**Reconciling Conflict between Knowledge Creation and Knowledge Utilization in the Entrepreneurial University: A Pasteurian Orientation Perspective**

**Abstract**

This paper develops the concept of the Pasteurian orientation (PO) as an approach to understanding reforms by university departments of their organizational strategies and structures to foster both knowledge creation and knowledge utilization in the new era of the entrepreneurial university. We put forward a model and four major hypotheses that posit PO as a mediator between a department’s organizational antecedents and collective departmental efficacy. The paper reports a dataset of responses from 634 department administrators and non-administrative faculty members from 99 departments at six Taiwanese universities collected via a postal questionnaire survey. Regression results indicate that organizational munificence and organizational flexibility, as contextual antecedents, are positively associated with a department’s PO development, at the same time as knowledge creation is a significant contributor to development of knowledge utilization. PO development is also positively associated with departmental collective efficacy, and balancing knowledge creation and knowledge utilization by means of PO development has a positive mediating effect on the relationship between contextual antecedents and this collective efficacy. The paper concludes that developing the PO of university departments acts as a crucial factor in facilitating their role in the transformation from traditional university into entrepreneurial university. Policy and managerial implications are also suggested.

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

**1. Introduction**

The rise of entrepreneurial universities in the past few decades has stimulated investigation by researchers studying the new economics of science (Merton, 1968; Partha & David, 1994; Stokes, 1997), university-industry linkages (D’Este & Patel, 2007; Stankiewicz, 1986), the triple helix model (Etzkowitz & Leydesdorff, 2000), and academic entrepreneurship (Etzkowitz, 2003; Shane, 2004). They have elaborated how, 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 more fundamental economic and social contribution to society (Etzkowitz, 1998).

When universities are encouraged to develop entrepreneurial habits, they still face severe problems balancing old and new missions, choosing between knowledge creation and knowledge utilization, and finding traditional and new sources of support (Clark, 2004; Van Looy et al., 2011). Although the tensions impede the transformation of traditional universities into more entrepreneurial ones, many universities have attempted to create favorable contexts for these dual tracks by providing new organizational changes, including in university leadership, climate, formal incentives, technology transfer office support, and faculty engagement promotion (Klofsten et al., 2019; Perkmann et al., 2013).

Stokes (1997) advocated use-inspired basic research, calling it Pasteur’s quadrant research, and encouraged academia to develop a balance between work on knowledge creation, for the purpose of exploring understanding of natural phenomena, and work on knowledge utilization, to the end of exploiting scientific knowledge for its practical use. However, Pasteur’s quadrant provides little insight into how organizational structures, strategies, and processes can be created so both knowledge creation and knowledge utilization can be pursued in universities simultaneously. Tackling organizational development, other researchers have argued that ambidextrous structures could be established by an organization to coordinate a mix of activities that foster both 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). In any case, universities need to develop a *Pasteurian orientation (PO)* to establish a balance between knowledge creation and knowledge utilization and respond to the call for an entrepreneurial professoriate, inspired by the concept of Pasteur’s quadrant and organizational ambidexterity. This will allow universities following the new organizational practices of the entrepreneurial university to facilitate collective action by faculty members, as it builds their efficacy beliefs and convinces them of the value of engaging in academic-industry cooperation (Aschhoff & Grimpe, 2014; Jain, George, & Maltarich, 2009).

As a focal unit in the work of a university, a university department plays an influential role not only with its achievements in knowledge creation and knowledge utilization but also in its identity as an illustrated organizational cognitive complex reshaping the behaviors of the group and the individual (Gustafsson & Autio, 2011). Therefore, the aim of this study is to explore the relations among a university’s context, PO development, and collective efficacy at the university department level, linking those achievements with its identity. The paper is organized as follows. After an introduction, a theoretical framework connecting organizational antecedents, PO construct, and collective efficacy is proposed. Thirdly, data, variables, and data analysis are presented. Descriptive statistics, correlations, and regression models are included. Finally, our empirical research results are discussed and compared to those of previous studies. Conclusions and implications are presented.

**2. Theoretical Model**

**2.1 The rise of and conflicts in the entrepreneurial university**

Contributing to the initiative to develop entrepreneurial universities, proponents of *the new economics of science approach* argued that university researchers could not only be involved in knowledge creation but could also support the development of knowledge applications with an economic benefit (Nelson, 2004; Partha & David, 1994; Stokes, 1997). For their part, advocates of *the triple-helix approach* emphasized that developing an entrepreneurial university could promote effective interaction between academia, industry, and government and result in better regional and national innovation systems supporting industrial innovation (Etzkowitz, 2003; Shane, 2004). In other words, the call for entrepreneurial universities implied that the professoriate should transit to new organizational trajectories and embrace a third mission, coordinated alongside the traditional ones of teaching and research, of commercializing work that would have a social and economic impact meeting the expectations of society (Chang et al., 2016; Clark, 1998; Etzkowitz, 2017).

