Managing Knowledge and Identity across the Boundary of Academic and Commercial Science

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Abstract: In the last few decades, institutions of higher learning are being transformed from ivory towers to become engines of regional and national economic development and 'knowledge businesses' increasingly focused on producing commercial products for private industry. The role of academics is rapidly shifting as many in the professoriate are becoming 'captured' by an ethos of commercialization as they rush to bring the product of their research to the marketplace. Critics of the entrepreneurial paradigm see academics as promoters as well as victims of commercialisation who internalize the pursuit of profit and value of money under the academic capitalist knowledge regime. While some academic researchers have enthusiastically embraced the transformation in the relationship between science and business, and between the academy and industry, many remain firmly committed to academic science, disinterested in pursuing commercial opportunities. Yet, others choose a middle ground and straddle the academic and commercial boundary. The purpose of this paper is to illustrate the role of identity to influence how academic scientists manage the boundary between the world of academic science and commercial science. Drawing from a large sample of Canadian university academic researchers in the applied sciences (n=379), four distinct categories of academic scientists are identified: Type I: Traditional academics who view the realm of academic science and commercial science as distinct and choose to position themselves strictly as academic scientists; Type II: Pragmatic academic hybrids who view academic and commercial science as distinct but decide to strategically pursue industrial links to acquire resources that support their research; Type III: Collaborative academic hybrids who believe in the paramountcy of academic and industry collaborations for the advancement of science; and Type IV: Academic entrepreneurs who abide in the fundamental importance of academic-industry links for application and for commercial exploitation. Results suggest that our researcher categories are further differentiated with respect to the strength of their collaborations with industry, their program of research, the extent of their industry experience, the degree of financial support they receive from industry, the size of their research laboratory, and by their scientific publications and the number of patents and licenses they hold from their research.

Keywords: faculty-industry engagement, academic-industry ideology, research identity

1. Introduction

Academic entrepreneurialism in institutions of higher learning is everywhere in vogue. Universities are being transformed from ivory towers to engines of regional and national economic development and 'knowledge businesses' increasingly focused on producing commercialisable product for private industry (Stein, 2004). The role of academics in universities is shifting. There is a growing concern that the professoriate is becoming captured by an ethos of commercialisation. Critics of the entrepreneurial paradigm see academics as promotors as well as victims of commercialisation who internalize the pursuit of profit and value of money under the academic capitalist knowledge regime (Slaughter & Leslie, 1997; Slaughter & Rhoades, 2004). While some academic researchers have enthusiastically embraced the transformation in the relationship between science and business, and between the academy and industry, many others remain disinterested and disengaged (Novotny, 2017). For those who choose to adopt this new role, not enough is known about existing patterns of relationship that academic scientists have with industry and their potential to reshape career trajectories in the pursuit of entrepreneurial opportunity (Audretsch & Kayalar-Erdem, 2005).

Institutional support and pressure for university-based scientists to engage with industry and business stakeholders have enabled and motivated academics to embrace an entrepreneurial identity (Guo, Restubog, Cui, Zou, & Choi, 2019). Academic entrepreneurs participating in commercialisation activities develop dual identities—those of a scholar and entrepreneur, and without effective role integration may incur identity confusion, inconsistency, and conflict as they impose opposing attitudinal and behavioral demands (Jain,

George, & Maltarich, 2009). Academic entrepreneurs carry multiple professional demands that are embedded in a hybrid career involving the original identity of an academic doing scholarly work and a newly acquired one as an entrepreneur involved in business venturing. Social identity theory provides a theoretical base to understand how individuals align their behaviors with social groups from which they craft their identity (Turner & Oakes, 1986). Rooted in social psychological theory, social identity theory explains a variety of group processes, including intergroup relations, the process of professionalizing, and generalized identity work in organizations and community ecosystems (Hogg, Terry & White, 1995; Zou, Li, Guo & Guo, 2019).

