of knowledge utilization orientation at university departments.*

Furthermore, Clark (1998) suggests that “universities need to become *quicker*, more adaptive and especially more focused in reactions to expanding and changing demands.” Moreover, Clark (2004) argues that “universities need to develop flexible and adaptive capabilities that permit them to weave together new and old, change and continuity, in a sustainable form.” Various policies, such as the enhancement of university-industry collaboration and the establishment of academic spin-offs, have been widely instituted in universities (Perkmann et al., 2013; Shane, 2004). Also, universities are adjusting their infrastructures to establish new units such as technology transfer offices, technology liaison offices, and university-affiliated incubators to support research commercialization (Etzkowitz, 2003; Landry, Amara, & Rherrad, 2006). Organizational flexibilitycan be seen as the outcome of an interaction between the responsiveness of the organizational design and the managerial task (Volberda, 1996). Smith and Tushman (2005) argue that organizational flexibility as an integrating capability involves shifting levels of analysis to identify potential linkage. Therefore, this study argues that these political and infrastructure reforms provide the university department with more organizational flexibility to promote KUO and KCO simultaneously. Thus:

*Hypothesis 2：The degree of organizational flexibility is positively associated with the development of Pasteurian orientation at university departments.*

*Hypothesis 2a：The degree of organizational flexibility is positively associated with the sustainment of knowledge creation orientation at university departments.*

*Hypothesis 2b：The degree of organizational flexibility is positively associated with the development of knowledge utilization orientation at university departments.*

**2.4 Pasteurian orientation and departmental collective efficacy**

Since Stokes (1997) proposed Pasteur’s quadrant and the concept of use-inspired basic research, it suggests a new direction in which the integration of knowledge creation and knowledge utilization could create the societal and scientific values in a research agenda. Stokes (1997) exampled Louis Pasteur had promoted fundamental knowledge of microbiology and commercialized the knowledge into practice using for fermentation technology. It means that knowledge creation and knowledge utilization are not conflict but complement, and knowledge creation are the predominant of knowledge utilization (Etzkowitz, 1983; Shibayama, 2012). In developing Pasteurian orientation, the universities do not intend to compete or replace the role of industry sectors in technological development but facilitate the innovation with the advanced knowledge which delivers from scientific research (Etzkowitz, 1983, 2017). Moreover, Glenna et al. (2011) also consider that the scientific foundations and advancement of industrial technologies are likely to decline when the universities have not sufficient investment in pursuing research excellence. Therefore, this paper argues that university departments have to sustain the commitment to knowledge creation, then they may have an active development of knowledge utilization. Thus:

*Hypothesis 3：The knowledge creation orientation of university departments has a positive influence on their development of knowledge utilization orientation.*

However, developing entrepreneurial university does not only creates a new organizational arrangement, or ambidextrous/hybrid organizations (Ambos et al., 2008; Etzkowitz, 2017; Guerrero & Urbano, 2012) but also promotes the self-efficacy on the new paradigm (Bouncken, 2018). As the focal unit in universities, self-efficacy on the new paradigm of university departments have strong peer influence on faculty members’ decisions and behavior (Aschhoff & Grimpe, 2014; Jain et al., 2009) as departmental collective efficacy(Stajkovic, Lee, & Nyberg, 2009; Watson, Chemers, & Preiser, 2001). The collective efficacy represents the self-efficacy at the group level, which is defined as a group’s shared belief in its conjoint capabilities to organize and execute the actions required to produce given levels of attainments (Bandura, 1997, 2000). A high degree of collective efficacy represents an organization has functional organizational readiness, which could internalize new organizational practices into the routines to pursue the goals of the organization when the organization is transforming (Bandura, 2000; Barrick, Thurgood, Smith, & Courtright, 2015; Holt & Vardaman, 2013). University departments develop PO organizational propensity, which combined knowledge creation orientation (KCO) and knowledge utilization orientation (KUO), represents they try to develop the new organizational practices by reshipment to the paradigm of the entrepreneurial universities(Leih & Teece, 2016). Moreover, departmental collective efficacy demonstrates that the members collectively judge the effectiveness of organizational transformation to pursue research excellence and research commercialization in the department. By the development of PO, strong organizational support, and faculty engagement on both knowledge creation and commercialization could conjointly enhance departmental collective efficacy with a favor departmental practices in the implementation of entrepreneurial universities. Thus:

*Hypothesis 4： University departments with a higher propensity of PO are associated with higher level of departmental collective efficacy.*

*Hypothesis 4a：University departments have a knowledge creation orientation is associated with higher level of departmental collective efficacy.*

*Hypothesis 4b：University departments have a higher knowledge utilization orientation is associated with higher level of departmental collective efficacy.*