However, development of the entrepreneurial university leads in directions that are in tension 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 conflict between traditional academic paradigms (e.g., talent training, publishing academic results, and pursuing academic reputation) and industrial or entrepreneurial ones (e.g., consulting, contract research, patenting and licensing research results, spin-off formation, and pursuing economic and societal returns). From the organizational development perspective, the two paradigms have different organizational settings at the two ends of a spectrum of scientific work (Philpott et al., 2011; Sauermann & Stephan, 2013). Academic logic implies a focus on basic and curiosity-oriented research (Ambos et al., 2008). Industrial logic, relatively speaking, leads to undertakings involving less risk and more direct commercial research. Second, the two follow different norms of knowledge dissemination (Kalar & Antoncic, 2015). Academic logic tends to encourage open disclosure and contribution to the scientific commons. On the other hand, industrial logic seeks beneficial ownership and privatization of intellectual property. These organizational conflicts may impede universities’ moves towards a more entrepreneurial orientation, and much effort may be needed 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 conflict in an organizational setting between the academic and industrial logics is critical work. Stokes (1997) proposed a framework that helps here, transforming the straight-line spectrum along which the strategic direction of scientific research ranges into a two-dimensional quadrant model. Stokes (1997) folded the two ends of the line model into the two orthogonal axes of a quadrant model. One axis is knowledge creation, which means enhancing our understanding of the world and pushing back the frontiers of knowledge. The other one is knowledge utilization, which means resolving specific technical or social problems and realizing the market potential of innovation (Figure 1)..

-------------------------

Insert Figure 1 Here

-------------------------

Research in the upper-left cell, referred to as *Bohr’s quadrant*, is basic research pursued with little consideration of its practical application. The lower-right cell, called *Edison’s quadrant*, characterizes research directed towards technological development which seeks more efficient knowledge utilization. The lower-left quadrant Stokes (1997) called Peterson’s quadrant and indicates research that neither creates new knowledge nor extends the use of existing knowledge. Finally, in *Pasteur’s quadrant* is use-inspired basic research, which Stokes (1997) proposed academic scientists should be encouraged to pursue, both exploring scientific understanding and exploiting it as technology to meet practical needs.

Universities moving in the direction of Pasteur’s quadrant need to create ambidextrous structures and contexts that can underpin the pursuit of research excellence and research commercialization simultaneously (Tushman and O’Reilly, 1996; Raisch and Birkinshaw, 2008). In a re-conceptualization of Pasteur’s quadrant and organizational ambidexterity that extends analysis of these ambidextrous structures and contexts, this paper argues Pasteurian Orientation (PO) includes two sub-orientations: a knowledge creation orientation (KCO) and a knowledge utilization orientation (KUO), creating a two-dimensional surface on which the major activities which distinguish an entrepreneurial university can be mapped. Moreover, we posit the effect of the two orientations is multiplicative and that PO is equivalent to the knowledge creation orientation multiplied by the knowledge utilization orientation, as shown in Equation 1 (Gibson & Birkinshaw, 2004). Conceptually, 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 consensus (Bercovitz & Feldman, 2008; Datta, Mukherjee, & Jessup, 2015) to support knowledge creation and knowledge utilization. *Faculty engagement* represents faculty members’ intentions and capabilities regarding time, awareness, experience, and research portfolios in their knowledge creation and knowledge utilization activities (Chang, Yang, & Chen, 2009; Jain et al., 2009). We can draw a figure to illustrate the composition of PO (Figure 2).