For most scientists employed at institutions of higher learning, taking the leap into the world of commercialisation represents a profound challenge. It can involve altering the set of activities that constitute a scientists' normal workload and entails addressing conflicting pressures, demands, and values that originate from competing normative cultures of the academic and business worlds. During a long period of training and socialization, research scientists are immersed in a normative system that Merton (1968) has identified as constituting the 'ethos of science.' Four facets that comprise this ethos include; *universalism* which asserts that scientific observation and measurement should be verifiable and independent of observer; *communism* (communalism) implying that scientists share their work with their community for the advancement of knowledge; *disinterestedness* which purports that scientists should have no emotional or financial attachments to the outcomes of their work, and *organized skepticism* which refers to the need for scientists to have no interest in a specific outcome and to suspend judgements about their findings until all facts have been assembled. Individuals trained in the career path for a traditional university scientist undergo a unique set of experiences that relate to the inculcation of these norms that over time become inextricably intertwined with their role identity as research scientists. For academics, participation in commercialisation activity involves the evaluation of the demands of an entrepreneurial role identity that may require them to initiate attempts to reconcile the new role with their existing one as academic scientist. This identity transformation is not an easy task as these specific value-based orientations entail role identity propositions that are generally regarded as appositional. As Merton (1968, p. 273) has observed "the communism [communalism] of the scientific ethos is abstractly incompatible with the definition of 'private property' in capitalist societies." The Mertonian belief in skepticism is in stark contrast with the entrepreneurial norm of optimism, while the scientists' notion of disinterestedness exists at odds with the entrepreneurial ideal of passion for a prescribed outcome. In contrast to the scientific ethos, "the entrepreneurial orientation typically requires an intense single mindedness of effort, a short-term focus, and an emphasis on execution with products and profits representing the key outcomes" (Jain, George, & Maltarich, 2009, pp. 924).

Given these incompatibilities, understanding the kinds of 'identity work' that university scientists engage in when they get involved in commercialisation represents a fertile field for further investigation. Personal and social identity is strongly conditioned by forces and factors that animate human motivation. Drawing on the work of Stephan and Levin (1992), Alice Lam (2010) links personal identity formation with characterizations of the evolving relationship between scientists' value orientations and their commercial engagements and associated personal motivations. She contends that those with traditional beliefs about the separation of science from commerce are more likely to be extrinsically motivated, using commercialization merely as a means to obtain resources in support of their quest for the 'ribbon' (peer recognition and reputation), which constitutes the normative social reward in academic science, and from which other extrinsic rewards may be derived. In contrast, those identifying with entrepreneurial norms tend to be motivated by the pragmatic 'puzzle-solving' (intrinsic satisfaction) features of commercial research as well as being motivated by financial rewards (the so-called 'gold').

Lam (2011) suggests that commercial engagement can be either a 'controlled' or an 'autonomous' activity depending on the degree to which scientists have internalized the values associated with it. When scientists adhere to traditional Mertonian norms of basis science they will perceive commercialisation to be at odds with their personal values and goals, and they likely will be 'a motivated' to engage in this behavior. Nevertheless, some may take part in commercial activity as a result of 'introjection' usually manifested as a desire to secure additional resources in furtherance of their research without having to actually embrace commercial values. Traditional academic scientists can be placed on the extrinsic end of the motivational continuum and may use commercialization as a means to obtain specialised resources in support of their pursuit of the ribbon. At the other end are entrepreneurial scientists who are motivated primarily by the quest for 'gold' and 'puzzle.' Between these polar opposites, are hybrid positions where scientists hold an ambivalent attitude toward science and its relationship with commercialisation. Academic scientists who choose to enter the realm of

commercialisable science, often find themselves torn between the traditional norms or Mertonian ideals of basic science and the reality of an encroaching market ethos. While some may choose to resolve the tension by making choices between these dichotomous alternatives where they choose one and forego the other, others may attempt to reconcile these differences by re-negotiating their roles at the intersection (boundaries) of these two domains.