**2.5 Mediating Effect of Pasteurian orientation**

Prior studies have argued that contextual antecedents can resolve the internal tensions, as well as the simultaneous capabilities for knowledge creation and knowledge utilization (Ambos et al., 2008). This study argues that organizational munificence builds the environmental capacity to sustain existed and new university missions, and organizational flexibility creates multiple choices for university missions, which thereby encourages cross-functional coordination and integration between knowledge creation and knowledge utilization. Therefore, these antecedents could enhance the efficacy in the organization, which has sufficient capabilities to develop the paradigm of entrepreneurial universities(Etzkowitz, 2003). However, Gibb et al. (2013) argue that universities are pluralistic organizations with different departments having very different organizational routines, orientations, and values. So, in the absence of departmental initiative, formal institutional contexts and flexibility may not sufficient to inspire the capacity and motivation for departments to take up challenges in organizational adjustment for the transition of entrepreneurial universities. Rasmussen, Mosey, and Wright (2014) also think that university departments also need to evolve their competencies to develop new organizational structures, routines, supports, and encourage and motive the members to engage in new practices. The concept of PO is meant to maintain multiple competencies that address the ambidextrous organization (Etzkowitz, 2003; Gibson & Birkinshaw, 2004; Tushman & O'Reilly, 1996). Therefore, university departments have to develop the PO as the organizational capabilities for creating their organizational practices, and the departments could employ the capabilities to promote departmental collective efficacy in the new university paradigm. Thus:

*Hypothesis 5a： Pasteurian orientation mediates the relationship between organizational munificence and departmental collective efficacy.*

*Hypothesis 5b： Pasteurian orientation mediates the relationship between organizational flexibility and Departmental collective efficacy.*

This study depicts the research framework and the corresponding hypotheses in Figure 3.

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**3. Methods**

**3.1 The Taiwanese institutional context**

Inspired by the U.S. *Bayh-Dole Act* of 1980, Taiwan enacted the *Science and Technology Basic Law* in 1999. Specifically, Article 6 allows universities to claim the ownership of IPRs derived from government-funded research and to remove the restrictions allowing a more decentralized licensing policy. Similarly, Taiwanese universities have increased the number of patent grants and licensing income, and universities are encouraged to develop research partnerships with industry (Chang et al., 2008).

The list of top ten universities in domestic patent grants are shown in Table 1. The primary participants in generating patent grants are public universities, and there is also a different pattern of the patent grant between public and private universities. Public universities have focused on ‘utility’ patents, whereas private universities, including Far East University, and Southern Taiwan University of Science and Technology, have focused on more non-utility patents that reflect their natures and features of the inventions. The statistics show a substantial increase in paper publication, patenting, licensing, and venture incubation between 2006 and 2010 (see Table 2).

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**3.2 Questionnaire development**

There are three parts to the questionnaire. The first part concerns contextual antecedents, organizational munificence, and organizational flexibility, followed by the PO part and departmental collective efficacy part. The six items of organizational munificence focus on the investigation of the munificent environment for resource, long-term support and strategic objectives in entrepreneurial universities (Bercovitz & Feldman, 2008; Clark, 2004; Landry et al., 2006) which are perceived by the university departments and the three items of organizational flexibility are referred from Volberda (1996). The 14 items of PO have adapted from Chang et al. (2009). The three items of departmental collective efficacy are referred to as Riggs, Warka, Babasa, Betancourt, and Hooker (1994). All of the survey items for contextual antecedents, PO, and Departmental collective efficacy used a 7-point Likert-scale.

**3.3 Sampling and Respondents**

Sampling criteria of this study focused on university departments of science, engineering, and medical research since they have a higher potential to commercialize their research results. In contrast to formal activities (i.e., patents, licensing, or spin-offs), the faculty members from social science and the humanities were excluded from the survey because informal activities (i.e., consultancy, training programs) are particularly preferred in these disciplines (Abreu and Grinevich, 2013).

Considering the differentiated attributes of organizational contexts and comply with the PO, six universities were chosen to represent different forms of universities. One medical and three generals in four public ones (Universities A, B, C & D), one private and general university (University E), and one private and technical university (University F). Finally, the original survey list of 29 schools and 172 departments within these universities was collected from their websites.

The data were collected from administrators and faculty members who serve for the same department to assess department-level characteristics. In line with multilevel theory, our model consists of “shared unit-level constructs” that we presumed to be shared within a department (Klein & Koslowski, 2000: 41). Moreover, to avoid the common method variance (CMV) problem, this paper adopted the following questionnaire design. First, the contextual antecedents are answered by the administrator(s) and reflect the departmental context. Second, the construct of Pasteurian orientation (PO) is answered by all faculty members for each department and then aggregated to represent department-level PO. Specifically, we computed the multiplicative interaction between KUO and KCO to reflect the theoretical concept of the PO.