-------------------------

Insert Figure 2 Here

-------------------------

**2.3 Contextual antecedents**

In the creation of the entrepreneurial university, university departments are the meso-level unit standing between the institutional contexts of the university and its faculty members, performing a crucial role in integration and engagement in the 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 will encourage internal actors to respond to the transformation of the university paradigm (Perkmann et al., 2013). And organizational studies have found organizations characterized by greater environmental munificence are more open to adopting new strategies and structures, even stabilizing new practices in turbulent environments (Boyne & Meier, 2009; Keats & Hitt, 1988). The level of munificence here refers to the availability of resources and support in the environmental context which could help an organization adopt new practices to sustain organizational growth and changes (Dess & Beard, 1984; Goll & Rasheed, 2005; Haveman, 1993). To create the entrepreneurial university, Clark (2004) suggests that a managerial group can provide a sustainable commitment to the new university paradigm to encourage internal actors to build an integrated context that will respond to the changes. O’Reilly and Tushman (2008) point out that senior managers can adapt, integrate, and reconfigure organizational skills and resources to orchestrate both new and existing routines suitable for the changing environment. Glenna, Welsh, Ervin, Lacy, and Biscotti (2011) recommend that university administrators provide sufficient commitment to a variety of incentive structures, funding sources, policies, and practices to allow it to invest in a diverse set of scientific research values. Gibb et al. (2013) consider that it is possible for university administrators to remove barriers and provide abundant resources and support associated with the entrepreneurial paradigm as well as carry on its existing culture, mission, and strategy. Above all, a university administration should continuously create organizational munificence to encourage internal actors to realign with the mission of the university (Andrews & Johansen, 2012; Smith, Mitchell, & Summer, 1984; Tilcsik, 2014; Wu, 2008). Therefore, this paper argues that the senior team (i.e., university administrators) has to provide sufficient organizational munificence to pursue research excellence and commercialization, and the degree to which it does this will influence departments’ enhancement and simultaneous integration of KCO and KUO. 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.” In addition, 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.” In line with this call, a variety of policies, such as the enhancement of university-industry collaboration and the establishment of academic spin-offs, has been widely instituted in universities (Perkmann et al., 2013; Shane, 2004). Also, universities are adjusting their infrastructure, establishing 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 flexibility* can 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 identifying potential linkages. 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, a new direction in science policy has been pursued, in which the integration of knowledge creation and knowledge utilization is seen to have value, creating both societal and scientific benefits from the one research agenda. Stokes (1997) took as his example Louis Pasteur, who had promoted fundamental knowledge in microbiology at the same time as he commercialized this knowledge into practice in fermentation technology. He showed that knowledge creation and knowledge utilization are not in conflict but complementary, even if knowledge creation predominates over knowledge utilization (Etzkowitz, 1983; Shibayama, 2012). In developing a Pasteurian orientation, the entrepreneurial university does not intend to compete with or replace industry in terms of technological development but facilitate innovation with the advanced knowledge which stems from scientific research (Etzkowitz, 1983, 2017). At the same time, Glenna et al. (2011) also consider that the scientific foundations and advancement of industrial technology are likely to decline if universities do not have sufficient investment to pursue research excellence. Therefore, this paper argues that university departments have to sustain the commitment to knowledge creation, and that then they may foster 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 a entrepreneurial university does not only create a new organizational arrangement, or ambidextrous/hybrid organization (Ambos et al., 2008; Etzkowitz, 2017; Guerrero & Urbano, 2012). It also promotes self-efficacy in the new paradigm (Bouncken, 2018). As a focal unit in the university, self-efficacy in the new paradigm in a university department has a strong influence on faculty member peers and on their decisions and behavior (Aschhoff & Grimpe, 2014; Jain et al., 2009) as departmental collective efficacy (Stajkovic, Lee, & Nyberg, 2009; Watson, Chemers, & Preiser, 2001). Collective efficacy represents self-efficacy at the group level, and is defined as a group’s shared belief in its conjoint capabilities to organize and execute the actions required to produce given levels of attainment (Bandura, 1997, 2000). A high degree of collective efficacy indicates an organization has functional organizational readiness, and has been able to internalize new organizational practices into its routines to pursue the goals of the organization as the organization transforms itself (Bandura, 2000; Barrick, Thurgood, Smith, & Courtright, 2015; Holt & Vardaman, 2013). University departments develop PO organizational propensity, combining knowledge creation orientation (KCO) and knowledge utilization orientation (KUO), and this propensity represents their attempts to develop new organizational practices by reshapement to the paradigm of the entrepreneurial university (Leih & Teece, 2016). Moreover, departmental collective efficacy indicates that the department’s members collectively judge they now are organized to effectively pursue research excellence and research commercialization in the department. By means of the development of PO, strong organizational support and faculty engagement in both knowledge creation and knowledge commercialization can conjointly enhance departmental collective efficacy with favorable departmental practices in the development of the entrepreneurial university 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 of, as well as develop 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 existing and new university missions, and *organizational flexibility* creates multiple paths for these missions, which thereby encourages cross-functional coordination and integration between knowledge creation and knowledge utilization. Therefore, these antecedents may enhance efficacy in an organization which is capable of developing according to the paradigm of the entrepreneurial university (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 be sufficient to inspire a department to develop the capacity or motivation to take up challenges in organizational adjustment required to make the transition to the entrepreneurial university. Rasmussen, Mosey, and Wright (2014) also think that university departments need to cultivate their ability to develop new organizational structures, routines and support, and to encourage and motivate their members to engage in new practices. Central to the concept of PO is the maintaining of the multiple competencies that characterize the ambidextrous organization (Etzkowitz, 2003; Gibson & Birkinshaw, 2004; Tushman & O'Reilly, 1996). Therefore, university departments have to develop PO as the organizational capability to create organizational practices, and then they can employ this capability to promote departmental collective efficacy according to 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’s research framework and the corresponding hypotheses are depicted in Figure 3.

-------------------------

Insert Figure 3 Here

-------------------------

**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 removes other restrictions allowing a more decentralized licensing policy. Consequently, Taiwanese universities have increased their number of patent grants and licensing income, while universities are encouraged to develop research partnerships with industry (Chang et al., 2008).

The list of top ten universities in terms of domestic patent grants is shown in Table 1. The primary participants in generating patent grants are public universities, and there is also a different pattern in the patent grants of 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 more on non-utility patents that reflect their interests and the features of their inventions. Statistics also show a substantial increase in paper publication, patenting, licensing, and venture incubation between 2006 and 2010 (see Table 2).

-------------------------

Insert Table 1 Here

 -------------------------

-------------------------

Insert Table 2 Here

**-------------------------**

**3.2 Questionnaire development**

A questionnaire was developed with three parts. The first part concerns contextual antecedents, namely, organizational munificence, and organizational flexibility, and is followed by a PO part and a departmental collective efficacy part. The six organizational munificence items focus on the investigation of the degree of munificence, in terms of resources, long-term support and strategic objectives, enjoyed by the department (Bercovitz & Feldman, 2008; Clark, 2004; Landry et al., 2006), as perceived by the department, and the three items of organizational flexibility were taken from Volberda (1996). The 14 PO items were adapted from Chang et al. (2009) and the three departmental collective efficacy items were developed referring to Riggs, Warka, Babasa, Betancourt, and Hooker (1994). All of the contextual antecedents, PO, and departmental collective efficacy survey items used a 7-point Likert scale.

**3.3 Sampling and Respondents**

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

Because of the differentiation in organizational contexts and presumed PO orientation, six universities were chosen to represent the different forms of university, four (one medical and three general) public universities (Universities A, B, C & D), one private general university (University E), and one private technical university (University F). Finally, the original survey list of the 29 schools and 172 departments within these universities was prepared, collecting data from their websites.

Questionnaire responses were collected from administrators and faculty members who serve in 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). However, to avoid the common method variance (CMV) problem, this paper adopted the following questionnaire design. First, the contextual antecedent questions are answered by administrator(s) and reflect the departmental context. Second, the Pasteurian orientation (PO) construct questions are answered by all faculty members in each department and then aggregated to represent department-level PO. Specifically, we compute the multiplicative interaction between KUO and KCO to reflect the theoretical concept of PO.