Early writers in the sociology of science have spoken about the ambivalence of scientists and the frequent deviation of their actual behavior from Mertonian norms and their willingness to explore new social identities in their search of scientific truth. Gieryn (1983) coined the term 'boundary work' to denote the active agency of scientists to continually test norms while drawing and redrawing the boundaries of their work. As a means of protecting their professional autonomy, scientists labour hard to establish the boundary between the production of knowledge and its exploitation. However, the boundary becomes increasingly blurred when scientists seek to secure additional resources and public support for scientific research. According to Lam (2011, p. 1356), "this ambiguity is a source of internal tension, as well as giving scientists much opportunity for choice and variation. The contemporary transformation in the relationship between science and business has brought the sociological ambivalence of science to the forefront and opened up opportunities for individual action."

Drawing on earlier work that attempts to categorize those who engage in science, Lam (2010) uses this framework to identify four types of research scientists. Type I traditional academics are characterized by a strong belief that academia and industry should be distinct and that the appropriate role for academic scientists is to shun commercial modes of engagement and to hold suspicions of those who do so. The type I traditionalist believes in a limited form of engagement with industry, while seeking to maintain their academic role and engage in boundary work characterized as 'boundary separation.' Like type I traditionalists, type II pragmatic academics believe that academia and industry should be distinct, but recognize the need to collaborate with industry in a targeted way. While securing industrial resources in furtherance of their research as well as field placements for graduate students are strong motivators, type II hybrids chose to establish distinct collaborative linkages with industry, protecting their dominant academic identity while experiencing some cognitive dissonance as they attempt to reconcile their roles. Type II pragmatists will accommodate industry and engage in 'boundary testing' behaviors, but remain strongly identified with their academic roles. On the other end of the spectrum are type IV academic entrepreneurs who believe in the fundamental importance of science-business collaboration. These research scientists have fully developed, strong commercial ties with firms, and demonstrate a continuous engagement with commercial activity. These research academics have a fused identity and engage in what Lam (2010) terms 'boundary inclusion' activities. Finally, type III collaborative hybrids believe in the fundamental importance of science-business collaboration but recognize the need to maintain categorical distinctions while negotiating shifting borders. This type of scientist retains a focal academic identity while choosing to pursue commercial opportunities at will, but not all of its associated meanings. For the most part, type III collaborative hybrids will experience lower levels of cognitive dissonance than type II pragmatists and type III collaborators because they have made greater progress in integrating the entrepreneurial role into their academic identity. The type of research that an academic engages may also assist in this transformation, whereby academic scientists doing more applied science may find it easier to negotiate boundaries, while academic scientists doing more basic, theoretical science may have fewer reasons to do so. Academic scientists working in research fields that are closer to the marketplace have more incentives to engage in boundary spanning behaviour than do scientists whose research product has weaker commercial application (Colyvas & Powell, 2006; Mendoza, 2009). Academic scientists that have established strong forms of engagement with private industry may be more likely to pursue research commercialisation in that they are in position to better exploit the social capital they have acquired through these relationships (Perkmann, Tartari, et. al., 2013). Research productivity may also be impacted by how academic scientists set and manage their relationships with industry. Traditional forms of academic productivity remain the peer-reviewed publication, yet those who cross boundaries to engage in research commercialisation also generate patents, sponsored commercial products, and engage in new venture business start-ups. Resources provided by industry can facilitate the direct or indirect production of all forms of academic productivity, increasing the overall size of the research program (Gulbrandsen & Smeby, 2005). Nevertheless, heavy involvement with industry can produce threats to faculty autonomy and independence, including faculty conflicts of interest and commitment (Tartari & Breschi, 2012).