Moreover, the dimensions KUO and KCO are computed through the multiplicative interaction between the o*rganizational support* and *faculty engagement*. The compositions of KUO and KCO are based on the prior studies that two mechanisms are non-substitutable and interdependent. Finally, the dimension of departmental collective efficacy is answered by all of the respondents for each department.

The paper built a complete survey list by referring to both university websites and the Ministry of Science and Technology academic researcher database. Overall, the total number of the sample in six universities was 2,868 faculty members. This study also compared respondents with non-respondents, in terms of position (χ2= .97, p= .629), age (χ2= 1.00, p= .484), and tenure (χ2= .82, p= .945) of respondents, indicating non-response bias is minimal. After a three-round survey collection, we obtained 711 returned questionnaires, an overall 26% response rate. To meet the analysis criteria, we required that at least one administrator and four faculty members compose a valid sample of the department. Finally, there were 634 valid questionnaires, representing 27 schools and 99 departments. Table 3 provides a brief breakdown of the respondents.

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Specifically, the respondents include 157 department administrators and 477 non-administrative faculty members. Some departments have more than one administrator answered the questionnaires, such as administrative head, chairs of departments or institutes, and directors of administrative offices. Overall, there are 70 departments with only one administrator who answered the survey. The average number of administrators replies per department is 2.20. The answers of all administrators in the same department were averaged to represent the status of the department. Moreover, there are 368 male respondents (83% of the respondents). There were 342 full professors (54%), 139 associate professors (22%), and 133 assistant professors (21%). The working years for the respondents are 13.6 years on average. Moreover, there are 393respondents (62%) who had already received tenures as faculty members.

**3.4 Measurements**

**3.4.1 Departmental collective efficacy**

To measure departmental collective efficacy, we collected the subjective measures over the three years (2007-2009). The survey asked the respondents to ‘assess your department/institute’s capabilities and practices on pursuing research excellence/research commercialization over the past three years compared to other equivalent departments.’ Three original items loaded on a single factor having an eigenvalue of 1.048 (α = .75) (see Appendix 1).

**3.4.2 Pasteurian orientation**

PO is a two-dimension construct comprised of KUO and KCO. It is worth noting that all faculty members in each department perceive the PO construct. We measured knowledge creation orientation by asking faculty members to indicate the degree to which they agree with the statements. Specifically, there are four items loaded on a single factor having an eigenvalue of 1.568 (α = .77). We refer to this factor as o*rganizational support for knowledge creation*. Also, there are three items loaded on a single factor having an eigenvalue of 1.192 (α =.77). We referred to this factor as *faculty engagement in knowledge creation*. Moreover, we computed the multiplicative interaction between the above knowledge creation dimensions as the k*nowledge creation orientation* (KCO) at departments.

Similarly, we measured knowledge utilization orientation by asking faculty members to indicate the degree to which they agree with the statements. There are four items loaded on a single factor having an eigenvalue of 7.084 (α = .97). We referred to this factor as o*rganizational* s*upport for knowledge utilization*. Also, three items load on a single factor having an eigenvalue of 1.048 (α =.75). We referred to this factor as *faculty engagement in knowledge utilization*. We computed multiplicative interaction between the above knowledge utilization dimensions as *knowledge utilization orientation* (KUO) at departments. Finally, we computed the perceived *PO* as the multiplicative interaction between KCO and KUO (see Appendix 1).

* + 1. **Contextual antecedents**

The dimension of contextual antecedents has nine items that were perceived by the department administrator(s). In organizational munificence, to make question items more specific, three items addressed to research excellence while the other three items addressed to research commercialization. Three items of the organizational munificence to research excellence are loaded onto a single factor having an eigenvalue of 2.02 (α = .91) (Appendix 1). Three items of organizational munificence to research commercialization are loaded onto a single factor having an eigenvalue of 4.73 (α = .97) (Appendix 1). Then, we aggregated the two factors as organizational munificence represented the level of munificence for old and new missions in entrepreneurial universities. Moreover, three items of organizational flexibility load on a single factor had an eigenvalue of 3.035 (α =.93). Thus, we retained this factor as *organizational flexibility* (see Appendix 1).

**3.4.4 Control variables**

This study employed four control variables to reflect the characteristics of the departments. First, the ownership is measured by the departments are from the public universities. Second, the size is measured by the number of faculty members in a department. Then, we used the macro-variables to represent the research attribute of the departments. We created three “college” variables as the dummy variables to represent the colleges whether the departments belonged to Engineering, Science, Life Science, and Medical Colleges, respectively (Ambos et al., 2008; D’Este & Perkmann, 2011).

**4. Results**

Table 4 reported the descriptive statistics for the variables. Among these 99 departments, the average size of the departments is 21 faculty members. There are 53 departments (54%) from engineering colleges, followed by 13 departments (13%) from science colleges, 26 departments (26%) from life science and medical colleges. The PO is significantly and positively correlated with the departmental collective efficacy (β = .560, p < .001) as well as the two contextual antecedents, organizational munificence (β = .260, p < .01) and organizational flexibility (β = .172, p < .10).

