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A CONDITIONAL PROCESS ANALYSIS OF BOUNDARY SPANNING FUNCTIONS IN US RESEARCH UNIVERSITIES

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A CONDITIONAL PROCESS ANALYSIS OF BOUNDARY SPANNING FUNCTIONS IN US RESEARCH UNIVERSITIES

A DISSERTATION APPROVED FOR THE GRADUATE COLLEGE

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For Tia.

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Abstract

I sought to establish whether boundary-spanning offices in US Universities are effectively aligned with institutional strategy. I further sought to move beyond the focus on valorization activity that is typical of US researchers studying interactions in the *triple helix* by focusing on the uniquely US enterprise of philanthropic corporate relations. Finally, I also sought to better align US-based university business cooperation research to contemporary global approaches, specifically in the European Union and Australia, while also challenging those perspectives through the introduction of conditional process analysis approaches. To this end, using Galán-Muros and Davey's (2017) University Business Cooperation (UBC) Ecosystem Framework (framework) and data from 174 universities, I explored the relationships between Carnegie Classification of Institutions of Higher Education (classification), National Science Foundation Higher Education Research and Development reported expenditures (R&D), and Corporate Voluntary Support of Education (philanthropy) as moderated by variability in office type. Recognizing that the relationship between classification and philanthropy is underexplored and likely indirect, I further examined the mediating mechanisms through which institutional capacity (i.e., its ability to conduct its mission) is derived. Study results, based in ordinary least squares (OLS) regression analyses and bootstrapped estimates, were consistent with the hypothesized conceptual scheme of mediation, in that R&D and philanthropy were found to have an indirect effect on classification and future philanthropic returns. However, results also suggest that prevailing approaches to corporate relations have no measureable effect on financial returns when controlling for classification. These findings broaden the focus

on UBC research theory by incorporation of prevailing organization theory, establishing a temporal relationship among elements of the UBC ecosystem, and establishing a basis for converging functions, refocusing boundary-spanning offices toward more accurately aligned outcomes.

Chapter 1: Overview of the Study

Background

Contemporary US universities face dwindling resources, significant scrutiny regarding operational and academic performance, and increased demand for economic impact and alignment. These pressures are further heightened by the normalization of institutional rankings, whose indicators arguably underrepresent academic "distance traveled" and provide misleading appraisals of quality by focusing on research outputs and peer assessment scores. Competition for students and resources is intense, putting strain on traditional budget and organizational approaches, while the pursuit of the ever-moving "quality" target perverts expectations and creates inefficient allocation of resources (Bowen, 1980; Armstrong, 2014) through systematic organizational mimicry of elite institutions, sometimes called isomorphism (DiMaggio & Powell, 1983; Huisman, 1998; Huisman & Morphew, 1998; Neave, 1979; Morphew & Jenniskens, 1999; Morphew, 2002).

The prevalence of classification and rankings systems, while inevitable (Altbach, 2013), encourages institutions to make decisions intended to maintain relative position or influence ascension to the next classification. This is a behavior known as striving. While there is not an accepted instrument to accurately determine intent to strive, it is widely accepted that the majority of (primarily research) institutions are striving. As both consumers and marketers of their relative reputational capital (Ressler & Abrattt, 2009), institutions allocate human, financial, and physical resources in response to classification constructs (Bowen, 1980; Lombardi, 2013). Namely, they shape themselves organizationally and operationally to absorb many internal (human)

and external (funding) resources as due their stature in an attempt to increase their stature.

There is a cost of prestige (Morpher & Baker, 2004), and as long as resources are reliably tied to reputation (Volkwein & Switzer, 2006, Bastedo & Bowman, 2011), the vast majority of universities will never have the research affluence to establish the prestige that comes with age, location, and a fortunate circumstance. Yet, rather than focus efforts around exploiting existing factor endowments and exploring innovative collaborations through their roles as anchor institutions in local, regional, and national economies (Lester, 2005; Hodges & Dubb, 2012; Birch, Perry, & Taylor, 2013; Lane & Johnstone, 2012; Perry, Wiewel, & Menendez, 2009), institutional leaders striving for reputation strategically shift to mirror the goals and approaches of the elites. This may be due to the influence of modern boards of directors (trustees, regents, etc.) that are often staffed with interested business partners as a mechanism of cooptation (Aldrich & Herker, 1977). It might also be a result of the influence of external professional organizations bent on professionalizing fields in higher education through best practices, comparative metric development, and self-preservation (Metcalfe, 2004). There are likely influences from leader development pipelines as well, constrained by traditional pathways and driven by the elite institutions, which result in an innate desire to replicate the prestige a leader knows (Morphew & Swanson, 2011).

Given the way rankings and classifications are derived, striving behavior often results in increased administrative costs (Leslie & Rhoades, 1995; Morphew & Baker, 2004) both operationally (R&D funding, non-faculty R&D staff, and increased doctoral degrees) or organizationally (development of new professional offices) to influence

reputation and to pursue seemingly unrelated revenue sources (often royalties and philanthropy) to recover costs related to research (Morphew & Baker, 2004). This, of course, leads to budgetary challenges for institutions, since research is a money-losing enterprise for most, if not all, universities (Armstrong, 2014, NSF, 2018). To address these deficits, administrators again turn to the elites to mimic how they might cost shift and recover losses while still bolstering prestige. Among the many mechanisms employed by elite institutions, few of whom have made any substantial cost recovery, are the implementation of boundary-spanning functions (Tornatzky, Wuagmann, & Gray, 2002), including technology transfer offices to commercialize intellectual property and corporate and foundation relations offices to pursue research and philanthropic support. Boundary-spanning functions, as explored in detail later in this dissertation, denote people and organizational functions whose role is to regularly traverse organizational social boundaries (both internal and external) for the purpose of knowledge transfer with a particular goal of increasing absorptive capacity across all parties (Tushman, 1977; Cohen & Levinthal, 1990).

Resource recovery via new "administrative lattice" (Zemsky & Massey, 1990) is often deemed by researchers, practitioners, and intermediary organizations (Metcalfe, 2010) as the new role of universities as institutional anchors (Lester, 2005; Hodges & Dubb, 2012; Birch et al., 2013; Lane & Johnson, 2012; Perry et al., 2009) in a modern economy, putting higher education on par with industry and government. Etzkowitz and Leyesdorff first deemed this new mode of university-industry-government interaction as the Triple Helix of Higher Education in 1997, with a particular focus on the creation of new industries through innovation. Their argument is simple: as

universities become more essential to social and economic mobility, community and cultural development, and regional resilience, they are conceivably playing a growing and outsized role in economic growth. When combined with dwindling funding streams, this requires universities to develop and enhance relationships with industry partners, create new industries, and bolster employment outcomes for students. The problem is that most administrators aren't looking at these boundary functions as essential to creating impact. They are looking to them to enhance prestige via some substantial gift from a major industry partner that says the Fortune 100 cares about (insert university name here) or via the silver bullet of the next Gatorade or Google.

Data from the Association of University Technology Managers (AUTM) suggest that a mere 5% of universities produce a net profit from their licensing operations (AUTM, 2015), a number that has held steady for more than a decade. However, those few institutions that have licensed "unicorn" intellectual property or announced a multimillion-dollar gift, receive a superficial windfall of royalties, increased department and faculty recognition, and resulting prestige impacts. Aspiring universities have followed suit organizationally, if only to reserve the right to get lucky, and have created technology transfer offices (TTOs) and pressured corporate relations offices in an attempt to position themselves for pending prestige jackpots.

Indeed, globally, significant work has been done to assess the nature of university-business cooperation (UBC). This increased assessment of boundary-spanning organizations towards UBC (Etzkowitz & Leyesdorff, 1997, 2000; Gibbons, Gibbons, Limoges, Nowotny, Schwartzman, Scott, & Trow, 1994; Parker & Crona, 2012), is evidenced by the significant increase in university-industry related

publications over the last 30 years (Davey, 2017; Perkmann et al., 2012; Skute, Zalewska-Kurek, Hatak, & de Weerd-Nederhof, 2017). The growth in UBC publication activity, however, has some notable vacancies and deficiencies, particularly in a US context. Primarily, research related to UBC is more often than not focused on technology commercialization (Perkmann, Tartari, McKelvey, Autio, Broström, D'Este, Fini, Geuna, Grimaldi, Hughes, Krabel, Kitson, Llerena, Lissoni, Salter, & Sobrero, 2012) at research universities. This seems to assume, by default, that the only meaningful interactions in the *triple helix* are those that involve research universities, and only when those universities have substantial intellectual property. By default, then, the *triple helix* is only for elite universities with substantial research funding.

Emerging UBC research suggests this premise is inaccurate, however, as university and business are significantly more intertwined in an ecosystem of interactions (Galán-Muros & Davey, 2017). This research better defines the context for UBC activity in the *triple helix* and establishes a mechanism to study the relationships between university facilitating mechanisms, the barriers and drivers of UBC, and the eventual outcomes of the resulting relationships. However, this nascent framework is built off of previous UBC research, meaning there is little focus on boundary organizations beyond TTOs, little focus on the relationship of UBC and institutional reputation, and no focus on the uniquely US context of philanthropy in relation to UBC. This means that other lesser-studied boundary organizations, most of which are consequences of university striving behavior, have not been empirically connected to the *triple helix*. There are few, if any, academic studies that assess the role, outcomes, or strategic efficacy of real estate offices (REO), research parks (RPs), careers offices

(COs), government relations offices (GRO), economic development offices (EcDev), corporate relations offices (CRO), or any significant convergence of the above. Yet, like technology transfer organizations, each of these understudied offices is also responsible for building reputation and maximizing institutional resources, even if their specific performance metrics are likely considerably different from each other.

Important to the US concept of UBC are ideas related to corporate philanthropy and the mechanism by which relationships are facilitated with business. CROs are an emerging and important element both in the *triple helix* and in relation to university prestige seeking. This is evidenced by the substantial growth of the Network of Academic Corporate Relations Officers (NACRO), which has grown from fewer than 100 members representing 20 universities in 2007 to well over 500 members from nearly 230 institutions in 2017 (NACRO, 2018), all focused on developing CROs to optimally interface with industry. Despite this growth, there is a dearth of peer-reviewed publications related to CROs. In a master's thesis, McCoy (2011) provides a typology of US CROs, highlighting variations of 3 core types (Philanthropic, Industry [research], and Hybrid) while recognizing both that all higher education institutions maintain an unmanageable decentralized approach and that the Hybrid approach is nascent and not optimally converged. This is helpful in exploring the evolution of such offices in the *triple helix,* but does not provide empirical evidence related to performance or efficacy.

McCoy (2011) also establishes that a majority of CROs have some corporate philanthropic focus, a fact affirmed by NACRO where nearly 90% of members report some fundraising responsibility. Yet data from the Center for the Advancement and

Support of Education (CASE) suggest that the amount of corporate philanthropy gleaned from university fundraising endeavors pales in comparison to the lost expense of running the research enterprise. Conservatively, research universities accounted for 25% of total R&D outlay in 2016 ($14.9b) and sourced $2.9b in corporate philanthropic support, of which only 21% was directed towards research and likely didn't carry any overhead recovery monies. This seems to bring in to question whether CROs are an efficient and effective use of institutional resources in their current iteration.

Accordingly, this study is designed to explore the relationship of corporate philanthropy with institutional classification, R&D expenditures, and organizational approaches towards UBC. I propose that, as with other allocations intended to drive resources and reputation, contemporary CROs are inherently inefficient due to their misalignment with institutional objectives. Even among UBC studies published to date, I find little research exploring the allocative efficiency of boundary-spanning offices in the literature, as most are focused on direct outcomes (such as license revenues) or the circumstances related to increased or decreased UBC activity (Galán-Muros & Davey, 2017; Plewa, Korff, Baaken, & Macpherson, 2013; Bruneel, D'Este, & Salter, 2010).

Should universities invest haphazardly in boundary-spanning organizations? Perhaps not. Perhaps a more thoughtful, institution specific approach would bolster outcomes. Perhaps a convergence of organizations, combined with more aligned measures of success tied to reputation building, institutional efficiency, and resource development, would best position universities to fulfill their role as institutional anchors (Lester, 2005; Hodges & Dubb, 2012; Birch et al., 2013; Lane & Johnson, 2012; Perry et al., 2009), and collaborative partners in the *triple helix*.

Thus, the purpose of this paper is to determine if CROs, as a proxy for boundary-spanning offices, are an efficient and efficacious investment when considered as a part of the UBC ecosystem. By uniting a foundation of research related to university prestige-seeking behavior with a foundation of UBC research, and then applying organizational and philanthropic contexts unique to the US, it is possible to understand how each of these elements interrelate to assess the "organizational behavior that accompanies aspiration" (Morphew & Baker, 2002, p. 382). Such an assessment requires the use of conditional process analysis to account for the numerous boundary conditions (those unique variables that exist between interacting entities) in a UBC ecosystem, thus a secondary purpose of this paper is to advance an assessment tool for use in UBC research.

Accordingly, this study poses the following hypotheses:

1. After accounting for covariation, research and development resource flows will have a significant indirect effect on the positive relationship between classification and philanthropic resource flows from industry.
2. Taken together, the comprehensive conditional indirect effects are sequentially dependent. (This is based on Hayes' mediation and moderation model of how we look at interactions, as explored later in Chapter 3.)
3. After accounting for covariation, the presence of a corporate relations office, regardless of type, will have a positive moderating effect of a) classification on research and development resource flows, b) research and development resource flows on philanthropic resource flows from industry, and c) classification on philanthropic resource flows from industry.