1.1 Research questions

The framework proposed by Lam (2010; 2011) provides an ideal one for investigating the cognitive frames by which academic scientists negotiate the boundaries between academic and commercial science. A hybrid career broadens the opportunities for academics but can also bring new challenges associated with a role transition. Managing the multiple identities associated with a hybrid career is key to the successful development of a career as an academic research scientist. A research agenda can be surfaced which has the following questions requiring further elaboration:

- 1. Can academic scientists be characterized on the basis of research orientation and on the basis of their degree of identification with the traditional values of academic science or with the values of commercial science?
- 2. In what ways is the general research orientation of academic scientists predictive of the relationships, engagements, and experiences they have with private industry?
- 3. How do normative academic and commercial values of academic scientists relate to their research productivity?

2. Methodology

Data for this study was collected by means of an online questionnaire sent to three thousand nine hundred sixty-two (3962) full-time and continuing academic faculty members in Canadian university-based schools of engineering and applied science. The study population included faculty employed at twenty-eight (28) top-ranked, research-oriented institutions with a diverse and rich array of research programs represented. Institutional review board (IRB) approval for the study was secured from the University of Exeter (UK). The questionnaire and letter of introduction was sent to identified faculty members, with five follow-up reminders over a three-week period given to those who did not respond to earlier requests for participation. Data was collected in October 2022. In total, 379 completed questionnaires were returned and constituted the study sample. After subtracting those in the population that were refused, demitted, or returned as undeliverable (88 persons), an effective response rate of 9.8 percent was achieved. Study validity was investigated for generalizability of results by comparing the academic rank of members from the study population (3962 persons) against the reported academic rank of respondents indicating that those holding the designation of assistant professor may be slightly under-represented while those with the rank of full professor may be slightly over-represented in the study sample. Study validity was further investigated by examining differences in key demographic indicators between early and later respondents (assuming that late responders are more like non-responders than early responders to the request for participation), indicating that our study sample contains more individuals who are slightly older and of senior academic rank.

2.1 Study variables

The dependent variable in our analysis is a construct of ten commonly-expressed channels of industry engagement and collaboration. Academic-industry collaborations range from more informal, diffusive relationships with industry (informal networking with industry; involvement with industry advisory boards; and the placement of students with industry) to more formal, prescribed relationships (university-based and industry-sponsored research centers; collaborative research with industry partners; and contract-based research with industry). Subjects were asked to estimate their degree of involvement with each form of academic-industry engagement and university-industry engagement where 1=no involvement to 4=extensive involvement. An industry engagement scale was constructed of these ten channels and produced a Cronbach alpha of .80 for our study sample, indicating an acceptable level of internal reliability for this measure.

2.1.1 Independent variables

We are interested in examining the relationship of individual-level faculty characteristics to academic-industry engagement. We hypothesize that three key academic faculty predictors are associated with the strength and magnitude of faculty engagement with industry: previous faculty employment with private industry, holding an industry-sponsored research chair, and the percentage of total research funds coming from industry sources. To assess faculty-industry experience, subjects were asked about their full-time industry work experience. To assess industry-faculty research support, respondents were asked if they presently hold, or have previously held, an industry-sponsored research chair. To assess their financial involvement with industry, subjects were asked to estimate the percentage of their total research funds presently coming from

industry. The number of graduate students under supervision was a proxy measure for the size of the academic research laboratory.

The type of research being conducted can be characterized using a framework provided by Stokes (1997). A research typology can be produced that characterizes research as a consequence of knowledge creation on the basis of whether it advances theory or if it advances practice. For purpose of distinction, basic research is considered to advance theory but not practice (Bohr's Quadrant). Applied research advances practice but not theory (Edison's Quadrant). User-based research advances both theory as well as practice (Pasteur's Quadrant). Study respondents were asked to allocate 15 points on the basis of how they perceived their program of research according to the categories of 'basic', 'applied', and 'user-based'. It should be noted that these allocations reflect researcher subjective assessments and not any kind of objective determination.