In addition, the dimensions KUO and KCO are computed through multiplicative interaction between o*rganizational support* and *faculty engagement*. This composition of KUO and KCO is based on prior findings that the two mechanisms are non-substitutable and interdependent. Finally, the dimension of departmental collective efficacy is aggregated from the answers of all of the respondents in 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 size of the sample in the six universities was 2,868 faculty members. The 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 was minimal. After a three-round survey collection process, we obtained 711 returned questionnaires, an overall 26% response rate. To meet our analysis criteria, we required that at least one administrator and four faculty members respond to be recognized as 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.

-------------------------

Insert Table 3 Here

-------------------------

Specifically, the respondents included 157 department administrators and 477 non-administrative faculty members. In some departments, questionnaires were answered by more than one administrator, including by administrative heads, chairs of departments or institutes, and directors of administrative offices. Overall, there were 70 departments where only one administrator answered the survey, but the average number of administrator replies per department was 2.20. The answers of all administrators in the same department were averaged to represent the status of the department. In terms of gender, there were 368 male respondents (83% of the respondents). There were 342 full professors (54%), 139 associate professors (22%), and 133 assistant professors (21%). The length of career of the respondents was 13.6 years on average. However, there were 393 respondents (62%) who had already received tenure as faculty members.

**3.4 Measurements**

**3.4.1 Departmental collective efficacy**

To measure departmental collective efficacy, we collected subjective measures for the three years (2007-2009). The survey asked the respondents to ‘assess your department/institute’s capabilities and practices pursuing research excellence/research commercialization over the past three years compared to other equivalent departments.’ The 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 perceived their departments to have a Pasteurian orientation. We measured knowledge creation orientation by asking faculty members to indicate the degree to which they agreed with the corresponding statements. Specifically, 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, three items loaded on a single factor having an eigenvalue of 1.192 (α =.77). We refer to this factor as *faculty engagement in knowledge creation*. Then, we computed the multiplicative interaction between the above knowledge creation dimensions as the k*nowledge creation orientation* (KCO) of departments.

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

* + 1. **Contextual antecedents**

The contextual antecedent part of the questionnaires had nine items that assessed the perceptions of department administrator(s). To make the six question items related to organizational munificence more specific, three items addressed research excellence while the other three items addressed research commercialization. The three items about organizational munificence and research excellence loaded onto a single factor having an eigenvalue of 2.02 (α = .91) (Appendix 1). The three items about organizational munificence and research commercialization loaded onto a single factor having an eigenvalue of 4.73 (α = .97) (Appendix 1). We aggregated the two factors as organizational munificence, the level of munificence for the old and new missions of the entrepreneurial university. The other three items of organizational flexibility loaded on a single factor with an eigenvalue of 3.035 (α =.93). Thus, we retained this factor as our *organizational flexibility* measure (see Appendix 1)

**3.4.4 Control variables**

This study employed three control variables reflecting the characteristics of the departments. First, ownership was measured by whether the department belonged to a public university or not. Second, size was represented by the number of faculty members in the department. Third, we used a macro-variable to represent the nature of the discipline of the department. We created three “college” variables as dummy variables to represent whether a department belonged to an Engineering, Science or Life Science and Medical College, respectively (Ambos et al., 2008; D’Este & Perkmann, 2011).

**4. Results**

Table 4 reports descriptive statistics for the variables. Among the 99 departments, the average size of the departments was 21 faculty members. There were 53 departments (54%) from engineering colleges, followed by 13 departments (13%) from science colleges, and 26 departments (26%) from life science and medical colleges. PO was significantly and positively correlated with 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).

As for the control variables, whether the department belonged to a public university was negatively correlated to organizational munificence (β = -.200, p < .05), KUO (β = -.459, p < .001) and departmental collective efficacy (β = -.241, p < .05). Most of the variables of interest were not significantly correlated to department size, except for departments in life science and medicine colleges where they were negatively correlated. The nature of the discipline had more general effects. Whether a department belonged to an engineering college or not was positively and statistically significantly related with PO (β = .436, *p* < .01) and departmental collective efficacy (β = .399, *p* < .01). And for affiliations with science and life science and medicine colleges, the correlations were negative (*p* < .05)

-------------------------

Insert Table 4 Here

-------------------------

This study tested its hypotheses using ordinary least squares (OLS) regression. The first, H1 predicted a relationship between organizational munificence and PO, and its sub-hypotheses H1a and H1b similarly posited the influence of organizational munificence on the development of KCO and KUO. As seen in Table 5, Model 2 and 5 indicate organizational munificence has a significant positive impact on KCO (β = .251, *p* < .05) and KUO (β = .175, *p* < .05) and Model 7 shows the same on PO (β = .216, *p* < .05). H1 is fully supported. H2 states that organizational flexibility has a positive influence on PO. Model 3, Model 6 and Model 8 confirm that organizational flexibility has a positive relationship with KCO (β = .237, *p* < .05), KUO (β = .152, *p* < .10), and PO (β = .184, *p* < .10), respectively. However, H2 is only partially supported due to the marginal impact on the development of KUO and PO.