Significance of the Study

This study makes several contributions to the literature of higher education and UBC research. First, it contributes by expanding and refining the existing UBC ecosystem model. It does this by addressing US research institution activity in the *triple helix* beyond knowledge transfer activity, while also linking US UBC to non-US UBC research by leveraging the UBC ecosystem framework, normalizing terms (i.e. knowledge transfer equals commercialization equals technology transfer equals valorization), and introducing philanthropy into the framework. This allows for future international comparative studies, filling an identified vacancy in the literature (Perkmann et al., 2013).

Second, it establishes a model to evaluate combined interactions within the UBC ecosystem model using mediation, moderation, and conditional process analysis. The use of conditional process analysis, a modern form of multivariate behavioral research, is a key contribution of this study because it provides a mechanism to account for all of the possible conditions that might influence various UBC activities (conditional effects) while accounting for temporal causality. This study specifically examines the relationship between classification (context), CRO (structure), R&D expenditures (circumstance), and corporate philanthropy (process). However, future studies might easily replace some or all of those to assess conditional effects (the term "assess conditional effects" here meaning exploring all potential indirect and direct effects of a group of variables within a given process, often called mediating or moderating effects). For example, one might simply replace the proxy for boundary spanning in this study with technology transfer offices, careers offices, research engagement offices, economic

development offices, and so on. Validation of conditional process analysis using the UBC ecosystem allows for any combination of variations, presenting numerous potential avenues for new relatable research.

Finally, this study provides an important practical foundation for establishing more accurately aligned metrics and incentives for CROs, and by extension, other boundary-spanning functions. This allows for potential future organizational constructs that might include converging organizational functions with an onus towards greater resource efficiency, innovation, and strategic institutional support. This foundation also allows for existing organizations, particularly CROs, to draw from an empirical study to assess whether current objectives are valid and to identify the conditions affecting their particular UBC ecosystem and processes.

Limitations and Delimitations

This study uses the Carnegie Classification for Institutions of Higher Education (CCIHE) as a primary source of data. However, CCIHE, by application is a point in time assessment that classifies using Principal Components Analysis to reduce total assessment factors and then maps those results across two indices to determine the final classification. The process is both not replicable and limited in its analysis due to the factor reduction process, making the identification of institutional behavior over time a significant challenge. For the purposes of this study, then, striving is identified as only those institutions that successfully advanced to the next classification and non-strivers as those institutions that dropped classifications.

Similarly, because this study focuses primarily on the effects of R&D expenditures as a mediating variable, other CCIHE influencing variables were not considered for

mediation exclusively. It is logical, however, to consider R&D expenditures as a proxy for the other load factors. Both the addition of non-faculty R&D staff and the conferring of additional PhDs across multiple subject areas are highly related to R&D expenditures, as both increase research capacity from a human resource standpoint. Additional variables identified in the UBC ecosystem framework, such as institutional strategies, policies, or characteristics (to name a few) that may have covariance or colinearity effects are impossible to accurately account for across significant numbers of institutions. As such, it is possible that not controlling for such effects is a limitation of this study.

Office typology is another limitation due to the lack of consistent data. While a schema for identifying offices types has been established for this study, it is clear from the NACRO survey data that there are challenges among practitioners in normalizing this typology consistently. Additionally, I find this study limited by the lack of data related to the provision of total resources to boundary-spanning functions, both in real numbers of people and funding towards such activities. As these data are not available, it is possible that an office is more or less effective than perceived in this study.

Finally, from an economic value relationship perspective, this is not a study that deploys production efficiency techniques, such as technical, price (or allocative), or overall economic efficiency techniques typically used by economists. Carlos Solerno (2002) produced an excellent dissertation studying the allocative efficiency of research-intensive universities, specifically exploring academic labor inputs (faculty and graduate students) and the efficient production of education and research. However, there exist few other economic and education literature of note that might inform this

study appropriately. When combined with the nascence and diversity of the UBC research, leveraging such techniques may enable increased robustness, but would likely be premature. For example, the lack of clearly defined and aligned outputs across the system would render such a study indefensible, narrow the statistical relevance, or be mathematically inaccurate at best. However, economic efficiency approaches should be considered in future studies as UBC research matures.

Chapter 2: Review of the Literature

Introduction

According to university administrators, researchers, and business leaders, trust is the most important antecedent to meaningful university business collaboration (Davey, Baaken, Galán-Muros, & Meerman, 2011). In fact, a recent study commissioned by the OECD covering 17,000 respondents and 33 countries across Europe found that commercialization of intellectual property was the least valuable interaction between universities and business (ibid). Yet, UBC studies in the US tend to focus primarily on outcomes of knowledge transfer via commercialization and monetization avenues (Davey, 2017; Perkmann et al., 2013). In research and in practice, there is significant strain between these ideas of *trust* and *transaction* for US research institutions. To fully explore the nature of university business cooperation in the US context, then, these are important contextual elements that must be wedded in an accepted framework for UBC research. Therefore, this literature review coalesces three key conceptual premises.

The first, generally derived from the *triple helix* of higher education because of its prevalence in US UBC research, is the recently advanced UBC Ecosystem Framework offered by Galán-Muros and Davey (2017). For simplicity I refer to this as the Framework throughout this document. I explore the Framework in some detail, intending to establish the boundaries of this study and to indicate how a more comprehensive *conditional process analysis* might avail more meaningful interpretations of reality when using the Framework as a guide. As noted previously, conditional process analysis is a common approach to assessing how a combination of elements work together to influence the relationship between an independent and

dependent variable (Hayes, 2018). While more typical in psychological statistics, the methodology has been used in organizational studies, including higher education, to explore leadership, innovation, performance, and reputation. This study advances such a model in an effort to establish a better understanding of the comprehensive effects of all identifiable organizational conditions on UBC.

Second, building off of substantial higher education organizational research, is the idea of prestige and its prevalence for US institutional behavior. Here, I look to relate an important missing component related to US UBC discussing two key theories in relation to the UBC Ecosystem. These include *institutional theory*, whereby universities tend to mimic the elite universities (isomorphism) in their quest for prestige, and *dependence theory*, the idea that the acquisition of resources is essential in the quest for prestige. These are important concepts in that they show a set of behaviors that are antithetical to the prevailing and tangled conceptual frameworks (Davey, 2017) related to the university's "new" perceived position of prominence in the knowledge economy.

Finally, throughout this review, I explore corporate relations offices as a consequential US organizational construct that stems from the pursuit of prestige. While there is little literature regarding these offices, the majority of them have foundations in the philanthropic mission of university administration and a significant number also support a dual mission related to the research enterprise. Contextually, these offices are an important aspect of US higher education, primarily because their philanthropic historical origin is a major difference between US and non-US institutions. I intend in this study for these offices to serve as a proxy for other more

typical *boundary-spanning functions*; however, it is important to note that such offices are rarely found outside of the US. Thus, they are missing from the prevailing literature and simultaneously tend to serve as a barrier to receptiveness of non-US UBC empirical data. Why not focus on commercialization offices instead? Primarily, I find little evidence that such offices are focused on the multifaceted relationships presented in the OECD study and therefore fail to fully contextualize US UBC. Not all UBC in the *triple helix* occurs via commercialization interfaces and ignoring that fact understates the complexity of university-to-business interactions.

The goal, therefore, is to contextualize US UBC within the ecosystem construct advanced by Galán-Muros and Davey (2017), such that US institutions might avail themselves to more global findings in this space. In so doing, the Framework's applicability is therefore extended *and* a new methodology is introduced to explore more complex conditional processes.

Triple Helix Theory

Etzkowitz and Leyesdorff describe "university–industry–government relations in terms of three interlocking dynamics: *institutional transformations*, *evolutionary mechanisms*, and *the new position of the university*" (2000, p. 114). In doing so, they provide a theoretical innovation by redefining roles in an innovation system (Etzkowitz & Leyesdorff, 2000), elevating the role of the university and reducing the role of government to establish equal importance of impact across all three stakeholders.

As shown in Figure 1, the three organizational elements of university, industry, and government maintain equal roles and those roles overlap creating areas of interdependence wherein varied organizational dynamics are at play for each entity in

the system (political, economic, social, technological, legal, and environmental) (Etzkowitz & Leyesdorff, 2000). These interactive dynamics create the circumstances by which interaction occurs, or does not occur, depending on the conditions at hand. What looks like a simple Venn diagram is actually designed to conceptualize a substantial shift away from government-driven interactions to a more equal contributory framework. This diagram is both a simplification and a foundation for substantially more complex theoretical perspectives developed by numerous scholars not covered in this review. Davey (2017) does an excellent job of reviewing these conceptual frameworks. However, the intent for the current study is to explore the interlocking spaces among the actors, particularly that of university and industry as it is influenced by prestige and R&D expenditures.

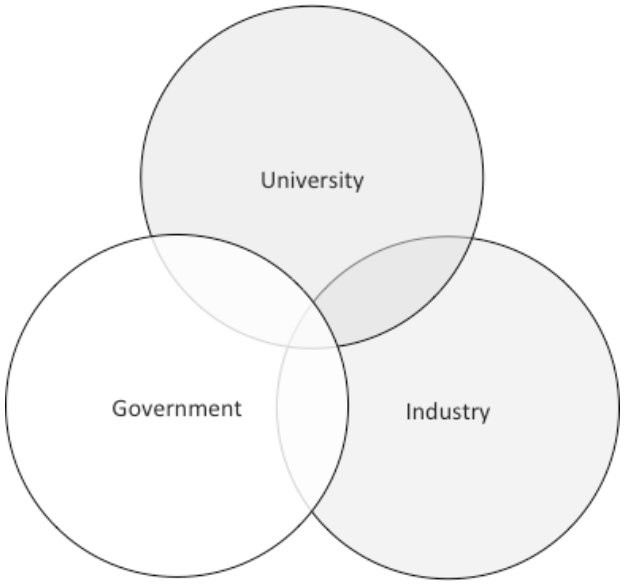


Figure 1 - Triple Helix of University-Industry-Government
(Etzkowitz & Leyesdorff, 2000, p. 111)

For universities adjusting to increased prominence, this requires purposeful and comprehensive responses, including the development of, or repurposing of, organizational mechanisms such as CROs, government relations, technology transfer, career services, economic development, and others to support these interactions. The "area of focus" for this study is the intersection of university and industry with particular focus on UBC via CROs, though dismissing interactions at the center of the diagram (core intersections) would be a mistake, since the majority of R&D support still comes from the federal government. It is in this space where corporate relations offices exist and must evolve in the effort to facilitate broader multi-structural and multifunctional interactions. Unfortunately, there has not been a significant transformation or evolution of these mechanisms at most institutions (McCoy, 2011).

The simpler point here is that universities, industry, and government have been repositioned to more equally contribute to modern knowledge economies. Sometimes this means that the university starts to do things that industry is known for doing, such as start new endeavors. Sometimes this means that industry might undertake activities universities typically do, such as create educational programs. Sometimes this means that government intervenes in new ways as well, such as fostering public private partnerships for the development of new technological programs or making non-standard investments in infrastructure. The *triple helix* model suggests that these "new" roles are essential, interdependent, and situational (Etzkowitz & Leyesdorff, 1996; 2000).

While somewhat symbolic, the theoretical frame of reference does provide a strong visual context, and this study explores one situational set of interactions amidst a

broader ecosystem without dismissing the existence of additional subdynamics. This, in effect, was one of the primary goals of Leyesdorff and Etzkowitz in developing the model. Another goal, accomplished herein, is the use of the model to critique "situations in which the various dynamics are 'locked-in' into co-evolutions of insufficient complexity" (2001, p.20). In this case, the examination explores the effectiveness of CROs, many of which have shown little transformation to becoming an *evolutionary mechanism* for the new position of the university. I argue that they are essential to the *new position of the university* in that, as institutions face continued retrenchment (Alpert, 1985; Pfeffer & Salancik, 2003), pressure to leverage relationships with industry and government will only increase and institutions will have to actively manage them. Understanding organizational effectiveness and efficiency among the spheres of university and industry can thereby help generate alternative strategies, including convergence and collective focus (Etzkowitz & Leyesdorff, 2000).

While *triple helix* theory has become seminal to numerous research and practical applications across the globe, it is not exempt from critique. Several researchers suggest that *triple helix* fails to account for the complexities of innovation systems due to its simplifications of the actors and associated interactions (Davey, 2017; Morgan, 2016). Such simplicity lacks consistency and often fails to challenge researchers to look beyond linear and univariate methodological approaches, meaning that explanations of institutional interdependence within the *triple helix* are often understated. Or as Morgan suggests, "empirical evidence that triple helix interactions are effective at producing desired outcomes is missing from the literature, leading to charges that it is an unproven theoretical proposition" (2016, p. 107).

Perhaps one point too often undervalued is the idea that there are numerous mechanisms by which universities and business interact. Notably, however, the *triple helix* model was established on a premise that universities now must move innovations into the knowledge ecosystem via entrepreneurial endeavors if they are to have any real impact. This has led to most US-related research in this realm to glorify technology transfer offices and to neglect the impact of *institutional transformation* on the other industry- or government-facing functions of a university (Goldstein & Renault, 2004; Smith, 2007; Davey, 2015; Galán-Muros & Davey, 2017). As a result, there are few studies related to the other evolutions and, in the US in particular, a lack of adoption of research that explores UBC more broadly.