2.1.2 Control variables

Two faculty-level variables were controlled in our analysis: academic rank and gender. Individuals who hold more senior academic rank may be expected to have developed more social capital with industry. They are also more likely to have more research publications and hold more patents derived from their research over the lifetime of their careers. Women are found to be significantly under-represented in senior academic ranks in the applied sciences and, as a consequence, more likely to have had fewer opportunities to develop extensive ties with industry, have fewer life-time publications, and hold fewer patents from their research.

2.2 Data analysis

Data was analyzed and study questions addressed using SPSS (Version 28.0)™. Descriptive statistics show the overall characteristics of the study sample. Study data is displayed according to academic rank (assistant, associate, and full professor), and by gender. Academic scientists can be categorised according their values and attitudes concerning the proper role of academic and commercial science.

3. Results

Table 1 includes the general characteristics of study sample as reported on the basis of faculty rank (assistant, associate, and full professor) and gender. Women make up about 22 percent of the roster of assistant professors but comprise only six percent of full professors. On average, assistant professors report 34 publications and 1.22 patents, while full professors have 160 scientific publications and hold 3.54 patents.

Table 1: General characteristics of Study Respondents[a]

	Assistant Professor	**Associate Professor**	**Full Professor**	**Male**	**Female**
Number of respondents (n)	51	92	231	310	56
Age of respondents (years)	40.2	48.0	57.9	54.3	46.9
Gender (Female)	0.22	0.11	0.06	----	----
Employment status (# respondents)					
Contractual (non-tenure track)	6	2	1	7	1
Non-tenured (tenure track)	43	5	2	33	16
Tenured	2	84	224	265	39
Professional and research achievement					
Professional engineer designation (P.Eng)	0.49	0.78	0.81	0.78	0.63
Industry-sponsored Research Chair holder	0.02	0.07	0.17	0.14	0.05
Research funds coming from industry[b]	0.21	0.37	0.36	0.34	0.34
Full-time industry work experience (years)	4.88	4.67	5.85	5.52	4.50
Graduate students under supervision	6.11	7.53	7.57	7.37	7.75
Weighted Research Orientation[c]					
Basic-research orientation	0.16	0.18	0.17	0.18	0.14
User-based research orientation	0.49	0.50	0.49	0.48	0.52
Applied research orientation	0.35	0.32	0.34	0.34	0.34
Research Productivity					
Total career peer-reviewed publications	33.8	63.1	160.7	130.5	68.1
Total career patents/licenses	1.22	1.99	3.54	3.10	1.39

[a]Numbers may not sum because of missing data
[b]As a proportion of total research funds received
[c]Research orientation as proportional weight (sum to 1.00)

Academic faculty can be characterized on the basis of their declared identity with respect to their alignment with academic versus market (entrepreneurial) values. Drawing on the framework provided by Lam (2010; 2011), it is possible to characterize academic faculty on the basis of four basic identity categories: traditional academic, pragmatic academic hybrid, collaborative academic hybrid, and entrepreneurial academic. Table 2 reports on the research orientations of study respondents.

Table 2: Academic-Industry ideology

Academic Researcher Ideology: Select one that best describes your professional beliefs.	**Frequency**	**Valid Percent**	**Cumulative Percent**
Traditional Academic I believe that academics and industry should be distinct. I pursue success strictly in the academic area.	21	5.6	5.6
Pragmatic Academic Hybrid I believe that academics and industry should be distinct. I pursue industrial links to acquire resources that support my academic research.	75	19.9	25.5
Collaborative Academic Hybrid I believe in the fundamental importance of academic-industry collaboration. I pursue industrial links for scientific advancement.	190	50.6	76.1
Entrepreneurial Academic I believe in the fundamental importance of academic-industry links for application and commercial exploitation.	90	23.9	100.0
Total	376	100.0	100.0

Many academic faculty in the applied sciences have established extensive networks of engagement with private industry. Academic-industry networks reflect industry social capital and enable academics to more easily cross academic-industry boundaries. These linkages provide a basis for understanding how academic faculty are able to more easily assume industry collaborative and entrepreneurial norms that are antithetical to traditional Mertonian academic norms. Academic scientists were asked to identify the strength of their collaborations with ten (10) faculty-industry channels of engagement, indicating a 1=no significant involvement to 4=extensive involvement for each channel of engagement. Table C reports on academic-industry engagement channels.