With the control variables, the public university is negatively correlated to organizational munificence (β = -.200, p < .05), KUO (β = -.459, p < .001) and departmental collective efficacy (β = -.241, p < .05). Moreover, most are not significantly correlated to the department size, except the departments in life and medicine colleges are negatively correlated. However, the departments in engineering colleges have shown positive and statistically significant relationships with PO (β = .436, *p* < .01) and departmental collective efficacy (β = .399, *p* < .01). The departments from science colleges are negatively correlated with life and medicine colleges (*p* < .05).

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This study tested the hypotheses using the ordinary least square (OLS) regression. H1 predicted that the relationship between the organizational munificence and PO, and it was also divided into H1a and H1b for observing the influence of organizational munificence on the development of KCO and KUO in university departments. As shown in Table 5, Model 2 and 5 indicated organizational munificence has significantly positive impact on KCO (β = .251, *p* < .05) and KUO (β = .175, *p* < .05) as well as PO in Model 7 (β = .216, *p* < .05). H1 is fully supported. Moreover, regarding H2, which also states the organizational flexibility has a positive influence on the PO. Model 3, Model 6 and Model 8 confirmed the organizational flexibility has positive contribution on KCO (β = .237, *p* < .05), KUO (β = .152, *p* < .10), and PO (β = .184, *p* < .10). However, H2 is partially supported due to the impact on the development of KUO and PO.

H3 stated that KCO is positively associated with departmental KUO. As shown in Table 6, Model 9 confirmed the relationship with strong effect (β = .605, *p* < .001). Furthermore, H4 predicted that the development of the PO would contribute to departmental collective efficacy. For observing the sub-effects of KCO and KCO, we also divide the hypothesis into H4, H4a, and H4b. As shown in Model 10, Model 11, and Model 12, It confirmed that university departments develop KCO (β = .381, *p* < .001), KUO (β = .459, *p* < .001), and PO (β = .459, *p* < .001) could positively enhance their collective efficacy. In other words, H4 is fully supported. In the final, H5 attempted to verify the mediating effect of PO on the between contextual antecedents and departmental collective efficacy. Following the Baron and Kenny (1986), we examined separately for the two antecedents as H5a and H5b. Through the results of Model 13 and Model 14, it shown PO partially mediated the relationship between organizational munificence (β = .177, *p* < .05) and departmental collective efficacy (β = .414, *p* < .001). And, in Model 15 and Model 16, it also shown PO fully mediated the between the organizational flexibility (β = .081) and departmental collective efficacy (β = .442, *p* < .001) . H5a and H5b are supported, but it is worthy to note that the balance of organizational munificence on pursuing research excellence and research commercialization still has a partial influence on departmental collective efficacy (Aldwin, 1994; Baron & Kenny, 1986).

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**5. Discussion**

By positioning the academic transition on organizational development for the rise of entrepreneurial universities, this paper aimed to understand an ambidextrous development in university departments (Etzkowitz, 2017). The study proposed an organizational propensity, ‘Pasteurian orientation,’ and examined its development and relationships between university antecedents and departmental collective efficacy. First, the findings suggest that the university munificence and flexibility are critical determinants for facilitating the development of Pasteurian orientation within departments. This study argues that organizational munificence provides necessary legitimacy and support for the subordinated departments to redefine their organizational practices towards Pasteurian orientation (Powers & McDougall, 2005; Vanaelst et al., 2006). Through a significant effect on knowledge creation and knowledge utilization, this evidence confirms organizational munificence has a secure connection with the engagement of university departments, even has a direct effect on departmental collective efficacy (Owen-smith, 2005; Perkmann et al., 2013). Furthermore, the result is aligned with other organizational contexts that can facilitate or transit to ambidextrous structures or Pasteurian orientation in universities (Gibson & Birkinshaw, 2004), including shared vision, common culture (O’Reilly & Tushman, 2008)and social integration (Jansen, Tempelaar, van den Bosch, & Volberda, 2009) between the existing (e.g. teaching and research) and the new missions (commercialization and entrepreneurship). Moreover, there is significant evidence in line with Clark's (2004)’s survey of the leading entrepreneurial universities, which suggested that a more flexible and adaptable organization can respond to environmental changes and encourage the development of ‘entrepreneurial’ universities. Jansen et al. (2009) also suggested that cross-functional interfaces create a formal integration mechanism that can respond to environmental changes. Furthermore, the result is consistent with the arguments of past research that universities and managers are more flexible and less bureaucratic, and create a munificent environment for facilitating their organizational ambidexterity or Pasteurian orientation (Andrews & Johansen, 2012; Friedman & Silberman, 2003; Siegel, Waldman, & Link, 2003; Tilcsik, 2014; Tushman & O'Reilly, 1996).