H3 states that KCO is positively associated with departmental KUO. As shown in Table 6, Model 9 confirms there is a strong relationship between the two components of PO. (β = .605, *p* < .001). Furthermore, H4 predicted that the development of PO would contribute to departmental collective efficacy. To observe the effects of KCO and KUO, we sub-divided the H4 hypothesis into H4a and H4b. Model 10, Model 11, and Model 12 confirm that university departments developing KCO (β = .381, *p* < .001), KUO (β = .459, *p* < .001), and PO (β = .459, *p* < .001) positively enhance their collective efficacy. In other words, H4 is fully supported. Finally, H5 predicted there would be a mediating effect of PO on the relationship between contextual antecedents and departmental collective efficacy. Following Baron and Kenny (1986), we examined separately this hypothesis for munificence and flexibility as H5a and H5b. Through the results of Model 13 and Model 14, we see 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 is shown PO fully mediated the relationship between 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 exerted by organizational munificence on pursuing research excellence and research commercialization has partial influence on departmental collective efficacy (Aldwin, 1994; Baron & Kenny, 1986).

-------------------------

Insert Table 5 Here

-------------------------

-------------------------

Insert Table 6 Here

-------------------------

**5. Discussion**

By examining the development of ambidexterity in university departments, this paper aimed to understand the academic transitions involved in the organizational changes associated with the rise of the entrepreneurial university, (Etzkowitz, 2017). The study took an organizational propensity, ‘Pasteurian orientation,’ and examined its development and its relationships with university antecedents and departmental collective efficacy. First, the study found that university munificence and flexibility are important determinants facilitating the development of a Pasteurian orientation within departments. These findings suggest that organizational munificence provides the subordinated departments the necessary legitimacy and support required for them to redefine their organizational practices and move towards Pasteurian orientation (Powers & McDougall, 2005; Vanaelst et al., 2006). Its significant effect on knowledge creation and knowledge utilization confirms that organizational munificence has a firm connection with the engagement of university departments, and even a direct effect on departmental collective efficacy (Owen-smith, 2005; Perkmann et al., 2013). Furthermore, this result is aligned with findings that other organizational contexts can facilitate or result in 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 stemming from Clark's (2004) survey of the leading entrepreneurial universities, which suggests that a more flexible and adaptable organization can respond to environmental changes and encourage the development of entrepreneurality. 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 recommendations of past research that universities and managers be more flexible and less bureaucratic, and create a munificent environment facilitating organizational ambidexterity or Pasteurian orientation (Andrews & Johansen, 2012; Friedman & Silberman, 2003; Siegel, Waldman, & Link, 2003; Tilcsik, 2014; Tushman & O'Reilly, 1996).

Second, the paper found that a knowledge creation orientation predominated over the development of a knowledge utilization orientation, but that the two orientations could be reconciled via the development of PO. This empirical finding is consistent with the argument that research excellence and research commercialization are complementary rather than in conflict, within the entrepreneurial university (Guerrero, Urbano, Fayolle, Klofsten, & Mian, 2016; Sengupta & Ray, 2017). It is suggested that university departments sustain an excellent level of research work first, but that they also create a hybrid context that allows a balance between KUO and KCO. Specifically, university departments should employ PO to create organizational norms, routines, and recognition for leading faculty members consistent with the new university paradigm. (Ambos et al., 2008; Bercovitz & Feldman, 2008; Chang et al., 2016), because our results confirm that PO has a robust association with departmental collective efficacy.

Third, PO acts as a mediator between contextual antecedents and departmental collective efficacy. Etzkowitz (2003) considers that universities can provide institutional spheres that overlap for pursuing research excellence and research commercialization and that these can function effectively to regulate emerging conflicts of interest in developing the new paradigm of the entrepreneurial university. Moreover, the development of overlapping institutional spheres encourages the development of hybrid entities which can reconcile seemingly contradictory ideas and practices (Schildt & Perkmann, 2017; Tuunainen, 2005). In our findings, university departments with a high degree of PO could harbor “opposing” norms and orientations, and had the capability to reinterpret these norms and orientations for the legitimation of harmony and mutual reinforcement of each goal (Etzkowitz, 2003). In other words, the universities provided sufficient organizational munificence and a sufficiently flexible environment to facilitate the departments’ engagement in multiple missions. They needed to develop PO to coordinate knowledge creation and knowledge utilization in the new paradigm of the entrepreneurial university for better departmental collective efficacy.

**6. Conclusion**

Previous studies have indicated university departments are essential and focal units which shape, lead, and demonstrate the behaviors of faculty members, a process which is reflected in organizational identity, norms, learning, and peer relationships (Aschhoff & Grimpe, 2014; Jain et al., 2009; Perkmann et al., 2013). Taking its cue from these studies and unlike previous entrepreneurial university research which has focused on the analysis of institutional (e.g., the passage of the *Bayh-Dole Act*) or individual (e.g., faculty member) players, this paper used organizational meso-level university departments as the unit of analysis and studied their role in the interplay of organizational layers responsible for the development of the entrepreneurial university.

It found that organizational munificence and organizational flexibility are critical organizational antecedents in the development of a Pasteurian orientation (PO). The level of organizational munificence influences the degree to which university departments engage in the new paradigm, and even-handed support for the multiplicity of activities undertaken in pursuit of the university’s goals is a necessary part of its balancing act. At the same time, a high degree of organizational flexibility could help university departments to develop the agility to align with the new paradigm of the entrepreneurial university and to quickly adopt new practices with no adverse influence on existing ones.