Table 3: Academic-Industry engagement channels

***Academic Researcher-Industry Engagement Channels*:** Degree of your involvement with industry channel (1=none to 4=extensive)	**Mean**	**Std Dev.**	**Range**
Informal networking with industry	3.01	.85	1 - 4
Industry governing boards or industry advisory committees	2.06	1.04	1 - 4
Industry-sponsored research projects for my students	3.21	.90	1 - 4
Executive and continuing education, industrial training programs	1.83	.98	1 - 4
Collaborative research with industry partners	3.27	.87	1 - 4
University-based research centers and institutes	2.84	1.05	1 - 4
Industrial research parks	1.43	.79	1 - 4
New venture business incubators	1.62	.91	1 - 4
Consulting for industry	2.29	1.04	1 - 4
Contractual research for industry	2.39	1.07	1 - 4
Academic-Industry engagement scale (10-items; alpha=0.80)	2.37	.56	1.00 – 3.91

After categorizing respondents into one of four researcher identities, we can show how researcher ideology relates with respect to associated researcher characteristics, forms of academic-industry engagement, research program orientation, as well as research productivity (scientific publications and research patents). Table 4 reports on the researcher profiles of the four identity/ideology categories.

Table 4: Academic researcher profiles

	Type I Traditional Academic (n=21)	**Type II Pragmatic Academic Hybrid (n=75)**	**Type III Collaborative Academic Hybrid (n=190)**	**Type IV Entrepreneurial Academic (n=90)**
Faculty rank[a]	2.55	2.47	2.45	2.53
Faculty gender (female)	.048	.181	.178	.103
Industry-sponsored research chair	.000	.067	.149	.156
Research funds coming from industry	.066	.279	.376	.367
Years of industry work experience	4.21	4.28	5.43	6.70
Graduate students under supervision	4.45	6.21	8.27	6.97
Faculty-industry engagement scale	1.69	2.18	2.44	2.64
Weighted Research Orientation				
Basic research orientation	.375	.229	.153	.113
Applied research orientation	.143	.290	.337	.423
Research productivity				
Total career peer-review publications	134.7	107.0	123.2	117.2
Total career patents/licenses held	1.35	1.99	2.67	4.20

[a]Assistant professor=1; Associate professor=2; Full professor=3

4. Discussion

With respect to our study questions, we are able to characterize academic scientists on the basis of our four identity categories. Generally speaking, the four profiles are not distinguished by either faculty rank or faculty gender. The first two identity categories (traditional and pragmatic hybrid) maintain the insolubility of academic and commercial norms. Type I traditional academics report the lowest level of industry experience and receive less than seven percent of their research funds from industry sources. Compared with other academic scientists, they have developed the weakest faculty-industry collaborations. Examining their overall research orientation, traditional academics are more likely to characterize their research as theoretical and less likely to engage in applied research. Compared with their colleagues, these academics have highly productive research programs inasmuch as they have more peer-reviewed research publications, congruent with the traditional reward system (the ribbon) offered in the academy. Consistent with their focus on basic research, type I traditional academics report holding the fewest number of research-based patents and licenses.

Pragmatic academic hybrids identify more strongly with academic values, but engage with industry in an instrumental fashion, in part to acquire the financial and material resources that aid in their research. While faculty in this category report low levels of industry work experience, they receive almost 28 percent of their research funds from industry sources, a four-fold increase over traditional academic researchers. Type II pragmatic hybrids have larger research programs than traditional academics, as measured by the number of research students under their supervision. By diversifying the base of the research funding to include industrial sources, research scientists may be able to expand their program of research. The general research orientation of pragmatic academic hybrids is characterized as less basic but is more applied than traditional academics. While the number of scientific publications of pragmatic academic hybrids is less than traditional academics, pragmatic hybrids hold more commercial patents/licenses.