Further complicating this are data from AUTM, the professional organization for university practitioners in the technology commercialization space. These data show that less than 5% of technology transfer offices (TTO) are profitable and a mere 15 institutions have produced nearly 70% of US license income since the 1980 Bayh-Dole Act that allowed universities to own intellectual property developed at their institution (AUTM, 2015). Thus, researchers and practitioners attempting to leverage the *triple helix* model are constrained to a handful of the most prestigious institutions to make their arguments (Rodrigues & Melo, 2013; Morgan, 2016). Therefore, studies may not be applicable to all variety of institutions and may not accurately capture interactions that may occur at multiple levels (local, regional, national, etc.) or across multiple conditions (Leyesdorff & Etzkowitz, 2001; Hayes, 2013).

Goldstein and Renault support this contention, finding that "mechanisms by which university R&D activity stimulates economic development are much broader and

diverse than just patenting and licensing activity" (2004, p.744). Smith (2007) suggests that *triple helix* likely overvalues higher education's contribution, additionally offering that assigning universities an elevated and substantial role in innovation economies cannot be done without accounting for political (and likely industrial) pressures. Minimizing political pressures also implies that the *triple helix* disregards conflict among the stakeholders (Morgan, 2016), yet it is a primary purpose of boundary-spanning objects or organizations like TTOs and CROs to manage numerous conflicts and barriers between institutions. The bottom line is that *triple helix* researchers, and many who study UBC, tend to focus on commercialization above other university-industry-government interactions, and in so doing, they ignore the many ways in which a university works with business and government. Perhaps Smith (2007) is inaccurate, but there are no multivariate empirical studies that account for all conditions in the literature to accurately argue otherwise.

I argue that contemporary efforts to glorify innovation successes using the *triple helix* are also a consequence of prestige-seeking behavior, based on the notion that such behavior spurs investment in research and a culture of scholarship above all else (Finnegan & Gamson, 1996). These glorifications enforce inefficient resource allocation in response to increased R&D expense, as very few institutions recover expenses from license revenue (AUTM, 2015), most have minimal meaningful effect on resource acquisition (i.e., they lead to limited new external investments in the institution), and univariate studies attempt to avoid the complexities of the ecosystem. Further, the focus on elite institutions only promotes isomorphic behavior of non-elite

institutions while simultaneously adding administrative functions and cost (Morphew & Baker 2004).

This is not an argument against the *triple helix*, as the ecosystem is indeed complex (Morgan, 2016; Galán-Muros & Davey, 2017). Researchers need a guide; they must look beyond commercialization as the lone *institutional transformation* or *evolutionary mechanism*, and need to explore complex interactions in context. The simple Venn diagram of the *triple helix* model does not encourage more complex research methodologies. A more comprehensive framework to guide researchers regarding the intersections and conditions of organizational actors within, and meaningful outcomes from, the *triple helix* ecosystem is necessary.

The UBC Ecosystem Framework

The literature lacked an integrative scaffold until Galán-Muros and Davey developed the Framework (2017) to normalize UBC research in the *triple helix*. In so doing, they both "address the absence of a common framework for researchers, managers and policymakers that describe in an inclusive way all the elements involved in UBC" (ibid, p. 2) and simplify "the high level of complexity of UBC providing a common understanding of how UBC works" (ibid, p. 2) within the *triple helix*. As shown in Figure 2, the current instance of the Framework coalesces literature from multiple fields to define four distinct "macro" elements: UBC context, UBC circumstances, UBC supporting mechanisms, and UBC process. These comprehensively reflect the interactive space identified as the "ecosystem" in the *triple helix* diagram above, within with CROs exist and where universities engage with industry (primarily). Contextually, these Framework elements are specific to higher

education institutions, developed to guide practitioners and investigators toward more productive UBC outcomes based on robust UBC literature.

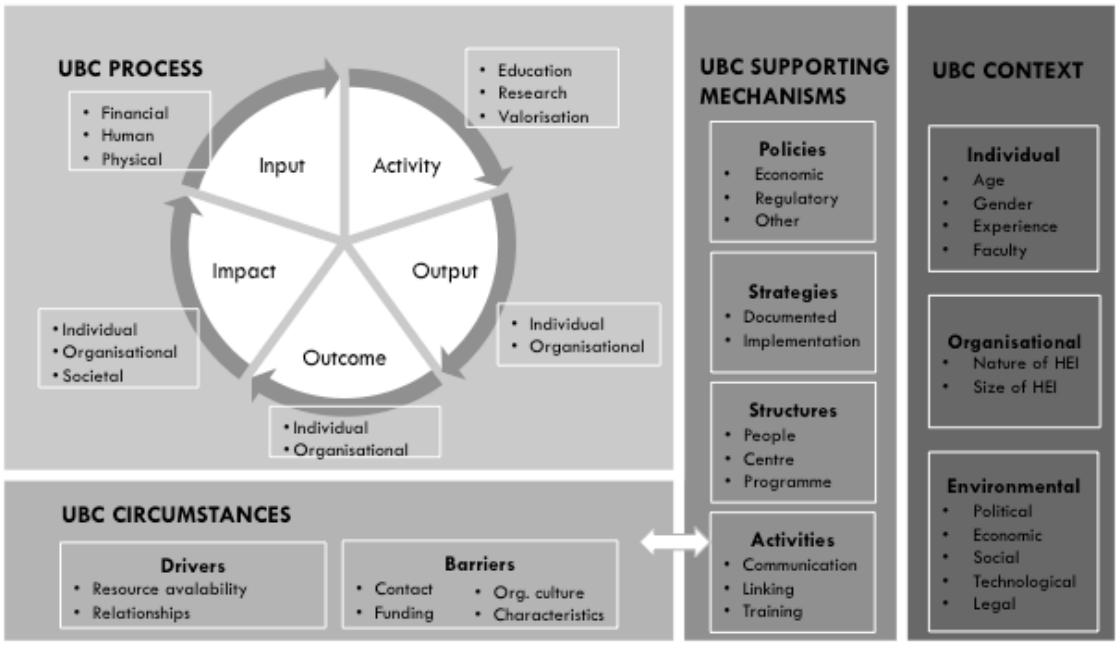


Figure 2 - UBC Ecosystem Framework (as provided by Galán-Muros & Davey, 2017)

As intended, this review leverages the Framework to define the boundaries of research for this paper and demonstrates how a multivariate approach, particularly conditional process analysis methods, can be used to assess interactions within the ecosystem. Additionally, this review integrates literature from other fields, particularly higher education organizational scholarship, as a function of contextualizing the Framework for use in US research universities. To do this, I first review the UBC *context* elements. I then work inwards by reviewing *supporting mechanisms*, relating those to institutional theory and US situations. A review of *circumstances* is then explored with a particular focus on resource dependence theory. UBC *process* rounds out the review and includes some additionally integrated elements that increase the range of the Framework. While conditional process analysis is not covered robustly in this chapter, the methodology is reviewed in depth in Chapter 3 and is foundational to

this study. Accordingly, this review also looks to map potential mediating and moderating effects, establish causal contexts, and establish directionality of influence.

Context in the Framework leverages extensive UBC literature review work from Perkmann et al. (2013) to determine the most inflexible factors in the ecosystem. These factors, on their own and in combination, are seemingly less susceptible to managerial stimulus. As shown in Figure 2, these factors include *individual*, *organizational*, and *environmental* influences on institutions. In economist parlance, these could be considered firm-specific factors, or those underlying factors that might shape a university's choices with respect to UBC but that are largely beyond immediate direct influence of leadership.

Individual factors refer to the human actors in UBC, with specific focus on the expertise, demographics, and experiences (both in academia and in business) of academics. A reader of this review might interpret *individual* factors as something highly malleable by institutional leadership. However, when considering systems of dual governance, faculty tenure, and the complexities of an administrative lattice (Zemsky & Massey, 1990), rapid shifts in *individual* factors are unlikely. Perhaps with considerable investment it might be possible to "buy" new researchers who bring significant existing research portfolios and relationships with industry, but empirical studies suggest these faculty typically are more senior and often less likely to have the desire or skillset to work with businesses (Davey, 2017; Davey et al., 2017).

As presented currently, *environmental* factors draw from a tool used in marketing analysis called a PESTLE Analysis. Firms use PESTLE tool to monitor the competitive environment within which they operate, to manage organizational change,

and to inform strategic planning. These factors generally refer to the political, economic, social, technological, legal, and environmental (PESTLE) elements in this external environment. Any complex combination of these factors might enable or inhibit proficiency in UBC. An excellent example of PESTLE influencing UBC can be found in Adams' 2009 review of engineering at Stanford University compared to that of UC Berkeley during the 1940s and 1950s. In short, as a private university, Stanford faced a different macro-environmental context than UC Berkeley did as a public university. Berkeley focused on developing political skills to drive resources from the state while Stanford was forced to develop robust interface skills with industry partners in order to survive. Neither approach is wrong, per se, but in the context of UBC, Stanford's PESTLE analysis advantageously informed the institution quite differently than Berkeley's. Parenthetically, *triple helix* researchers point to Stanford as the foundation of the model, given its outsized influence on the development of Silicon Valley. Not coincidentally, higher education and government leaders with visions of greatness desire to replicate that phenomenon, often presenting guiding premises such as "Silicon Prairie," "Silicon Alley," or "Silicon Beach." As discussed earlier, however, such an undertaking is not as easy as drawing a simple Venn diagram and proclaiming success.

Finally, *organizational* factors are those characteristics of the institution itself. Galán-Muros and Davey (2017) identify type and size of an institution as the lone elements in this space. They note that research regarding organizational factors in UBC is quite scarce. Understandably, the Framework does not incorporate the abundance of research related to higher education organizations found outside of UBC research. The

current study intends to provide more depth to this element by incorporating Carnegie classification as an additional factor. Outside of the US, it might be logical to incorporate regional assessments or possibly rankings here, though in this study Carnegie is the preferred construct, given the historical premise behind the creation of the classifications. As with the other two factors, *organizational* factors are elements university leaders have less control over than desired. This is particularly true of universities already at the top of the classification spectrum. Imagine attempting to change the core nature of the University of Oklahoma away from a comprehensive research institution to one that is more focused on purely applied research in support of industry. Shuttering the entire athletics program might be an easier undertaking when considering all of the boundary conditions. Similarly, a challenge to scale student population exponentially would take substantial new structures and practices, a robust strategy, external political support, and time. Hence, in practice and in scholarship, *context* factors provided in the Framework provide the firm specific factors that must be considered with perspective when assessing interactions within the ecosystem.

The next major element identified in the Framework is *supporting mechanisms*, identified as activities undertaken by institutions to manage, develop, and coordinate UBC (Galán-Muros, Van der Sijde, Groenewegen, & Baaken, 2017; Kliewe, Davey, & Baaken, 2013; Korff, Van der Sijde, Groenewegen, & Davey, 2014; Galán-Muros & Davey, 2017; Davey et al., 2011). As established by Galán-Muros and Davey (2017), and shown in Figure X, these can be categorized as *policy, strategic, structural,* and *activities* mechanisms in support of UBC. Of most importance to this study are the structural mechanisms, though ignoring the others would be to ignore their

interdependence. Tornatzky, Wuagmann, and Gray (2002) recognize their combined effectiveness in facilitating boundary spanning through barrier reduction and active facilitation. Optimally, these functions are situationally adaptable, creating favorable conditions for various cooperative activities and maximizing efficiencies and alignment (Davey et al. 2011; Korff et al., 2014; Galán-Muros & Davey, 2017; Henrekson and Rosenberg, 2001). Accordingly, CROs are well positioned to actively manage all of these factors towards UBC that facilitate institutional goals.

Policy mechanisms, identified in the literature by Galán-Muros and Davey (2017), encompass "all the regulations of the UBC field at different levels, from organisational policy to international regulation" (p. 14). These are described as *economic and financial* (e.g., funding in the form of grants or venture capital, infrastructure investment, tax allowances, etc.) provided by governments to universities and/or industry. These investments are encompassed within a framework of *regulatory mechanisms* and implemented via *other mechanisms* (promotional, governance, and developmental activities and approaches) to foster and facilitate engagements (ibid).

Strategic mechanisms are institution-specific approaches aimed at establishing an environment conducive to long-term, integrated, and comprehensive UBC (Davey et al. 2011; Korff et al. 2014; McCoy, 2011; Davey & Galán-Muros, 2013). These mechanisms equate to establishing a stated (*documented*) institutional objective (McCoy, 2011) and facilitating a comprehensive philosophy related to UBC (Galán-Muros & Davey, 2017). Of importance to this study are the elements of *implementation* related to UBC, described as incentives, resource allocation, and publicity (ibid). This study is an investigation of the efficiency and effectiveness of resource allocations in

support of UBC, particularly in relation to institutional strategy. The literature is notably light in analysis of these elements, a fact made more conspicuous when identified in the context of the Framework.

Structural mechanisms are the primary area of concern in this investigation, as these include the formally defined offices dedicated to UBC. While I use CROs as the proxy for these offices, the literature includes TTOs, research parks (Etzkowitz, 2001), careers offices, real estate offices, government relations offices, economic development offices, and community and regional affairs groups (Davey et al., 2011; McCoy, 2011; Etzkowitz, 2001). Another *structural* element identified by Galán-Muros and Davey (2017) include those *people-based* network development methods such as board participation (Tornatzky et al., 2002; Davey et al., 2011), recruitment of faculty and staff with industry experience (Davey et al., 2011), and professional development through intermediary organizations (Metcalfe, 2004). Galán-Muros and Davey (2017) refer to *program-based* structural mechanisms, or those activities that foster networking and interaction through event type activities, as the final identified structural mechanism.