Moreover, the findings also suggest that PO provides valuable strategic help for establishing departmental collective efficacy. PO acts as a mediator between contextual antecedents and departmental collective efficacy, indicating that the university’s contextual factors act only as a *necessary condition* to promoting departmental engagement in the new entrepreneurial paradigm, while the development of PO is a *sufficient condition*. The paper concludes the concept of PO is well-suited for reconciling the conflict and establishing a balance between knowledge creation and knowledge utilization in the entrepreneurial university. Encouraging organizational contexts with a high level of organizational munificence and flexibility that generate dual capacities in knowledge creation and knowledge utilization may be a critical source of competitive advantage when creating one.

This paper advances our understanding of organizational strategies and structures in the development of PO in university departments. First, it integrates the Pasteur’s quadrant framework and ambidexterity theory into a strategic and organizational system where PO plays the major role. It also extends the application of the Pasteur’s quadrant framework at the organization level. Second, via the developed construct and measurement of PO, university departments can compose, diagnose, and measure their own PO. Third, it confirms the organizational meso-mediation relation between contextual factors, PO, and departmental collective efficacy.

The following policy and managerial implications are suggested. Universities are characterized as bureaucratic organizations that stress institutionalization (Clark, 1998), while resource endowments determine the paths to organizational development (Siegel & Wright, 2015). However, they also have high autonomy and are self-organizing system (Martin, 2012). Building the paradigm of the entrepreneurial university, university administrators should create a munificent environment and provide a high degree of flexibility to allow departments to reshape organizational practices. However, maintaining a strategic and structural balance between old and new missions, and knowledge creation and knowledge utilization tasks is 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. To develop PO within departments, departmental heads may use the construct and its measurement proposed in this paper to diagnose or build up their departments’ norms, routines, support, and engagement with PO.

**References**

Aldwin, C. M. 1994. ***Stress, Coping, and Development: An Integrative Perspective***. New York: Guilford Press.

Ambos, T. C., Mäkelä, K., Birkinshaw, J., & D'Este, P. 2008. When Does University Research Get Commercialized? Creating Ambidexterity in Research Institutions. ***Journal of Management Studies***, 45(8): 1424-1447.

Andrews, R., & Johansen, M. 2012. Organizational environments and performance: A linear or nonlinear relationship? ***Public Organization Review***, 12(2): 175-189.

Aschhoff, B., & Grimpe, C. 2014. Contemporaneous peer effects, career age and the industry involvement of academics in biotechnology. ***Research Policy***, 43(2): 367-381.

Bandura, A. 1997. ***Self-efficacy: The exercise of control***: Macmillan.

Bandura, A. 2000. Exercise of Human Agency Through Collective Efficacy. ***Current Directions in Psychological Science***, 9(3): 75-78.

Baron, R. M., & Kenny, D. A. 1986. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. ***Journal of personality and social psychology***, 51(6): 1173.

Barrick, M. R., Thurgood, G. R., Smith, T. A., & Courtright, S. H. 2015. Collective organizational engagement: Linking motivational antecedents, strategic implementation, and firm performance. ***Academy of Management journal***, 58(1): 111-135.

Bercovitz, J., & Feldman, M. 2008. Academic Entrepreneurs: Organizational Change at the Individual Level. ***Organization Science***, 19(1): 69.

Bouncken, R. B. 2018. University coworking-spaces: Mechanisms, examples, and suggestions for entrepreneurial universities. ***International Journal of Technology Management***, 77(1-3): 38-56.

Boyne, G. A., & Meier, K. J. 2009. Environmental turbulence, organizational stability, and public service performance. ***Administration & Society***, 40(8): 799-824.

Chang, Y.-C., Yang, P. Y., & Chen, M.-H. 2009. The determinants of academic research commercial performance: Towards an organizational ambidexterity perspective. ***Research Policy***, 38(6): 936-946.

Chang, Y.-C., Yang, P. Y., Martin, B. R., Chi, H.-R., & Tsai-Lin, T.-F. 2016. Entrepreneurial universities and research ambidexterity: A multilevel analysis. ***Technovation***, 54: 7-21.

Clark, B. R. 1998. ***Creating Entrepreneurial Universities: Organizational Pathways of Transformation. Issues in Higher Education***: ERIC.

Clark, B. R. 2004. ***Sustaining Change In Universities***: McGraw-Hill Education.

D’Este, P., & Patel, P. 2007. University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry? ***Research Policy***, 36(9): 1295-1313.

D’Este, P., & Perkmann, M. 2011. Why do academics engage with industry? The entrepreneurial university and individual motivations. ***The Journal of Technology Transfer***, 36(3): 316-339.

Datta, A., Mukherjee, D., & Jessup, L. 2015. Understanding commercialization of technological innovation: taking stock and moving forward. ***R&D Management***, 45(3): 215-249.

Dess, G. G., & Beard, D. W. 1984. Dimensions of organizational task environments. ***Administrative science quarterly***: 52-73.

Etzkowitz, H. 1983. Entrepreneurial scientists and entrepreneurial universities in American academic science. ***Minerva***, 21(2-3): 198-233.

Etzkowitz, H. 1998. The norms of entrepreneurial science: cognitive effects of the new university–industry linkages. ***Research Policy***, 27(8): 823-833.

Etzkowitz, H. 2003. Research groups as ‘quasi-firms’: the invention of the entrepreneurial university. ***Research policy***, 32(1): 109-121.

Etzkowitz, H. 2017. Innovation Lodestar: The entrepreneurial university in a stellar knowledge firmament. ***Technological Forecasting and Social Change***, 123: 122-129.

Etzkowitz, H., & Leydesdorff, L. 2000. The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations. ***Research Policy***, 29(2): 109-123.

Friedman, J., & Silberman, J. 2003. University Technology Transfer: Do Incentives, Management, and Location Matter? ***The Journal of Technology Transfer***, 28(1): 17-30.