Second, this paper finds that knowledge creation orientation is predominant in developing knowledge utilization orientation, and the two orientations can be reconciled via the development of the PO. This empirical finding is consistent with the argument that research excellence and research commercialization are more complementary, rather than contradictory, within entrepreneurial universities (Guerrero, Urbano, Fayolle, Klofsten, & Mian, 2016; Sengupta & Ray, 2017). University departments are suggested to sustain excellent research works firstly, and they should create a hybrid context that allows the balance of KUO and KCO. Specifically, university departments employ the PO to create organizational norms, routines, and recognition for leading faculty members engaging in the new university paradigm. (Ambos et al., 2008; Bercovitz & Feldman, 2008; Chang et al., 2016). Our results confirm that the PO has a robust association with departmental collective efficacy.

Third, the PO acts as a mediator between contextual antecedents and departmental collective efficacy. Etzkowitz (2003) considers that the universities provide equivalent institutional spheres on pursuing research excellence and research commercialization could function effectively to coordinate the emergence of conflict of interests in developing the new paradigm of entrepreneurial universities. Moreover, the development of overlapping institutional spheres that encourages the development of hybrid entities which they can reconcile seemingly contradictory ideas and practices (Schildt & Perkmann, 2017; Tuunainen, 2005). In our findings, university departments with a high degree of PO mean that they could harbor the “opposing” norms and orientations, and they have the capabilities to reinterprets the legitimation of harmony and mutual reinforcement from each goal. In other words, the universities provide sufficient organizational munificence and shape a flexible environment that could facilitate the departments to engage in multiple missions. They need to develop the PO to coordinate knowledge creation and knowledge utilization in the new paradigm of entrepreneurial universities for better departmental collective efficacy.

**6. Conclusion**

In the previous studies, it has indicated university departments are essential and focal units which shape, lead, and demonstrate to the behaviors of faculty members which is reflected on organizational identity, norms, learning, and peer reference (Aschhoff & Grimpe, 2014; Jain et al., 2009; Perkmann et al., 2013). Unlike previous studies focusing on the analysis of institutional (i.e., the passage of *Bayh-Dole Act*) or individual (i.e., faculty members) aspects, this paper used organizational meso-level, university departments as the unit of analysis and suggested their interplay of organizational layers in stimulating the development of entrepreneurial universities.

This paper finds that organizational munificence and organizational flexibility are critical organizational antecedents. The level of organizational munificence would influence the university departments to engage in the new paradigm, and equivalent support to differentiated activities of the university’s missions could keep a balancing act. Moreover, a high degree of organizational flexibility could help university departments quickly adopt new practices with no adverse influence on existing ones, and it provide agility to align with the new paradigm of entrepreneurial universities.

Moreover, the findings also indicated that the PO is a valuable strategic perspective for departmental collective efficacy. The PO acts as a mediator between contextual antecedents and departmental collective efficacy, suggesting that the university contextual factors act only as a *necessary condition* to promote departments engaging in the new paradigm of universities. However, the development of the PO is a *sufficient condition*. The paper concludes the concept of PO as highly promising for reconciling the conflicts and balance between knowledge creation and knowledge utilization in entrepreneurial universities. Encouraging organizational contexts with a high level of organizational munificence and flexibility that generates dual capabilities for knowledge creation and knowledge utilization may be a critical source of competitive advantage for creating entrepreneurial universities.

This paper advanced our understanding of organizational strategies and structures to develop PO at university departments. First, this paper integrates the Pasteur’s quadrant framework and ambidexterity theory into a strategic and organizational ability of PO. It also extends the application of Pasteur’s quadrant framework at the organization level. Second, via the developed construct and measurement of PO, university departments could compose, diagnose, and measure their PO. Third, this paper confirms the organizational meso-mediation relation between contextual factors, PO, and departmental collective efficacy.

Some policy and managerial implications are suggested as follows. The nature of universities is characterized to be bureaucratic organizations that stress the institutionalization (Clark, 1998), and the resource endowments would determine the paths to organizational development (Siegel & Wright, 2015). However, the universities also have high autonomy and self-organizing system (Martin, 2012). For building the paradigm of entrepreneurial universities, university administrators should create a munificent environment and provide a high degree of flexibility to encourage departments to reshape organizational practices. Moreover, to maintain strategic and structural balances between old and new missions, and knowledge creation and knowledge utilization tasks are never easy. It is necessary to develop the right degree of integration and coordination among the administrative team, colleges, and departments in order to maintain the right balance and a coherent action plan. For developing the PO at departments, departmental heads may use the proposed construct and measurement to diagnose or build up their departments’ norms, routines, support, and engagement towards PO.