Activities, as offered in Figure 2, refer to operational practices in support of UBC. Galán-Muros and Davey describe these as communication, linking, and training (2017). These include ideas such as facilitated networking to foster collaboration among university and business researchers, the creation of workshops to encourage interactions across boundaries and change mindsets, and communication via an array of channels to promote cooperation and celebrate partnerships. I find the nomenclature of *activities* confusing, particularly given its repeated use in the UBC *process,* and suggest

that these are instead operational *practices*, much along the lines of "best practices" one might find promoted by professional organizations (Metcalfe, 2010). Importantly, these *practices*, as provided in the Framework construct, indicate approaches that may not be recognized in a meaningfully measurable manner. In other words, it would be difficult to prove that facilitation of a relationship had a direct impact on net new resources (Galán-Muros & Davey, 2017), particularly when not measured in concert with the surrounding ecosystem conditions.

The interrelation of *supporting mechanisms* is perhaps best explained anecdotally. An apt example is a university wishing to move up to the top tier Carnegie classification (R1). This process would be different for each institution when taking into context existing organizational status, size, and type. The pathway for a small liberal arts school to advance is substantially different from a regional state system institution or a private research university with established research centers. Regardless, to undertake such an endeavor, the university might intentionally define areas for growth and investment and then pronounce in its strategic plan that it was "moving up!". Of course, this undertaking would require support from external stakeholders who presumably benefit from the new stature of the University and thus would begin engagement of government and industry partners to leverage policies and funding support. Government and industry stakeholders, with concerns of their own, would likely influence the university to establish programs, degrees, research centers, and other mechanisms to their respective benefits. The point is, an undertaking such as this requires complex and consistent university, industry, and government interaction, and those interactions cannot exist in isolation as they are inherently related in the

ecosystem. In fact, these interactions must also be actively and regularly managed by some organizational mechanism with a dedicated group of people, such as a CRO.

Supporting mechanisms are essential to UBC, as several studies have explored their effectiveness within the *triple helix* (Metcalfe, 2010), but researchers have yet to address essential interdependencies of other structural mechanisms (offices), strategies (resource allocations), practices (areas of focus), and policies (funding). These mechanisms are a direct response to leadership efforts to influence the wider context and they should act in concert, rather than in isolation, to optimize institutional circumstances.

UBC circumstances are defined as a "complex array of temporary internal and external influencing elements, which can be changed by management actions" (Galán-Muros & Davey, 2017, p. 16). The fact that these elements are subject to direct stimulus by action taken within the institution is the primary differentiator to those circumstances found in the wider context elements, for which management control is substantially more difficult. As a result, UBC literature is most robust regarding this area of the Framework, with researchers exploring how to eliminate *barriers* that limit UBC (Bruneel et al., 2010; Plewa et al., 2013; Perkmann et al., 2012, Galán-Muros & Davey, 2017) and *drivers* that encourage and enable UBC activity (D'Esta and Perkmann 2011; Bruneel et al., 2010; Plewa, 2006; Galán-Muros & Davey, 2017).

Currently identified *barriers* to UBC in the literature include *contact*- (connecting with the right knowledgeable person, a *competent authority*), *cultural*- (alacrity, semantic differences, misaligned outcomes and incentives, and bureaucratic rigidity), *characteristic*- (basic research versus product need development, finding the

right areas of intersection, absorptive capacities of businesses, and legal inelasticity) and *funding*-related (Bruneel et al., 2010; Plewa et al., 2013; Perkmann et al., 2012, Galán-Muros & Davey, 2017; Korff et al., 2014). While scholars have identified effective barrier management practices in substantive case studies (Davey et al., 2011; Davey, 2017), there is no empirical evidence of systematic homogenization of those practices. This leads to barrier persistence, which is possibly a consequence of variances in organizational approach, the focus of UBC research on TTOs whose activities are largely transactional, and imprecise operational incentives for universities and businesses.

Of course, the fact the barriers remain might also be a consequence of a slow pace of change or supporting mechanism orientation. For example, most research centers, TTOs, or CROs are focused on annual outcomes and are not rewarded for the facilitation of barrier removal. A TTO is more concerned with annual license deals and less focused on changing institutional culture, a long-term endeavor. This is not to say that these offices are not concerned with improving circumstances, but merely to note that efforts are likely unnoticed in practice or are actively discouraged. However, there are no studies exploring barrier persistence or the effect of structural mechanisms to facilitate barrier removal in the literature today. In fact, one of the visual challenges with the Framework as presented in Figure 2 is the perception that relationships between *supporting mechanisms* and *circumstances* are not premeditated.

Drivers of UBC are those elements that facilitate and encourage interactions, particularly related to mutual incentives and network development. There are two identified drivers in the current literature: resources (sharing and availability) and

relationships (one-one, many-many). Resources, in this sense, consider shared assets (human, capital, and infrastructure) across university and industry as necessary for strong cooperative relationships and operational efficiency (Etzkowitz & Leyesdorff, 2000; Galán-Muros & Davey, 2017). Relationships, for which the basis of trust (Plewa, 2005; Bruneel et al., 2010; Davey et al., 2011) is established, are primarily concerned with identified shared goals in academic-to-business interaction (Galán-Muros & Davey, 2017). Relationships should also consider professional staff-to -business and professional staff-to-academics as necessary mediators to the development of trust and shared objectives. This consideration is not found in the literature, denoting a deficiency in the connection between structural mechanisms and circumstances, particularly related to *offices* to amplify *drivers* and curtail *barriers*, necessities to UBC process optimization.

It is important to put some specific emphasis on barriers and drivers for a moment. First, the OECD study mentioned at the start of this chapter provides emphatic evidence that trust is the antecedent to strong relationships. So it seems a logical result might be that universities establish an evolutionary mechanism to actively facilitate trust among administration, academics, and faculty. This might further the sharing of resources and possibly create stability towards more robust relationships. Second, however, sustained persistence of barriers indicates universities have chosen instead to orient functional approaches towards transactional activities. There are any number of explanations for this, including isomorphism (the office is created because aspirational peers have one), resource dependence (low risk tolerance for drops in annual funding even if there is a larger long term opportunity), and increased influence

of intermediary professional organizations (our metrics should look like everyone else's metrics). The fact remains that in contemporary UBC approaches and studies, *transactions* are the focus of supporting mechanisms and establishing *trust* is not. Existing empirical studies perpetuate this by failing to consider the UBC process as a conditional process (i.e., there is a comprehensive effect of variables interacting simultaneously) and instead focus on transactional results by isolating interactions, meaning direct effects on outcomes are likely overstated and effects of *drivers* and *barriers* are likely understated.

In elaborating this *UBC Process*, Galán-Muros and Davey (2017) draw from the performance management logic model developed by the Kellogg Foundation, previously used in work from Perkmann et al. (2012) to study R&D alliances. The *process* contains "five major elements: inputs, activities, outputs, outcomes, and impact and is sometimes depicted as a circular model rather than a lineal one" (Galán-Muros & Davey, 2017, p. 5) suggesting that using this model generates resources for use as inputs to be used to generate more resources, nicely fitting Lombardi's 2013 analysis of university behavior. Galán-Muros and Davey (2017) provide robust literature support for each of the five major elements, fully validating the logic model and defining sub-elements associated with UBC. From the higher education lens, *output, outcome,* and *impact,* are generalized as organizational (university or business), individual (student or academic), and community (social, economic, or civic) (Galán-Muros, 2015) and are dependent primarily on the activities undertaken towards UBC.

This dissertation is not a study directly assessing outputs, outcomes, and impacts individually, but rather looks at them in aggregate as *UBC results* (Galán-Muros, 2015).

I posit that exploring *activities* at a tactical level might, in actuality, be misaligned with institutional objectives (i.e., a university wants prestige, efficient resource use, increased production) and reactionary (i.e., a university pursues these UBC activities as a mechanism of research cost recovery, cost shifting, salary augmentation, etc.). If that is true, then *results* of UBC, both in the literature and in practice, are also misaligned because they are also not aligned with institutional objectives. Therefore, the intent is to determine the effectiveness and validity of boundary-spanning offices charged with UBC, particularly in relation to influence on institutional strategic objectives and efficient capacity building, when considering all antecedents. Only then can a study incorporating outputs, outcomes, and impacts more granularly be conducted.

For this purpose, it is most important to more closely explore the *UBC input* and *UBC activity* elements of the *UBC process*. In this review, I make two recommended additions (one to each category) and suggest a shift from *input* to *resources.* The use of the term *resources* is an intentional shift from the term *inputs*. The Kellogg Foundation (2004) model offers the terms interchangeably, as do most economists, but the use of *resources* best aligns UBC research to higher education organizational research where significant literatures explore resource dependence theory.

Also defined as *enablers* (Tornatzky et al., 2002), *inputs* represent the allocation of institutional resources towards UBC. Scholars identify these as *human, financial,* and *physical* (Galán-Muros & Davey, 2017), though economists widely recognize them as factor endowments (land, labor, capital, and entrepreneurship). Cross-referencing these as *human=labor, financial=capital,* and *physical=land* (or perhaps, institutional assets writ large), identifies a hole in the *inputs* element, particularly if we remember

that *triple helix* theory relies on the premise of the university as essential to an *innovation* economy. If we support the notion of the Framework as a necessary organizing tool within the *triple helix*, AND support that UBC is a recurrent resource allocation process, AND thus, that we are concerned with total (institutional) factor productivity towards UBC activities, then we must add *innovation* as an available resource. This addition is founded in the literature of *triple helix,* primarily because the model is founded on the idea of the entrepreneurial university (Etzkowitz, 2001). Further support can be found from economist Michael Porter's premise that competiveness depends on innovation (1990).

To conceptualize innovation as a resource, consider the idea of digital immersion in modern higher education. While some universities have embraced this idea and actively sought to innovate pedagogically, others have anchored themselves in traditional classroom settings. In the context of UBC, collaboration with a technology company would look entirely different for these institutions. One might leverage the relationship and look to explore new pedagogy, research technology efficacy and application in different environments, and attempt to develop new applications themselves. The other is more likely to consider a hardware or software gift and/or simply become a customer of the company and nothing else. These are very different relationships, the latter more transactional, and rely on the university's ideas related to institutional transformation and evolution. Those ideas directly impact the types of UBC activities that might be undertaken.

Galán-Muros and Davey (2017) identify a wealth of literature categorizing UBC *activities* towards traditional mission-oriented functions of institutions, shown here in

the Figure 2 as *education, research,* and *valorization* domains. Valorization is derived from the work of Davey et al. (2011) and progressed in a 2013 study that advanced methods by which all mechanisms of knowledge transfer occurs (Wakkee, Van der Sijde, & Nuijens, 2013). In simplest terms, valorization here means creating economic and societal value from the transfer of knowledge. In this study, I use the term interchangeably with commercialization and technology transfer, as those are the most common forms of valorization (Davey, 2017).

For further elaboration of UBC *activities,* authors offer seven common underlying activities across the *UBC activity* domains: [education] *joint curriculum design, lifelong learning, student mobility* (internships & coops)*;* [research] *researcher mobility* (between university and business)*, collaborative R&D;* [valorization] *commercialization,* and *entrepreneurship* (Davey et al., 2011; Davey 2017; Galán-Muros & Davey, 2017). The agglomeration of these *activities*, while not exhaustive, validates the primary Framework applicability argument for "both researchers and practitioners" (Galán-Muros & Davey, 2017, p. 7) and sufficiently argues that these activities are additive and synergistically interdependent in relation to the UBC process.

Consider again any relationship between a company and a university. You might immediately think about companies hiring students, supporting internships, or providing support in the classroom as guest lecturers. You might also think about financial support in the form of scholarships or sponsorship of athletics. Perhaps sponsoring research and eventually licensing intellectual property comes to mind or even colocation on a research campus. All of these are UBC *activities* and the efforts of UBC researchers has been to categorize these into manageable categories (Davey,

2017). However, questions remain as to whether these are actually productive and aligned results in support of institutional goals and/or whether such activities are appropriately managed by institutions.

UBC Activities, therefore, rely on effective and efficient allocation of all four *resources* to robustly affect intended *UBC results*. Importantly, neither UBC scholars nor higher education scholars have explored allocation of institutional resources specifically towards these *UBC activities,* and only a few economists have explored allocative efficiency in higher education institutions (Adams and Clemmons, 2006; Salerno, 2002) specifically. Both of these studies focus on faculty production toward conferred degrees and peer-reviewed publications, which are arguably relatable to identified activity domains, but are a) not recognized as activities in the UBC literature, and b) don't necessarily oblige UBC as influencing production or cost. Salerno (2002) reveals a dearth of empirical economics research related to measuring HEI efficiency, while also noting that "two of the most commonly used estimation techniques in the study of higher education institutions, production and cost functions, implicitly *assume* efficient behavior" (p. 21).

UBC researchers espouse the importance of effective collaboration as core to the production function of innovation economies (Adams & Clemmons, 2006) having produced enough supporting publications to require the establishment of the Framework, yet I find no applicable empirical studies exploring efficiency toward the core element of *UBC activities*. Perhaps the *assumption* of efficiency holds true for UBC researchers as well, or perhaps as Salerno (2002) suggests, universities generally care little about internal efficiency, reacting primarily to external incentives.

The Framework subtly denotes the indifference for allocative efficiency among UBC scholars, as indicated by the absence of a *capacity* domain in *UBC activities*. *Capacity* is essential to any efficiency calculation, and in the case of education, *capacity enhancement* (Etzkowitz, 2008) is a primary undertaking. The addition of a *capacity* domain expands the bedrock literature beyond UBC researchers by including research into potential capacity categories tied directly to resources – namely *financial, human, physical* or *innovation* capacities.