Gibb, A., Haskins, G., & Robertson, I. 2013. Leading the Entrepreneurial University: Meeting the Entrepreneurial Development Needs of Higher Education Institutions. In A. Altmann, & B. Ebersberger (Eds.), ***Universities in Change***: 9-45. New York, NY: Springer New York.

Gibson, C. B., & Birkinshaw, J. 2004. The antecedents, consequences, and mediating role of organizational ambidexterity. ***Academy of management Journal***, 47(2): 209-226.

Glenna, L. L., Welsh, R., Ervin, D., Lacy, W. B., & Biscotti, D. 2011. Commercial science, scientists’ values, and university biotechnology research agendas. ***Research Policy***, 40(7): 957-968.

Goll, I., & Rasheed, A. A. 2005. The relationships between top management demographic characteristics, rational decision making, environmental munificence, and firm performance. ***Organization studies***, 26(7): 999-1023.

Guerrero, M., & Urbano, D. 2012. The development of an entrepreneurial university. ***The journal of technology transfer***, 37(1): 43-74.

Guerrero, M., Urbano, D., Fayolle, A., Klofsten, M., & Mian, S. 2016. Entrepreneurial universities: emerging models in the new social and economic landscape. ***Small Business Economics***, 47(3): 551-563.

Gustafsson, R., & Autio, E. 2011. A failure trichotomy in knowledge exploration and exploitation. ***Research Policy***, 40(6): 819-831.

Haas, M. R., & Park, S. 2010. To share or not to share? Professional norms, reference groups, and information withholding among life scientists. ***Organization Science***, 21(4): 873-891.

Haveman, H. A. 1993. Organizational size and change: Diversification in the savings and loan industry after deregulation. ***Administrative Science Quarterly***: 20-50.

He, Z.-L., & Wong, P.-K. 2004. Exploration vs. Exploitation: An Empirical Test of the Ambidexterity Hypothesis. ***Organization Science***, 15(4): 481-494.

Holt, D. T., & Vardaman, J. M. 2013. Toward a comprehensive understanding of readiness for change: The case for an expanded conceptualization. ***Journal of Change Management***, 13(1): 9-18.

Jain, S., George, G., & Maltarich, M. 2009. Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. ***Research Policy***, 38(6): 922-935.

Jansen, J. J. P., Tempelaar, M. P., van den Bosch, F. A. J., & Volberda, H. W. 2009. Structural Differentiation and Ambidexterity: The Mediating Role of Integration Mechanisms. ***Organization Science***, 20(4): 797-811.

Kalar, B., & Antoncic, B. 2015. The entrepreneurial university, academic activities and technology and knowledge transfer in four European countries. ***Technovation***, 36–37(0): 1-11.

Keats, B. W., & Hitt, M. A. 1988. A causal model of linkages among environmental dimensions, macro organizational characteristics, and performance. ***Academy of management journal***, 31(3): 570-598.

Klofsten, M., Fayolle, A., Guerrero, M., Mian, S., Urbano, D., & Wright, M. 2019. The entrepreneurial university as driver for economic growth and social change - Key strategic challenges. ***Technological Forecasting and Social Change***, 141: 149-158.

Landry, R., Amara, N., & Rherrad, I. 2006. Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities. ***Research Policy***, 35(10): 1599-1615.

Lavie, D., Stettner, U., & Tushman, M. L. 2010. Exploration and Exploitation Within and Across Organizations. ***The Academy of Management Annals***, 4(1): 109-155.

Leih, S., & Teece, D. 2016. CAMPUS LEADERSHIP AND THE ENTREPRENEURIAL UNIVERSITY: A DYNAMIC CAPABILITIES PERSPECTIVE. ***Academy of Management Perspectives***, 30(2): 182-210.

Martin, B. R. 2012. Are universities and university research under threat? Towards an evolutionary model of university speciation. ***Cambridge Journal of Economics***, 36(3): 543-565.

Merton, R. K. 1968. The Matthew effect in science. ***Science***, 159(3810): 56-63.

Nelson, R. R. 2004. The market economy, and the scientific commons. ***Research Policy***, 33(3): 455-471.

O’Reilly, C. A., & Tushman, M. L. 2008. Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. ***Research in organizational behavior***, 28: 185-206.

Owen-smith, J. 2005. Trends and transitions in the institutional environment for public and private science. ***Higher Education***, 49(1-2): 91-117.

Partha, D., & David, P. A. 1994. Toward a new economics of science. ***Research Policy***, 23(5): 487-521.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D’Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., & Sobrero, M. 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. ***Research Policy***, 42(2): 423-442.

Philpott, K., Dooley, L., O'Reilly, C., & Lupton, G. 2011. The entrepreneurial university: Examining the underlying academic tensions. ***Technovation***, 31(4): 161-170.

Powers, J. B., & McDougall, P. P. 2005. University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. ***Journal of Business Venturing***, 20(3): 291-311.

Raisch, S., & Birkinshaw, J. 2008. Organizational ambidexterity: Antecedents, outcomes, and moderators. ***Journal of Management***, 34(3): 375-409.

Rasmussen, E., Mosey, S., & Wright, M. 2014. The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures. ***Research Policy***, 43(1): 92-106.

Riggs, M. L., Warka, J., Babasa, B., Betancourt, R., & Hooker, S. 1994. Development and validation of self-efficacy and outcome expectancy scales for job-related applications. ***Educational and psychological measurement***, 54(3): 793-802.