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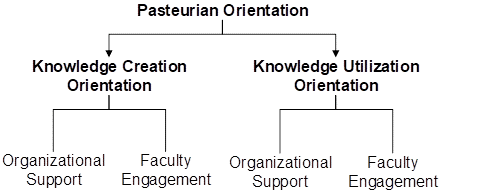
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**Figure 1 Quadrant Model of Scientific Research**

Source: Adapted from Stokes (1997)

  
**Figure 2 Decomposition of Pasteurian orientation**



**Figure 3 Pasteurian Orientation: Antecedents, Mediation and Collective Efficacy**

**Table 1 Top Ten Universities in Patent Grants (2004~2009)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rank** | **University** | **Utility Patent** | **Design Patent** | **Total Patent** |
| 1 | Far East University | 117 | 848 | 965 |
| 2 | National Cheng Kung University | 283 | 31 | 314 |
| 3 | National Chiao Tung University | 272 | 3 | 275 |
| 4 | Southern Taiwan University of Science and Technology | 49 | 194 | 243 |
| 5 | National Taiwan University | 221 | 19 | 240 |
| 6 | National Sun Yat-Sen University | 213 | 5 | 218 |
| 7 | National Chung Hsing University | 183 | 6 | 189 |
| 8 | National Formosa University | 177 | 11 | 188 |
| 9 | National Tsing Hua University | 178 | 4 | 182 |
| 10 | National Central University | 163 | 4 | 167 |

Source: Lo (2010)

**Table 2 Universities’ Publication and Research Commercialization Performance (2006-2010)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item**  **Year** | **Papers published**  **(SCI journals)** | **Patent grants** | **Licensing income** | **Venture incubation** |
| 2006 | 17,963 | 933 | NT$215.0 mil. | 446 |
| 2007 | 18,746 | 975 | NT$277.7 mil. | 633 |
| 2008 | 22,636 | 752 | NT$456.2 mil. | 712 |
| 2009 | 24,315 | 946 | NT$474.0 mil. | 840 |
| 2010 | 23,715 | 1,192 | NT$676.3 mil. | 1,066 |

Source: Lo (2010) and Chen (2011)

**Table 3 Characteristics of the Universities and Respondents**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **University** | **Ownership** | **Type** | **No. of**  **schools** | **No. of departments** | **Total respondents** | **Non-administrative faculty** | **Administrator** |
| A | Public | General | 8 | 42 | 256 | 214 | 42 |
| B | Public | General | 5 | 19 | 114 | 84 | 30 |
| C | Public | General | 5 | 9 | 66 | 46 | 20 |
| D | Public | Medical | 4 | 9 | 63 | 41 | 22 |
| E | Private | General | 3 | 12 | 81 | 62 | 19 |
| F | Private | Technical | 2 | 8 | 54 | 30 | 24 |
| Total |  |  | 72 | 99 | 634 | 477 | 157 |

**Table 4 Means, Standard Deviations, and Correlationsa**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variables** | **Mean** | **S.D.** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| 1. Public university | .80 | .40 |  |  |  |  |  |  |  |  |  |  |
| 2. Departmental size | 21.61 | 12.28 | .116 |  |  |  |  |  |  |  |  |  |
| 3. Engineer college | .54 | .50 | -.317\*\* | .217\* |  |  |  |  |  |  |  |  |
| 4. Science college | .13 | .34 | -.028 | 0.196 | -.417\*\*\* |  |  |  |  |  |  |  |
| 5. Life Sci. and Med. college | .26 | .44 | .300\*\* | -.403\*\*\* | -.641\*\*\* | -.232\* |  |  |  |  |  |  |
| 6. Organizational munificence | 30.67 | 5.10 | -.200\* | -0.053 | 0.084 | 0.015 | 0.083 |  |  |  |  |  |
| 7. Organizational flexibility | 13.45 | 3.91 | -.149 | -0.193 | -0.062 | -0.079 | .284\*\* | .737\*\*\* |  |  |  |  |
| 8. Knowledge creation | 35.81 | 3.37 | -.184 | -0.009 | .204\* | -0.066 | -0.088 | .288\*\* | .241\* |  |  |  |
| 9. Knowledge utilization | 28.10 | 4.37 | -.459\*\*\* | 0.018 | .530\*\*\* | -.246\* | -.306\*\* | .260\*\* | 0.172+ | .714\*\*\* |  |  |
| 10. Pasteurian orientation b | 1016.54 | 234.46 | -.387\*\*\* | 0.006 | .436\*\*\* | -0.195 | -.239\* | .288\*\* | .202\* | .875\*\*\* | .960\*\*\* |  |
| 11. Departmental collective efficacy | 14.57 | 1.87 | -.241\* | -0.054 | .399\*\*\* | -0.123 | -0.112 | .383\*\*\* | .237\* | .484\*\*\* | .540\*\*\* | .560\*\*\* |

aN = 99 departments.

bPasteurian orientation is the multiplicative interaction of knowledge creation orientation and knowledge utilization orientation.