Human capacity indicates the institution's ability to develop relationships, execute administrative and operational activities, and directly ties to the abilities of faculty and non-faculty researchers. This capacity might also indicate institutional ability to build and leverage networks to suit their needs as a part of activities with business (Etzkowitz, 2008; Etzkowitz & Zhou, 2008). *Financial* capacity indicates the ability of the institution to broadly support activities in UBC, especially in their unique roles as institutional anchors (Lester, 2005; Hodges & Dubb, 2012; Birch et al., 2013; Lane & Johnson, 2012; Perry et al., 2009). *Physical* capacities are all of the available physical infrastructures and assets that can be shared or leveraged in a given relationship, particularly but not exclusively related to research activity (Etzkowitz, 2008; Hazelkorn, 2004). *Innovation* capacity then, is similar to the addition above and quite literally refers to institutional ability to innovate. This might include technological capability, creative abilities, and cultural indicators.

Specific to this dissertation is the element of financial capacity enhancement, both in the areas of R&D support and corporate philanthropy. Broadly, these capacities should be considered *institutional* or *organizational* capacity (Etzkowitz & Zhou, 2008;

Etzkowitz, 2008), which can be taken together in whole or in part to execute on UBC activities. As a UBC *activity* domain, efforts to enhance institutional capacity would be specifically directed towards one or all of these varied capacities. For example, a relationship with a company might develop where research assets are shared to alleviate cost of research, or perhaps the parties enter into an agreement for the company to build a new building at its expense on university property for a low land lease rate. Both of these collaborations help to limit capital outlay for the institution but increase its physical capacity and make it more competitive for research funding.

Perhaps most important to this dissertation, however, is the idea that philanthropy is an investment in institutional capacity. Any voluntary support for an institution is provided to bolster financial stability, sometimes in place of dwindling governmental support (Cheslock & Gianneschi, 2008), regardless of where those investments are made. Generally, these investments are intended to support faculty recruitment (i.e., named faculty positions) or research activity, enhance physical infrastructure (i.e., naming of labs and buildings), or to support students more generally (i.e., graduate and undergraduate scholarships). Regardless of the specific intent, these capacity-enhancing efforts are an important and intentional element of UBC that are converted to new resources for institutional use.

In critique of the Framework, Galán-Muros & Davey (2017) offer five specific points. First, they note that across the field of UBC literature there is a general lack of consistency in naming conventions and concepts that makes comparisons across studies difficult. Part of their endeavor was to homogenize these elements. However, as seen in this review, there is much left to interpretation or validation. Accordingly, this

dissertation attempts to further homogenize these concepts while introducing additional elements found in the literature. Second, the authors admit that many of the relationships among factors are not empirically proven to date. They also offer a concern that many of these interactions might be impossible to prove. I do not entirely agree with that notion, recognizing that the Framework is an important yet nascent undertaking, and offer a methodology to assess interactions through this dissertation. This assumes, of course, that data are available to conduct the experiments for empirical validation.

Third, the authors note that the Framework does not identify any specific measures towards assessing comprehensive UBC or towards assessing the elements themselves. The complexity of UBC makes assessment of specific measures a significant challenge that might only be addressed following years of continued use of the Framework. However, as with above, the methodology used in this dissertation might avail a new foundation for the development of measures for certain organizational constructs. This might also provide insight into measures that are directly, indirectly, or impossibly influenced by institutions. Finally, the authors recognize that the newness of the Framework makes it more general than it is specific, and that there are likely to be numerous missing elements not provided in their offering. I concur with these assessments as well, but suggest that this is also an asset of the Framework, in that it becomes a malleable tool for researchers to adapt and improve as attempted herein.

Therefore, of specific concern to this dissertation are several key omissions from the Framework as initially devised. First, Galán-Muros and Davey (2017) leverage

UBC-related literature outside of the US, and equally recognize that most US research is focused on commercialization aspects. This means the Framework is not immediately applicable in US context beyond commercialization, and perhaps not even then. Specifically missing is the element of institutional capacity building, particularly philanthropy, which is a unique and essential function of US institutions and a primary subject of this paper. Second, funding is recognized in multiple locations in the Framework (see supporting mechanisms, barriers, drivers, and outcomes) without delineation as to the different types and uses of funding that may relate to UBC. As this paper is focused on two different monetary resources, R&D and corporate philanthropy, as well as the general allocative efficiency of institutions to support those endeavors, it is important to directly identify their respective locations within the Framework.

Third, as it relates to supporting mechanisms, there are two items of concern. With respect to CROs, the Framework provides little insight into the types and functions of such offices and seems to consider them only in their traditionally siloed organizational positions and structures. Accordingly, such approaches may also be barriers to UBC. For example, a US institution may set a strategy for fundraising over other UBC activities, which researchers have found to be restrictive (McCoy, 2011; NACRO, 2012). Organizational structures may or may not be aligned with institutional strategy and associated UBC activities may not be cohesive, leading to multiple unmanaged contacts between UBC parties. From a policy perspective, institutional and/or governmental legal policies may be too constricting to facilitate UBC, creating competing or reactionary performance directives and incentives. Pointedly, it is a very

different endeavor to suggest CROs undertake UBC for the sake of finding philanthropic funding than it is to engage them to drive down the cost of doing research.

Finally, while the Framework doesn't specifically present "reputation" as an element of wider context, it is inferred under the organizational element of UBC context. Reputation is arguably more important in a US context than on a global scale, as the CCIHE only addresses US institutions. Regardless, reputation is an important contextual element for UBC and should be explicitly recognized as such within the Framework. To address these concerns with the Framework proposed by Galán-Muros and Davey (2017), I offer adaptations, as illustrated in Figure 3.

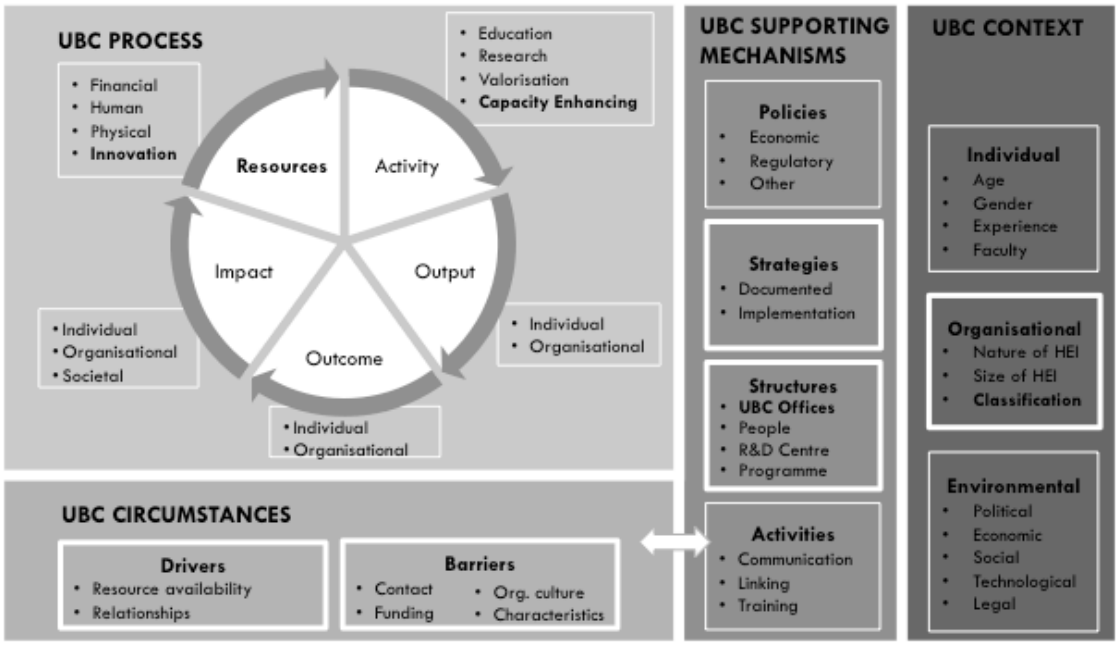


Figure 3 - UBC Ecosystem Initial Adaptation (adapted from Galán-Muros & Davey, 2017)

Framing Variables in the Ecosystem

Using the Framework provides a useful mechanism to study the connectivity of the UBC ecosystem. Given the nascence of the Framework, however, there are few empirical studies in the literature to validate its use. Galán-Muros (2015) provides a series of quantitative studies of using a preliminary model of the Framework,

representing the only studies leveraging the Framework to date. These studies are worth exploring here to provide perspective on the originally intended use of the Framework (for context), to indicate the validity of the Framework as a research tool in the literature, and to relate the empirical results to the efforts of this dissertation.

In the first study, perhaps most important to this dissertation, control variables (type, size, and location of HEI) are derived from: institutional *context*; independent variables (strategic importance, incentives, UBC promotion, and *UBC Office*(s)) from *supporting mechanisms*; and dependent variables from the seven activities across the three initial *activity* domains in the UBC process (as defined by Galán-Muros & Davey, 2017). The investigation establishes the importance of strategic institutional support ($p < .05$ across all *activities*) for UBC and indicates that a mix of well-developed support mechanisms are necessary, finding strong positive effects ($p < .05$) of *offices* across most *activities*. This confirms the importance of having some boundary-spanning resources to enable and support UBC, but leaves to question a) the effectiveness of these offices individually and collectively, b) given that the Galán-Muros study does not delineate between various offices, how these should be measured, and c) what the right skills, behaviors, and activities people in said offices should develop. As a result, Galán-Muros (2015) calls for future studies related to administration of UBC, something this dissertation addresses. One important note here is these data rely specifically on supporting mechanisms having a direct effect on activities. I believe this is a symptom of methodology, and as provided earlier, tends to overstate the influence of these mechanisms while understating the relationship between the variables in the ecosystem, or rather; the approach undervalues the *conditions* of the process.

In the second study, Galán-Muros (2015) finds correlations of *circumstances* (*barriers* and *drivers*) to the three UBC process domains of *education*, *research*, and *valorization* using *individual context* elements (age, gender, experience, etc.) as controls. As the first comprehensive exploration of UBC *circumstances*, it demonstrates the combined impacts on UBC *activities*, with greatest negative effects for the barriers of *connection* ($p < .01$), *funding* ($p < .01$), and *culture* (max $p < .05$) across all *research* activity and greatest positive effects, also on *research* ($p < .01$), from both *drivers* (resource availability and relationships). Research, research-related resources and incentives, therefore, are significant in the UBC ecosystem, when controlling for individual faculty context. Here again, Galán-Muros (2015) leverages the Framework to indicate that internal coordination and collaboration are essential to UBC and calls for development (and assessment) of a "common institutional strategy" (ibid, p. 126).

As with before, the study leaves a portion of potentially relevant conditions out of the context. This is not to question the validity of the study, though it is important to note that there are also likely influences from *supporting mechanisms* that might strengthen or weaken these interactions. For example, having an office whose role it is to foster collaboration might bolster the interactions, while an office focused solely on licensing technologies might weaken the interaction by complicating the engagement. Any institutional strategy, common or otherwise, would have to develop in the total context of the institution (its *conditions*) and not in a vacuum of isolated circumstances.

Galán-Muros (2015) examines experience factors of academics towards UBC in the final publication. Again using the three *activity* domains as dependent variables, she defines both independent and control variables from the *individual* context category,

delineating between experience (independent) and person-specific characteristics (control) factors accordingly. The resulting data are conclusive and overwhelmingly support academics having experience in both industry and academia, with emphasis on the former, towards positively influencing UBC activity. This holds true regardless of age or gender of the researcher, but not as strongly when controlling for individual specific experience (where a researcher works and in what field), particularly when considering the R&D domain. This indicates that institutional prestige *may* be a factor, a significant consideration of this dissertation. As with the previous studies, Galán-Muros (2015) confirms again the need for active management of all UBC activities and corresponding variables.

This call, however, is again not supported by recognition of conditions in the ecosystem. In other words, the finding in the study definitely states that a researcher with experience in industry is more likely to have better relationships with business, but as we saw in the previous study, among the many barriers to UBC are funding and organizational culture. So a researcher might be "good" at UBC because they have been in industry, but if the culture of the institution is prohibitive, they are less likely to have success. In essence, there are potentially significant mediating and moderating effects that are not brought into the equation in these studies, which I believe undervalues the Framework overall.

However, when taken as a whole, Galán-Muros' (2015) research using the Framework consistently affirms the relationship of the elements and validates the research tool, finding consistently positive correlations vertically and horizontally within the ecosystem. Each study calls for a "big picture" approach to UBC

management, yet none conducts research entirely at the organizational scale, as noted by the exploration of direct effect on activity domains in all three studies. These seemingly neglect the other elements in the UBC *ecosystem* and the UBC *process,* exploring only the importance of effects of *activities* rather than results from activities or the comprehensive conditional process.

As provided in Chapter 3, I use the Framework in a slightly different manner. Primarily, I apply Hayes' conditional process analysis (2018) to study direct and indirect effects of more comprehensive ecosystem elements across the Framework at an organizational scale. Galán-Muros and Davey call for the Framework to enable "the efficient allocation of limited resources into the most needed factors" (2017, p. 26), but it should be noted that constructs designed to explore only sub-elemental relationships towards *activities* risk encouraging optimized isomorphism and, consequently, neglect other important strategic and organizational concerns. UBC *activities* are a collection of direct and indirect byproducts of institutional efforts to influence their organizational *context.* These effects occur through some casual ordering that can only be accurately determined though assessment of interactions using all related boundary conditions (Hayes, 2018).

Therefore, using the Framework as a performance assessment tool to inform resource allocation requires recognition that UBC is a sub-element of the broader influence schema and that some activities carry more weight than others. Basically, UBC research is too focused on optimizing the wrong activities because it dismisses the institutional context as beyond influence. We likely measure the wrong things and then work to optimize those wrong things. The Framework can bring that to light if used as

an institutional optimization tool rather than an activity optimization tool. We eventually have to better understand and recognize WHY we are doing UBC and to what end.