The last two identity categories (collaborative academic hybrid and entrepreneurial academic) speak about the integration of academic and commercial research norms. Our largest category is the collaborative academic hybrid where academics report high faculty-industry engagement scores. Compared with other categories, type III collaborative academic hybrids receive the largest proportion of their research funds from industrial sources and report having the largest overall research programs (as measured by the number of graduate students under supervision). Collaborative hybrid academics also report having more industry experience, while about 15 percent report holding or have held an industry-sponsored research chair. They also report holding more commercial patents and licenses than either the traditional or pragmatic academics.

Our fourth researcher identity profile is labelled the entrepreneurial academic and comprises about 24 percent of our sample population. Academic entrepreneurs are able to cross the academic-industry boundary with

considerable ease. Lam (2011) contends academics in this category will demonstrate the least amount of cognitive dissonance as they have been able to successfully resolve the value-based conflicts inherent in academic and commercial science while crafting a new research identity. Faculty who characterize themselves as falling into this category are much more likely to be male, have extensive work experience in industry, and have acquired the greatest amount of industry social capital as measured by their overall strength and diversity of faculty-industry engagements. Not surprisingly, they are least likely to engage in basic or theoretical research and much more likely to characterize their research as applied. Compared with faculty in any other identify category, academic entrepreneurs hold the greatest number of career patents and licenses.

4.1 Limitations

The results reported in this study are somewhat exploratory in nature. There are a number of limitations that require further investigation. Data collected are from full-time, continuing academics employed in schools of engineering and applied sciences in Canadian research-based universities. Findings may not be generalizable to other jurisdictions or to post-secondary settings where research is of lesser importance. Second, the study suffers from mono-method bias in which respondents report on their own perceptions (Doty & Glick, 1998). Single respondent bias limits our ability to validate findings because of the potential of self-serving bias. Third, our identity categories were created through a single-item forced choice method which may be an entirely inadequate way of capturing more complex notions of research ideology and identity. It is also important to be aware of the difference between what respondents say they believe (what they espouse) and what subjects actually do (what they enact). By using categorical distinctions, there is a loss of statistical power. Indeed, a second choice was asked of respondents which when combined with their first choice would allow for the construction of a non-categorical, continuous variable. However, this data was not reported in this paper because of the ease and simplicity of using categorical distinctions as a means of exploring the concepts of ideology and identity would be lost. Finally, our operationalization of academic-industry engagement and its scale construction is somewhat problematic. There are many ways (channels) by which academic faculty can and do engage with industry with no universal agreement about what channels represent true industry engagement and which channels are more ornamental. A benefit of our measure is that it attempts to assess engagement embeddedness capturing not only the many forms of engagement but also measures the degree of strength of each engagement channel. Further exploration should be conducted to identify which specific channels of industry engagement are associated with academic research scientists' attitudes and beliefs with respect to the appropriate relationship between academic science and commercial science, and between the academy and business.

4.2 Conclusion

This study has provided evidence that academic researchers in the applied sciences can be differentiated on the basis of their research ideology and identity. Using a framework developed by Lam (2010; 2011), our sample of academic faculty employed in schools of engineering and applied sciences in Canadian research-based universities can be categorized as type I traditional academics who strictly pursue academic science while eschewing commercial engagements; type II pragmatic academics who choose to follow traditional norms of Mertonian science while engaging with industry to acquire additional resources in the pursuit of academic science; type III collaborative academic hybrids who believe in the association of academic and commercial science for the benefit of society; and type IV academic entrepreneurs who believe in the fundamental importance of academic-industry links for application and commercial exploitation. This framework provides a useful way of distinguishing academic research scientists on the basis of their industry engagements and associations, the size and orientation of their program of research, as well as their level of productivity as academic scientists (peer-reviewed publications) and as commercial scientists (patents/licenses held).

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