\* *p*< .05; \*\* *p*< .01, \*\*\* *p*< .001; two-tailed test

**Table 5 The relationship between organizational antecedents and the development of Pasteurian orientation** a

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Independent Variables** | **Model 1** | | **Model 2** | | **Model 3** | | **Model 4** | | **Model 5** | | **Model 6** | | **Model 7** | | **Model 8** | |
| **Knowledge creation** | | **Knowledge creation** | | **Knowledge creation** | | **Knowledge utilization** | | **Knowledge utilization** | | **Knowledge utilization** | | **Pasteurian orientation** | | **Pasteurian orientation** | |
| Public university | -.130 | (.251) | -.081 | (.251) | -.081 | (.474) | -.340\*\*\* | (.000) | -.306\*\* | (.001) | -.308\*\* | (.001) | -.247\* | (.014) | -.250\* | (.014) |
| Departmental size | -.014 | (.903) | -.017 | (.903) | -.004 | (.974) | -.001 | (.990) | -.003 | (.971) | .006 | (.953) | -.008 | (.938) | -.008 | (.975) |
| Engineer college | .329 | (.112) | .191 | (.112) | .242 | (.241) | .439\*\* | (.010) | .383\* | (.048) | .383\* | (.025) | .297 | (.113) | .348+ | (.061) |
| Science college | .113 | (.486) | .019 | (.486) | .061 | (.705) | -.058 | (.661) | -.091 | (.357) | -.091 | (.490) | -.083 | (.565) | -.043 | (.764) |
| Life Sci. and Med. college | .182 | (.340) | .035 | (.340) | .037 | (.853) | .063 | (.685) | -.030 | (.806) | -.030 | (.853) | -.015 | (.931) | -.002 | (.992) |
| Organizational munificence |  |  | .251\* | (.019) |  |  |  |  | .175\* | (.046) |  |  | .216\* | (.046) |  |  |
| Organizational flexibility |  |  |  |  | .237\* | (.030) |  |  |  |  | .152+ | (.090) |  |  | .184+ | (.059) |
| Δ*R2* |  | | .054\* | | .047\* | |  | | .026\* | | .019+ | | .040\* | | .028+ | |
| *R2* | .068 | | .122 | | .114 | | .383 | | .410 | | .402 | | .306 | | .294 | |
| Adjusted *R2* | .017 | | .065 | | .056 | | .350 | | .371 | | .363 | | .261 | | .248 | |
| ANOVA F | 1.347 | | 2.131+ | | 1.975+ | | 11.556\*\*\* | | 10.635\*\*\* | | 10.317\*\*\* | | 6.775\*\*\* | | 6.400\*\*\* | |

a For all models, N = 99. Standardized coefficients are shown.

+ *p* ≤ .1;\* *p* ≤ .05; \*\* *p* ≤ .01; \*\*\* *p* ≤ .001

**Table 6 The relationship between the development of Pasteurian orientation and Departmental collective efficacy** a

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Independent Variables** | **Model 9** | | **Model 10** | | **Model 11** | | **Model 12** | | **Model 13** | | **Model 14** | | **Model 15** | | **Model 16** | |
| **Knowledge utilization** | | **Departmental collective efficacy** | | **Departmental collective efficacy** | | **Departmental collective efficacy** | | **Departmental collective efficacy** | | **Departmental collective efficacy** | | **Departmental collective efficacy** | | **Departmental collective efficacy** | |
| Public university | -.261\*\*\* | (.000) | -.046 | (.610) | -.061 | (.530) | .037 | (.688) | -.044 | (.648) | -.058 | (.523) | -.062 | (.536) | -.049 | (.599) |
| Departmental size | .007 | (.907) | -.090 | (.327) | -.095 | (.304) | -.093 | (.303) | -.099 | (.311) | -.096 | (.282) | -.088 | (.379) | -.090 | (.322) |
| Engineer college | .239\* | (.038) | .792\*\*\* | (.000) | .727\*\*\* | (.000) | .727\*\*\* | (.000) | .771\*\*\* | (.000) | .648\*\*\* | (.000) | .858\*\*\* | (.000) | .704\*\*\* | (.000) |
| Science college | -.126 | (.157) | .363\*\* | (.006) | .433\*\* | (.001) | .407\*\* | (.001) | .307\* | (.031) | .341\*\* | (.009) | .371\* | (.010) | .390\*\* | (.003) |
| Life Sci. and Med. college | -.047 | (.651) | .490\*\* | (.002) | .531\*\* | (.001) | .409\*\* | (.001) | .404\* | (.019) | .410\*\* | (.009) | .460\* | (.010) | .461\*\* | (.004) |
| Organizational munificence |  |  |  |  |  |  |  |  | .266\*\* | (.004) | .177\* | (.041) |  |  |  |  |
| Organizational flexibility |  |  |  |  |  |  |  |  |  |  |  |  | .163+ | (.093) | .081 | (.357) |
| Knowledge creation | .605\*\*\* | (.000) | .381\*\*\* | (.000) |  |  |  |  |  |  |  |  |  |  |  |  |
| Knowledge utilization |  |  |  |  | .459\*\*\* | (.000) |  |  |  |  |  |  |  |  |  |  |
| Pasteurian orientation |  |  |  |  |  |  | .459\*\*\* | (.000) |  |  | .414\*\*\* | (.000) |  |  | .442\*\*\* | (.000) |
| Δ*R2* | .341\*\*\* | | .135\*\*\* | | .130\*\*\* | | .154\*\*\* | | .061\*\* | | .119\*\*\* | | .022+ | | .138\*\*\* | |
| *R2* | .725 | | .417 | | .411 | | .436 | | .342 | | .461 | | .303 | | .441 | |
| Adjusted *R2* | .707 | | .379 | | .373 | | .399 | | .299 | | .420 | | .258 | | .398 | |
| ANOVA F | 40.358\*\*\* | | 10.959\*\*\* | | 10.711\*\*\* | | 11.836\*\*\* | | 7.982\*\*\* | | 11.123\*\*\* | | 6.674\*\*\* | | 10.252\*\*\* | |