Institutional Context: Classification, Striving, Isomorphism

> The most salient organisational-level determinant for academic engagement is represented by the quality of the academic's university or department… Most notably, in contrast to commercialization, individual academic engagement tends to be negatively correlated with the research quality of departments or universities. Simultaneously, there is no conclusive evidence on the role of formal organisational support structures or peer effects for stimulating academic engagement. (Perkman et al., 2012, p. 427)

There are several important elements in the quote above. First, the more prestigious the institution, the less academics participate in UBC activities related to education or research (D'Este & Patel, 2007; Ponomariov, 2007). Conversely, extensive research regarding valorization activity has posited that being elite is a significant factor in commercialization of R&D outcomes (Perkmann et al., 2012). These can be attributed to a number of factors including that a) less prestigious universities receive less competitive grant funding and less resulting innovation and therefore *must* engage with industry for resources (Ponomariov, 2007; Perkmann et al., 2012); b) perhaps perceptions of quality attract industry in search of quality innovation; or, the culture of scholarship (Finnegan & Gamson, 1996) at prestigious institutions is focused on peer-reviewed research which distracts from UBC activities, other than valorization where faculty are forced to engage with industry (Ponomariov, 2007).

The second point is that, aside from examinations of technology transfer offices, there exists a dearth of data related to other offices that may support UBC. This is likely prestige related as well, given that scholarship focused on TTOs focuses on the research elites to bolster the *triple helix* idea of the new position of the university.

Consequently, other offices that span the boundaries of university and industry are not considered in the research because they are less likely to directly influence research prowess and resulting commercialization activity. This means they do not get the same attention from external stakeholders because they are not "shiny" enough (Davey, 2017; Plewa, Quester, & Baaken, 2006; Perkmann et al., 2012). Additionally, many studies are focused on activities of individuals towards UBC, particularly faculty who hold the "status" towards quality intellectual property. Finally, CROs related to philanthropy are a uniquely US archetype (McCoy, 2011), which means that a) they are not considered by non-US academic and b) they are perceived as serving a completely different purpose than TTOs. So prestige matters, but organizations do not, at least in the current literatures that, pointedly, have a heavy bias towards commercialization activities.

Finally, underlying all of this is the idea of institutional prestige as a contextual factor in determining the impetus for UBC. Economist Howard Bowen (1980), in what was likely the first comprehensive review of higher education financing, established what is now known as Bowen's Rule, or the "revenue theory of cost", wherein four tenets hold true: 1) the main goal of all universities is prestige, influence, and quality; 2) there is no monetary limit that can be applied to this endeavor; 3) therefore, every institution raises as much money as it can, every way it can, and; 4) every institution spends all the money it raises. Taken through that lens, elite academics' indifference towards UBC is clearly a rebuff of the idea that industry support positively affects prestige, influence, or quality. This also explains the academic participation in valorization and perhaps UBC researchers' fascination towards the same. In the same manner as a peer-reviewed publication, a successful commercialization event could play

a role in building influence and prestige, with an off chance of producing revenues (Tornatzky, et al., 2002).

Thus, it is essential to understand the organizational context of prestige in higher education, the foundational theories that explain university prestige seeking, and the consequences of such behavior across the ecosystem. This section of the literature review provides an overview of these three key ideas. Beginning with a short summary of the inevitability, embrace, and effect of institutional *classifications* and its relationship to prestige, followed by a review of institutional theory and the ideas of *isomorphism* as both a cause and effect of classifications, and finally, an exploration of *striving* behavior explored in the context of resource dependence theory. Taken together, these provide clarity around the independent variables in this study and bolster the Framework with the addition of *classification* to the organizational context as shown in Figure 3.

Carnegie Classifications

The Carnegie Classification(s) of Institutions of Higher Education (CCIHE), first published in 1973, was originally envisioned as a tool for higher education researchers and a comparative tool for administrators (Shulman, 2001). Despite the best efforts of its overseers, making regular adjustments to verbiage and calculations, postsecondary institutions continue to use the classifications as a "prestige barometer … because it classifies institutions using variables linked to normative models of prestige and stature (e.g., federal research dollars, selectivity, and number of doctorates awarded)" (Morphew & Baker, 2004, p. 367). Indeed, higher education pundits love to hate prestige, regular railing against the fallacy of *US News and World Report*

(*USNWR*) rankings, yet irrationally adjusting their business models to either maintain or increase stature (Armstrong, 2014; Aldersley, 1995; Finnegan & Gamson, 1996; Morphew & Baker, 2004; Morphew & Swanson, 2011; Iglesias, 2014; O'Meara, 2007; Alpert, 1985; Volkwein & Sweitzer, 2006; Bowman & Bastedo, 2011; Bastedo & Bowman, 2011; Kotler & Fox, 1995; Altbach, 2013).

As is evident, there is no shortage of research related to post-secondary prestige and related impacts. Most works focus on impacts towards HEI stakeholders, directly in response to ranking or classification calculations, including student-related (admissions, faculty-student ratios, class quality), resource attainment (particularly research related), and external relationship enhancement (mainly towards peer assessment and funding agencies) (Morphew & Baker, 2004; O'Meara, 1995; Clotfelter, 1996; Ehrenberg, 2000; Kim, Bastedo, DesJardins, Lawrence, & Stange, 2015). Conclusively, the findings are clear that pursuit of higher rankings is an expensive and futile effort for institutions. The consensus is best summarized by Morphew and Swanson noting "it is nearly impossible for any university outside the top 25 to break into this elite group, and aspirations to do so represent, in the vast majority of cases, organizational daydreaming" (2011, p. 11). A review of *USNWR* rankings confirms that between the first publication in 1983 and 2015 only 35 universities have occupied the top 25 and only 30 have done so since 1992 – the top 20 institutions have *never* changed (*U.S. News Rankings Through the Years*, 2007; *U.S. News National University Rankings*, 2015). While that is shocking, the point is, there is such significant literature debunking the value of chasing rankings, it is both surprising

scholars still explore the issue and that trustees and administrators still summarily ignore the empirical data.

One can hardly "blame" prestige seeking on rankings, particularly given the behavior has been traced back as far as the 1950's (Finnegan & Gamson, 1996; Garvin, 1980; Riesman, 1956) and maximizing prestige over maximizing profit is a recognized behavior of universities as nonprofits (Iglesias, 2014; Sweitzer, 2008). Altbach, considering rankings inevitable and "nonexistent zero sum game" (2013, p. 2), makes a point that displacement does not necessarily equate to decline, as there is plenty of room for world-class institutions. Data show that changing Carnegie classifications is at least a somewhat feasible undertaking, albeit extraordinarily expensive (Morphew & Baker, 2004; Ehrenbreg, 2000; Clotfelter, 1996), compared to changing rankings. For example, the 1994 report identified 59 universities in the highest classification, a number that, despite methodological adjustments, ballooned to 115 by the 2015 report (Weerts, 2002; Indiana University Center for Postsecondary Research, 2015). Perhaps Bowen (1980) reconciled it best by inferring that universities are in a high stakes competition with themselves (classifications) and with each other (rankings).

So, while some researchers have produced seminal work using *USNWR* (Morphew & Swanson, 2011; Volkwein & Sweitzer, 2006; Bastedo & Bowman, 2011; Bowman & Bastedo, 2011), most others have used CCIHE for research, as was the original intent of the Carnegie Foundation (Shulman, 2001). *USNWR* rankings do leverage CCIHE data, adding additional factors that influence institutional behaviors (e.g., making it more difficult to get accepted, actively influencing peer reputation scores, etc.), and studies using *USNWR* help define foundational concepts. Therefore,

such USNWR studies are important to the literature review, but this dissertation uses CCIHE. Importantly, CCIHE's use of Principal Components Analysis (PCA), while limited as a point-in-time calculation, provides insight into the weighting of variables that influence classification and that subsequently inform allocation of resources (Harmon, 2017). PCA enables the examination of *striving behavior* in institutions by bringing to light those areas where an institution wishing to drift upward (Aldersley, 1995; Morphew & Huisman, 2002) might make investments. Such investments indicate the characteristics of striving.

Striving here is defined as maintaining or improving institutional status relative to other institutions (Clotfelter, 1996; O'Meara, 2007; Winston, 1999). The underlying assumption here is that nearly all institutions are working to maintain their relative position and others are more aggressively pursuing greater relative status (Bowen, 1980). Such pursuits are identifiable by exploring how classifications are calculated and then subsequently reviewing institutional resource allocations in relation. However, the use of striving as an explicit indicator is a relatively recent approach, with most scholars electing to explore the effects of the underlying behaviors using various theoretical underpinnings to explain the correlations. These associations provide insight into "whether" and "if" there are relationships between prestige and organizational responses, attempting to provide empirical data towards the "why" (resource dependence, prestige maximization) and "how" (institutional) of such responses, but they do not explore the comprehensive and conditional nature of *striving* towards the contingent behaviors (Hayes, 2013). As with the Galán-Muros (2015) studies earlier, this is not to say that the studies are not valid, but rather to suggest that the research

designs are not built to look at the complete conditional nature of striving's impacts on downstream outcomes, only exploring more linear and controlled interactions.

Similarly, UBC researchers tend to focus more on "whether" and "if" underlying UBC behaviors have a controlled linear effect directly on UBC activities, attempting to provide empirical data toward "how" to enable those activities. While important, these studies miss the comprehensive conditional effect, including the causal "why" and the conditional "how" and "when" at the institutional level, as there are no studies to date that use conditional process analysis. This is, in part, due to the general acceptance that UBC is a necessary activity to support the "new" institutional role in the *triple helix* (Etzkowitz & Leyesdoff, 1997) and in part because until Galán-Muros and Davey (2017), no Framework had been established to comprehensively test hypotheses. It may very well be possible that *UBC is a consequence of prestige seeking* that, for a select few, produces an impactful institutional benefit.

In research related to striving, as with UBC, the literature provides no concrete methodology for use in empirical studies. This is not surprising, given the difficulties of reconstructing the classifications of rankings given limited extant data (Harmon, 2017). As such, researchers using CCIHE to identify striving institutions generally resort to counting only successful strivers (those schools that moved up a classification) for their investigations (Iglesias, 2014). This is somewhat limiting and doesn't meet the definition of striving used in this study. Thus, a summary exploration of the characteristics of striving environments (O'Meara, 2007) and of the primary components of the CCIHE PCA factors is necessary to best identify strivers and to isolate the characteristics most closely tied to UBC.

PCA loadings based on rank-order data 2010 CCIHE

Aggregate analysis (first principal component explained 71% of the total variance)	
Doctorates: STEM	0.919
Research Staff	0.906
S&E R&D Expenditures	0.894
Doctorates: Social Sciences	0.867
Non-S&E R&D Expenditures	0.856
Doctorates: Humanities	0.804
Doctorates: Other Fields	0.619

Per-capita analysis (first principal component explained 71% of the total variance)	
Per-capita S&E R&D Expenditures	0.919
Per-capita Research Staff	0.908
Per-capita Non-S&E R&D Expenditures	0.673

PCA loadings based on rank-order data 2015 CCIHE

Aggregate analysis (first principal component explained 70% of the total variance)	
Doctorates: STEM	0.914
Research Staff	0.902
S&E R&D Expenditures	0.900
Doctorates: Social Sciences	0.873
Doctorates: Humanities	0.819
Non-S&E R&D Expenditures	0.791
Doctorates: Other Fields	0.616

Per-capita analysis (first principal component explained 71% of the total variance)	
Per-capita S&E R&D Expenditures	0.931
Per-capita Research Staff	0.928
Per-capita Non-S&E R&D Expenditures	0.614

Table 1 - PCA Loadings Based on Rank Order Data for CCIHE 2010 and 2015

Shown in Table 1, PCA loadings from 2010 and 2015 provide some insight into researchers' use of underlying components of the classifications to explain striving behavior. While there are valid debates regarding the validity of PCA (Harmon, 2017) what is clearly evident is the emphasis on R&D-related activities in classification calculations. This is important for two reasons, the first of which is that these charts provide the basis for the temporal ordering of university behavior related to striving. This means that if a university is looking to change classification, they have to focus resources on these PCA factors specifically. Second, conceivably, all of the PCA factors could be considered R&D expenditures. Aside from the obvious R&D expenditures items, producing more doctorates, regardless of field, requires research activity and also allows faculty to opt out of teaching to focus on research. Non-faculty researchers exist for the sole purpose of conducting research, which means that resources are aimed at supporting them directly. Therefore, R&D-related expenditures are perpetually an essential element of classifications meaning that any lapse, taken in the context of institutional peers, may lead to a drop in classifications.

An important caveat is the distinction between striving and classification here. Classification and R&D-related expenditures *may* be endogenous, though Bowman and Bastedo (2011) find that *ranking* leads to increased R&D funding from the other two stakeholders in the *triple helix* (industry and government) and that this effect is primarily directional as stated. On the other hand, striving describes efforts to improve or *maintain* existing classification, which suggests that all institutions are taking some action accordingly. That undertaking is likely to be highly correlated towards increased R&D activity, such as investing in the research enterprise and increasing doctoral output. In other words, if an institution is striving, that should trigger investment in R&D-related activities (O'Meara, 2007; Clotfelter, 1996) and institutions with status already must maintain these increased investments (Brewer et al., 2002; Morphew & Baker, 2004; O'Meara, 2007).