Sauermann, H., & Stephan, P. 2013. Conflicting Logics? A Multidimensional View of Industrial and Academic Science. ***Organization Science***, 24(3): 889-909.

Schildt, H., & Perkmann, M. 2017. Organizational Settlements:Theorizing How Organizations Respond to Institutional Complexity. ***Journal of Management Inquiry***, 26(2): 139-145.

Sengupta, A., & Ray, A. S. 2017. University research and knowledge transfer: A dynamic view of ambidexterity in british universities. ***Research Policy***, 46(5): 881-897.

Shane, S. 2004. ***Academic entrepreneurship: university spinoffs and wealth creation***. Cheltenham, UK: Edward Elgar.

Shibayama, S. 2012. Conflict between entrepreneurship and open science, and the transition of scientific norms. ***The Journal of Technology Transfer***, 37(4): 508-531.

Siegel, D. S., Waldman, D., & Link, A. 2003. Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. ***Research Policy***, 32(1): 27-48.

Siegel, D. S., & Wright, M. 2015. Academic Entrepreneurship: Time for a Rethink? ***British Journal of Management***, 26(4): 582-595.

Smith, K. G., Mitchell, T. R., & Summer, C. E. 1984. ***The Relationship Between Stages of Organizational Development and Strategic Decision Priorities: A Dual Methodological Investigation***. Paper presented at the Academy of Management Proceedings.

Smith, W. K., & Tushman, M. L. 2005. Managing Strategic Contradictions: A Top Management Model for Managing Innovation Streams. ***Organization Science***, 16(5): 522-536.

Stajkovic, A. D., Lee, D., & Nyberg, A. J. 2009. Collective efficacy, group potency, and group performance: Meta-analyses of their relationships, and test of a mediation model. ***Journal of applied psychology***, 94(3): 814-828.

Stankiewicz, R. 1986. ***Academics and entrepreneurs: developing university-industry relations***. London, UK: St. Martin's Press.

Stokes, D. E. 1997. ***Pasteur's quadrant: basic science and technological innovation***. Washington,D.C.: Brookings Institution Press.

Tilcsik, A. 2014. Imprint–environment fit and performance: How organizational munificence at the time of hire affects subsequent job performance. ***Administrative Science Quarterly***, 59(4): 639-668.

Tushman, M. L., & O'Reilly, C. A. 1996. Ambidextrous organizations: managing evolutionary and revolutionary change. ***California management review***, 38(4): 8-30.

Tuunainen, J. 2005. Hybrid practices? Contributions to the debate on the mutation of science and university. ***Higher Education***, 50(2): 275-298.

Van Looy, B., Landoni, P., Callaert, J., Van Pottelsberghe, B., Sapsalis, E., & Debackere, K. 2011. Entrepreneurial effectiveness of European universities: An empirical assessment of antecedents and trade-offs. ***Research Policy***, 40(4): 553-564.

Vanaelst, I., Clarysse, B., Wright, M., Lockett, A., Moray, N., & S'Jegers, R. 2006. Entrepreneurial Team Development in Academic Spinouts: An Examination of Team Heterogeneity. ***Entrepreneurship Theory and Practice***, 30(2): 249-271.

Volberda, H. W. 1996. Toward the flexible form: how to remain vital in hypercompetitive environments. ***Organization Science***, 7(4): 359-374.

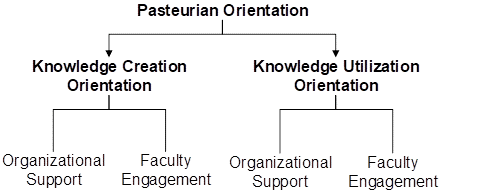
Watson, C. B., Chemers, M. M., & Preiser, N. 2001. Collective Efficacy: A Multilevel Analysis. ***Personality and Social Psychology Bulletin***, 27(8): 1057-1068.

Wu, H.-L. 2008. When does internal governance make firms innovative? ***Journal of Business Research***, 61(2): 141-153.



**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. Engineering 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) |
| Engineering 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) |
| Engineering 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 resources for pursuing research excellence. | | .889 |
| 1. My university is committed to long-term support for pursuing research excellence. | | .885 |
| 1. I perceive university administrators to consider pursuing research excellence to be a primary objective in my university. | | .821 |
| *Organizational munificence for research commercialization(eigenvalues=4.731, α=.971)* | | |
| 1. My university provides sufficient resources for pursuing research commercialization. | | .926 |
| 1. My university is committed to long-term support for pursuing commercialization. | | .843 |
| 1. I perceive university administrators to consider pursuing research commercialization to be a primary objective in my university. | | .857 |
| *Organization flexibility (eigenvalues=3.035, α=.933)* | | |
| 1. My university authorized my department to frequently set up cross-functional committees to reconfigure inappropriate regulations. | | .829 |
| 1. My university authorized my department to frequently set up cross-functional committees to respond to ongoing external opportunities. | | .824 |
| 1. My university authorized my department to 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 provided sufficient incentives and support for faculty to apply for and protect intellectual property rights | | .903 |
| 1. My department has provided sufficient incentives and support for faculty to engage in technology transfers | | .946 |
| 1. My department has provided sufficient incentives and support for faculty to engage in university-industry collaborative research | | .955 |
| 1. My department has provided sufficient incentives and support 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. Industrial firms have shown great interest in commercializing my research and keeping in 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 for the implementation of pursuing research excellence. | | .741 |
| 1. Compared to equivalent departments in other universities, my department has excellent capabilities and organizational practices for 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**