a For all models, N = 99. Standardized coefficients are shown.

+ *p* ≤ .1;\* *p* ≤ .05; \*\* *p* ≤ .01; \*\*\* *p* ≤ .001

|  |  |  |
| --- | --- | --- |
| **Variables and items** | **Factor loading** | |
| *Organizational munificence for research excellence (eigenvalues=2.022, α=.911)* | | |
| 1. My university provides sufficient resource for pursuing research excellence. | | .889 |
| 1. My university commits long-term support for pursuing research excellence. | | .885 |
| 1. I perceived that university administrators considered pursuing research excellence is one of primary objectives in my university. | | .821 |
| *Organizational munificence for research commercialization(eigenvalues=4.731, α=.971)* | | |
| 1. My university provides sufficient resource for pursuing research commercialization. | | .926 |
| 1. My university commits long-term support in pursuing commercialization. | | .843 |
| 1. I perceived that university administrators considered pursuing research commercialization is one of primary objectives in my university. | | .857 |
| *Organization flexibility (eigenvalues=3.035, α=.933)* | | |
| 1. My university authorized my department could frequently set up cross-functional committees to reconfigure inappropriate regulations. | | .829 |
| 1. My university authorized my department could frequently set up cross-functional committees to respond to ongoing external opportunities. | | .824 |
| 1. My university authorized my department could rapidly adjust the priority of goals. | | .821 |
| *Organizational support for Knowledge creation ( eigenvalues=1.568, α=.773)* | | |
| 1. My department has provided sufficient facilities for research. | | .681 |
| 1. My department is highly regarded for receiving domestic and world research excellence awards. | | .645 |
| 1. The director of my department has a high commitment to pursuing research excellence. | | .790 |
| 1. My colleagues have a high degree of consensus for pursuing research excellence. | | .739 |
| *Faculty engagement in knowledge creation (eigenvalues=1.192, α=.774)* | | |
| 1. I have devoted lots of time to research excellence activities. | | .725 |
| 1. I take charge of managing the research agenda and facilities in my lab. | | .817 |
| 1. I frequently participate in international conferences, seminars, and workshops related to my research agenda. | | .740 |
| *Organizational support for knowledge utilization (eigenvalues=7.084, α=.965)* | | |
| 1. My department has sufficient incentives and supports and for faculty to apply and protect intellectual property rights | | .903 |
| 1. My department has provided sufficient incentives and supports for faculty to engage in technology transfers | | .946 |
| 1. My department has provided sufficient incentives and supports for faculty to engage in university-industry collaborative research | | .955 |
| 1. My department has provided sufficient incentives and supports for faculty to engage in creating spin-offs | | .897 |
| *Faculty engagement in knowledge utilization (eigenvalues=1.209, α=.880)* | | |
| 1. I have devoted lots of time to research commercialization activities. | | .862 |
| 1. I frequently participate in technical conferences, industry forums, commercial exhibitions related to my research agenda. | | .851 |
| 1. The industrial firms have shown great interest in commercializing my research and keep the contact. | | .842 |
| *Departmental collective efficacy (eigenvalues=1.048, α=.750)* | | |
| 1. Compared to equivalent departments in other universities, my department has excellent capabilities and organizational practices on the implementation of pursuing research excellence. | | .741 |
| 1. Compared to equivalent departments in other universities, my department has excellent capabilities and organizational practices on the implementation of pursuing research commercialization. | | .655 |
| 1. My colleagues are confident that our department has sufficient abilities to achieve the missions of the university. | | .728 |

**Appendix 1** **Items and Factor Analysis**