This idea is bolstered by O'Meara's comprehensive review of striving literature and subsequent identification of the "characteristics of striving environments" (2007, p. 131), of which a modified version is provided in Table 2. Notably, 10 (shown) of the 15 indicators of striving align with the CCIHE PCA load factors (CCIHE Factors). For simplicity here, I combine CCIHE Factors into three groups: research staff (faculty & non-faculty), R&D expenditures, and doctorates. O'Meara's identified "areas of institutional operation" grouping also begin to align striving activity with elements of the UBC Ecosystem Framework's *supporting mechanisms*. The five indicators not shown in Table 2 are related to undergraduate admissions and education programs directed to influence *USNWR* rankings.

Areas of Institutional Operations	Indicators of Striving
Faculty Recruitment, Roles and Reward Systems	• Greater attempt to hire "faculty stars" with research emphasis, increase in faculty salaries and in start up research packages • Faculty teaching load decreasing; increase in discretionary time, loosening of institutional ties; increased emphasis on disciplinary ties • Faculty report expectations for research in tenure and promotion have increased • Rise in faculty grants, awards, prestigious fellowships
Curriculum and Programs	• Institution is adding graduate programs, shift in emphasis from undergraduate to graduate programs
External Relations and Shaping of Institutional Identity	• Institutional actors use language, speeches, websites, and symbols to shape the external image of the institution as more prestigious or "on the move" • Institutional actors also work to shape an internal, institutional narrative about striving and use the language and rhetoric of striving to frame major decisions, goals statements, and directives
Resource Allocation	• Increased spending on infrastructure and administrative support • Shift in resources from instruction to administrative support • Investments made in competitive amenities

Table 2 - Areas and Indicators of Striving (adapted from O'Meara, 2007)

The first of O'Meara's areas, faculty recruitment, roles, and reward systems, suggests striving indicators that direct faculty towards increased research productivity. This aligns directly with CCIHE's *research staff* and *R&D expenditure* factors and to the Framework's *policy* (pursuit of grants), *strategic* (incentives), and *structural* (faculty recruitment) mechanisms. The second area, curriculum and programs, aligns directly with CCIHE's *doctorates* factor but doesn't clearly align with the Framework.

However, a valid argument can be made that increased graduate programming is enabling towards *strategies* and *operational* elements by enabling adjusted teaching loads and research support. The third area, external relations and shaping of Institutional Identity, has both internal and external components. While there isn't a clear alignment with CCIHE Factors, a valid argument can be made that such efforts influence institutional recognition among funders. This area does align to the Framework via *policy* (promotion), *operational* (internal communication), and *strategies* (publicity) mechanisms. Finally, resource allocation clearly aligns with CCIHE's *research staff* and *R&D expenditure* as reflected by efforts to increase support to research administratively (non-faculty researchers) and competitive infrastructure investments. resource allocation also aligns with the Framework's *operational* (linking and support), *structural* (people and offices), and *strategies* (resource allocations and infrastructure) mechanisms. Figure 4 graphically represents the complete set of alignments identified above.

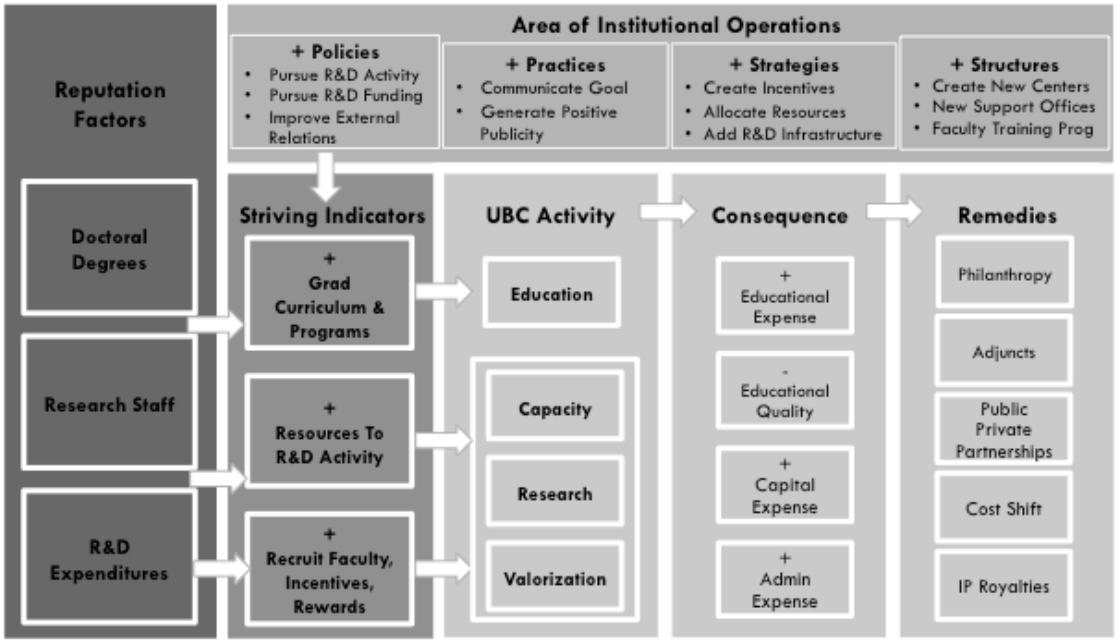


Figure 4 - Integration of Striving Characteristics within the UBC Ecosystem (own elaboration)

So we know that striving behavior has certain identifiable characteristics (O'Meara, 2007) and that those characteristics understandably align with CCIHE factor loads and now, that those characteristics also align with the UBC support mechanisms identified in the UBC Framework. Therefore, it is fair to argue that support mechanisms are a consequence of behaviors related to classification (or status). In her effort to identify the indicators of striving, O'Meara (2007) built on three key theories typically used by researchers to explain the "why" and "how" of institutional responses to striving: Resource Dependence Theory, Prestige Maximization Theory, and Institutional Theory. If Figure 4 is any indicator, it is possible to surmise that these theories explain the alignment to UBC supporting mechanisms to UBC Circumstances and the UBC Process. The remainder of this chapter explores this idea.

Supporting Mechanisms & Circumstances: Institutional Theory, Resource Dependence Theory, & Reframing Boundary Roles

Institutional Theory

Scholars have explored concepts of institutional striving behavior dating as far back as David Riesman providing the first observation of institutional homogenization in 1956, postulating a snake-like institutional procession headed by the most prestigious, followed by prestige building institutions, and tailed by the least prestigious (Brewer et al., 2002). In this scenario, the most prestigious work to maintain their position through continuous institutional investment of resources, often emulating peers so as not to lose their prestige, which by this point is a resource itself (O'Meara, 2007; Brewer et al., 2002). Accordingly, institutions in the middle are assumed to emulate the elites, while those at the end of the procession emulate the middle (Riesman, 1956). The net effect of this behavior is that "the acquisition of normatively defined practices and structures is more important for the survival of institutional organizations than are practices that enhance the efficiency of their technical processes or the quality of their organizational outputs" (Morphew & Huisman, 2002, p. 496). In other words, it is more important to look like the elites than it is to operate the institution efficiently or to direct efforts toward outcomes that cover the increased costs of pursuing a higher classification.

This behavior, known broadly as isomorphism (DiMaggio & Powell, 1983; Reisman, 1956) has been directly associated with increased administrative costs by numerous researchers, including Morphew and Huisman (2002) who offer the *academic drift* theory that institutions invest in new research activities to foster an increase in

classification, and Aldersley (1995) whose *upward drift* theory attributes investment in doctoral programs to increased expenditures. Morphew and Baker (2004) specifically explore the idea that new Research 1 universities incur higher costs, building specifically off of institutional theory (isomorphism) and a related idea called the *administrative lattice* (Zemsky & Massey, 1990; Ehrenberg, 2000; Clotfelter, 1996). There are two key points from their study relevant to this study. First, that both strivers and existing R1 universities spend significantly more on R&D with particular emphasis on support mechanisms that foster increased investment. This investment directly "emulates the most prestigious postsecondary models" (Morphew & Baker, 2004, p.366). The second idea is that "these increased administrative costs are a necessary evil" (Morphew & Baker, 2004, p.366), where the authors find that not only does the *administrative lattice* increase the number of administrators, it also seeks to professionalize these functions through intermediaries (professional organizations), effectively perpetuating these positions at aspirational universities (Clotfelter, 1996; Ehrenberg, 2000); Metcalfe, 2004; Morphew & Baker, 2004).

Both findings lead to the supposition that most research institutions are likely to have a dedicated professional staff whose function is to secure external funding. In the context of this study, this is relevant because it provides the theoretical foundation for investigating the relationships between classification, R&D expenditure, philanthropic investment, and CROs, whose job is primarily to secure external funding (McCoy, 2011). The same premise holds true for TTOs as well. Weinstein (2007) finds that institutional diffusion is so significant that if one institution opens a TTO, there is a high

likelihood that its peer institutions will open a similar office within a year, if they have not already established one.

The conclusion drawn from all of this is that increased classification is essential to accessing research funding because it creates a perception of excellence, yet actual quality and efficiency of education, research, or operations are significantly less important (Garvin, 1980; Finnegan & Gamson, 1996; Morphew & Baker, 2004; Morphew & Huisman, 2002). Accordingly, the increased classification also leads to the creation of offices that intend to garner increased resources and institutions simply replicate the constructs created by aspirational peers without regard to their specific needs or warrants. Thus, there is distinct homogeneity in the variety of boundary-spanning organizations intended to foster UBC as well and this is acutely prevalent in the construct of US CROs (McCoy, 2011). While it might seem odd to suggest "homogeneity in variety," the statement is not inaccurate. As already noted, there are numerous types of offices (e.g., CRO, TTO, Careers, etc.) that work with business and those offices are all the same type at nearly all research universities.

Resource Dependence Theory

In the same manner that increased classification indirectly results in isomorphic behavior, primarily through the adoption of structures and practices, the same can be said of increased resource dependence. In the simplest explanation, resource dependence theory suggests that as universities rise in classification, they incur increased costs (Morphew & Baker, 2004; Bastedo & Bowman, 2011), and as a result they must develop new resources to account for this increased expense. These new expenses are rarely stemmed because universities are not focused on efficiency and are

more concerned with status, which means they, in effect, become dependent on both existing resource and the pursuit of new resources in perpetuity (Tolbert, 1985; Morphew, 2002; Morphew & Baker, 2004; Cheslock & Gianneschi, 2008; Sweitzer, 2008; Volkwein & Sweitzer, 2006; Bowen, 1980; Pfeffer & Selancik, 2003; Bastedo & Bowman, 2011). There are never enough resources to satisfy efforts to enhance reputational capital and to also run the institution, and universities will use all means necessary to do both (Bowen, 1980; Ressler & Abratt, 2009).

This is important to this study, to UBC in general, and to the three premises of the *triple* helix for several reasons. First, in periods of extended retrenchment (essentially the last 30 years), this is heightened further and pressures institutions to pursue new resource streams that are exceedingly different from their originally conceived missions (Slaughter & Rhoades, 2004; Slaughter & Leslie, 1997). These new pursuits lead to the creation of new organizational structures on campus, including TTOs, CROs, and, most commonly, entrepreneurialism (Slaughter & Leslie, 1997; Alpert, 1985; Bok & Bok, 2009). Here, the term indicates not only technology commercialization programs in premise of *triple helix* theory, but also among academic units as well. Faculty and administrators find both institutional and personal prestiges are increased by successful entrepreneurial activities (O'Meara, 2007).

Second, resource availability is a key driver of UBC *and* a key barrier to UBC (Davey, et al., 2011; Galán-Muros & Davey, 2017; Galán-Muros, 2015; Bruneel et al., 2010; D'Esta and Perkmann, 2011; Plewa, et al., 2013). Thus, UBC is dependent on the creation of resources to enable successful processes. Notable as well is the connection of these new organizations and new resources towards increased reputational capital. In

effect, isomorphism and dependence are inherently connected, with one believed to enable the other. In the minds of administrators, creating a new function begets more resources because other successful universities have done it already. This permeates the culture of the institution (look and act the same as the elites) and impacts the development of relationships accordingly (mostly negatively). In most cases, this simply creates more barriers to successful UBC, but institutions do not really notice as they are thankful for the new resources.

In a related manner, the third impact of this resource dependence on UBC is the resource outcome expected from these new organizations. When a new organization is created to foster new resources, it is done in a manner consistent with Zemsky & Massey's *administrative lattice* concept. In other words, universities do not just copy the organizational structure, they copy the approach to pursuing new resources, compete for the same resources, and measure themselves in the same manner (Metcalfe, 2010). So, if a new commercialization program is created, the metrics of that organization are the same at nearly all institutions. The same holds true for CROs. This means that the dependence on resources becomes an annual metric and incentive for those who work in those organizations, which means that they become singularly focused on achievement in that specific arena.

Why is this a problem? Well, take for example the creation of a new CRO. A striving university might look to the elites and find that those institutions are achieving a rate of 10% of total philanthropic revenues from corporations and automatically make that the goal of the new CRO. The staff of that CRO then do all they can to hit an arbitrary target created for them based on another institution's reality and immediately

ignore any opportunity to find efficiencies amidst the broader institutional construct (Pfeffer & Selancik, 2003). All that matters is hitting a target dollar figure, even if there is no actual relationship to the operations of the institution. Thus, the efforts of the office ignore any conditional process and focus only on UBC activities, in much the same manner found in Galán-Muros' 2015 studies.

So, classification creates an interorganizational dependency (Bastedo & Bowman, 2011) that perpetuates inefficient behavior through the creation of new organizations rather than the repurposing of existing organizations *and* promotes behavior that misaligns the use of resources for the sake of pursuing the same resources as other institutions. This has a strong correlation to UBC as these new and existing boundary-spanning functions become less evolutionary and more uniform in structure, outcomes, and process. Alpert, in 1985, refers to this idea as performance and paralysis, and it is clear that despite the *new position of the university* (Etzkowitz & Leyesdorff, 1997, 2000), little has changed during this hyperextended period of retrenchment (Pfeffer & Selnacik, 2003).

Boundary-Spanning Organizations

In an effort to remained anchored to the ideas of the *triple helix*, the indications are clear that *institutional transformation*, *evolutionary mechanisms*, and the *new position of the university* should be called in to question for any boundary-spanning officer not specifically related to commercialization. It is unlikely that Etzkowitz & Leyesdorff (1997, 2000) intend for the *triple helix* model to mean, "Mimic elite institutions regardless of impacts on actual quality and that count transformation and

evolution". In fact, this offering considering the future of the university suggests otherwise:

> Beyond the ability of the top leadership of the university to engage with their counterparts in other institutional spheres, a mid level organisational linkage capability gives the university the ability to identify confluence of interest between external organisations and their academic counterparts. Interface specialists make introductions, organise discussions, negotiate contracts, and otherwise act in an intermediary role to facilitate interactions with their counterparts and other potential partners in government and in industry. Interface specialists emanating from various organisations and institutional spheres forge a common identity, independent of their employers. This is expressed organisationally in the creation of organisations representing the emerging interface professions. – Etzkowitz, Webster, Gebhardt, Regina, & Terra, 2000, pg 316

Again, classification leads to R&D investment and eventual resources, which is critical to enabling the new role of the university, and offices to pursue these diverse resources with business and government are important. Despite this criticality of boundary-spanning roles, they remain disaggregated and require substantial empirical exploration to understand how these organization work and to what end (Aldrich and Kercher, 1976). To understand why these functions have yet to evolve, it is important to explore the ideas of boundary spanning in more depth.

The *support mechanism* space of the Framework identifies multiple elements that influence UBC, including policies, strategies, practices, and structures. Each of these elements, or objects, exists at the boundary of institutional context and internal constituency, requiring active and regular management to facilitate successful interactions. Researchers using boundary organization theory refer to these types of elements as boundary objects and their use as boundary-spanning activities (Guston, 1999, 2001; Tornatzky et al., 2002; Kirby, 2006; Parker & Crona, 2012). However, little work has been done to either identify boundary organizations or to explore their

functionality, efficiency, or impact within universities (Parker & Crona, 2012), particularly in the context of UBC. As with most *triple helix*-related research, much attention has been given to TTOs, whose outcomes are related mostly to knowledge transfer via intellectual property. This is understandable given that the earliest investigator of boundary spanning, Paul Hirsch (1972), focused his work on industrial transfer of innovation to market, which provided a foundation for Etzkowitz & Leyesdorff's eventual premise of the university as a primary driver of innovation systems (1997, 2000).

Among the initial researchers to study the idea of boundary spanning for universities was David Guston (1999). While Guston (1999) primarily explores boundary spanning of science and policy using the TTO, his work is still relevant to this study as it is the first to explore principal-agent theory in the context of universities. Guston also explores the role of the TTO as a boundary-spanning organization and provides support to the notion of professionals akin to the "interface specialists" referred to by Etzkowitz et al., who act on behalf of the institution and its researchers. In his follow-on 2001 study, Guston furthers his exploration of boundary organizations and presents several assumptions to frame boundary organization theory. The first presents a firm bilateral position of boundary organizations holding distinct positions within their institutions and serving only those constituents. The second presumes that boundary organizations are equally accountable to all stakeholders. The final assumption suggests that all parties can be satisfied and that the organization represents stability through their satisfaction. Through the lens of the TTO, with its primarily transactional enterprise, these may generally hold true – particularly in satisfying an

external demand (primarily governmental) to measure productivity via research outcomes.

From the standpoint of CROs and UBC, however, Guston's work is not sufficient enough to explain the complexity of interactions represented in the Framework, much less in the *triple helix*. For this, we turn to Parker and Crona's (2012) modified and more relevant exploration of university-based boundary organizations. The authors' important amendments include a recognition that such organizations work within a hybrid space (*triple helix*) that includes numerous directive constituents; the recognition that some stakeholders (funders) influence accountabilities more than others; and that stability is unlikely, given the strain associated with maximizing one stakeholder demand over another (striving constraints). These adaptations more adequately equate to the *supporting mechanisms* and *barriers* identified in the Framework.

Parker and Crona's (2012) six summary points also inform concerns of this dissertation. First, they note that boundary management (the role of the boundary organization) is an ongoing *process*, which suggests that established annual metrics are unlikely to be useful in determining organizational success. This assumes that, second, boundary management is not transactional or bilateral but instead requires identification and management of competing needs and opportunities (*circumstances*) with an eye toward stability. Third, the desired outcomes of each party (and associated incentives) rarely coalesce across boundaries or even internally. As such, an expressed *strategy* to address demands explicitly and purposefully is required to remove *barriers* and leverage *drivers*. Fourth, boundary organizations should identify collaborative

mechanisms (activities) that allow various stakeholders to address divergent demands. Fifth, boundary organizations should enable regular external assessments of their processes and undertakings, particularly to align best with powerful external stakeholders (*policies*). A process I suggest is a mechanism of professionalizing the function, which may also support the final point that boundary organization(s) should be highly aligned with their institutions administratively (*structures*).

Parker and Crona (2012) provide the only empirical study to consider boundary management beyond transactional outcomes. It is clear to this point that CROs are considered essential to resource development but have failed to substantially evolve beyond transactional support. This fact is bolstered by McCoy's (2011) findings that, while there are different reporting schema for CROs, the majority still maintain their philanthropic transactional nature. In developing a typology of US CROs, he determines that there are three common types active in contemporary research universities: *philanthropic* (primarily responsible for corporate fundraising); *industrial* (focused on philanthropy and research); and an emerging *hybrid* (similar to Parker and Crona but still responsible for resource development). Such offices are certainly staffed with interface specialists (McCoy, 2011; Clevenger & MacGregor, 2015), so it would seem that these would be great candidates to more purposefully follow the Parker and Crona recipe. Questions remain as to whether these functions are actually boundary spanning, why they haven't evolved more aggressively, and whether they are effectively aligned with the institution.

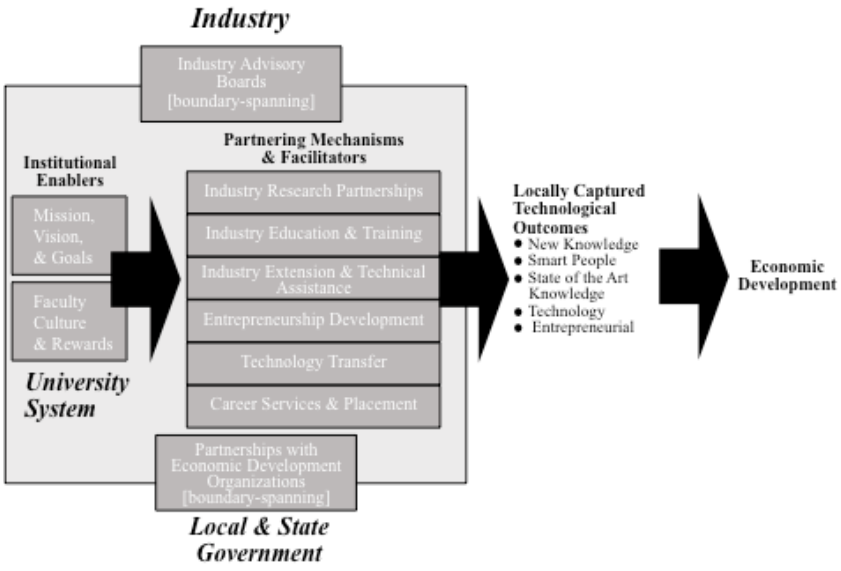


Figure 5 – Institutional Enablers & Boundary-Spanning Structures in a Knowledge System (Tornatzky et al., 2002, p.19)

Tornatzky et al.. (2002), following an extensive study of innovation across 12 US institutions, identified organizational enablers that facilitate UBC. Shown in Figure 5, these are conceptually important to understanding how institutional alignment affects partnering mechanisms in all university-business relationships. Notably, these enablers represent some of the internal variables within the *support mechanism* section of the Framework. The graphic also identifies some common boundary-spanning activities (partnering mechanisms) and provides examples of boundary-spanning structures. Tornatzky et al.. (2002) submit that universities that are more active in UBC are more likely to have multiple boundary-spanning organizations to manage UBC, a fact supported by numerous other investigators as already discussed.

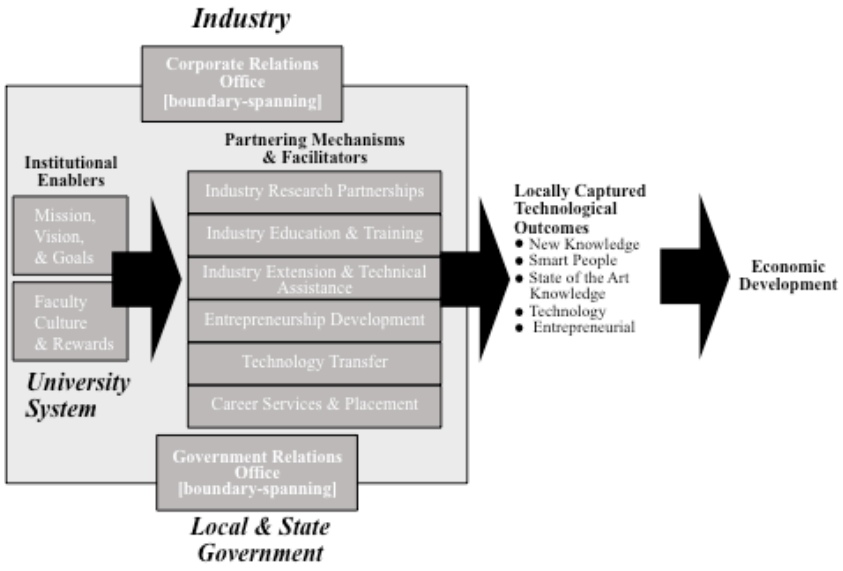


Figure 6 - CROs as Boundary-Spanning Offices (adapted from Tornatzky et al., 2002, p. 19)

In Figure 6, I propose that despite the omission of resource development in Figure 5, we know that CROs are key to UBC, and therefore they *are* boundary-spanning organizations. As such, their work is complex and inherently informed by both internal and external forces that make measuring efficiency and effectiveness nearly impossible given the numerous variables. Rather, the work of these offices should be considered an ongoing effort to satisfy multiple constituents among changing institutional contexts, support mechanisms, and circumstances. In that sense, CROs could be *aligned* with the institution; however, I propose that these perceptions of alignment are more a reflection of isomorphic metrics than active alignment towards enabling increased UBC and institutional reputation. This misalignment is one indication of lack of substantial evolution and potentially indicates a lack of true efficacy for CROs in boundary management.

Parker and Crona remark that the organization studied in their paper "struggled in its attempts at boundary management" (2012, p. 286) and conclude that effectiveness

of boundary management requires knowing what to do when and for whom. Perhaps more broadly applicable is this recognition from Alpert from nearly three decades prior: "On most campuses, there are a few dedicated individuals who have aspirations for redirecting educational programs across departmental boundaries, but they typically are denied sufficient organizational, financial, or moral support to translate these intentions into functional programs" (1985, p. 277). From this we can again affirm that merely looking like elite universities seems to suffice, which means that efforts to be less transactional and more rational, efficient, or efficacious, are likely to go unnoticed and unrewarded. Evolution, in effect, is impossible without a stronger understanding of the comprehensive boundary conditions and the conditional effects that result.

Summary

This literature review established the boundaries of this dissertation through the use and enhancement of the nascent UBC Ecosystem Framework (Galán-Muros & Davey, 2017) that normalizes UBC research within *triple helix* theory. The review then leverages the Framework to reveal the connections of striving behavior (institutional context) to boundary-spanning functions (supporting mechanisms), R&D expenditures (circumstances) and, corporate philanthropy (UBC process activity). The literature has yet to provide a clear view of these connections, particularly though the lens of *triple helix* theory. The premise of the *triple helix,* while optimal for legitimizing the need for intermediaries between industry and university and advocating for higher education's increased importance in a knowledge economy, does less for compelling complex models to explore complex relationships. In part, this is due to the focus on technology commercialization outcomes, particularly in elites, for which the metrics are more

easily measured, labeled as UBC, and then touted as successes for lesser schools to copy. In practice and in theory, *triple helix* advocates and UBC researchers might present more compelling data and arguments by taking all conditional effects into consideration in their work. Thus, the implementation of a more inclusive methodology that explores the comprehensive effects within a given UBC process is warranted and will provide a much stronger picture of organizational behaviors towards UBC outcomes and institutional objectives.

With respect to striving, much has been written about the behavior but the construct remains difficult to consistently use, given the challenges of varied ranking protocols, the use of PCA for CCIHE, and the assumption of perpetual upward drift. However, researchers have leveraged striving to good effect and this study replicates their approach with some minor modification. Striving creates institutional behaviors, including academic and upward drift (Morphew & Baker, 2004; Aldersley, 1995), that are supported by an administrative lattice (Zemsky & Massy, 1990) in pursuit of increased reputational capital (Ressler & Abrattt, 2009). These behaviors lead to seemingly irrational spending decisions with respect to resource allocation and encourage institutions to develop organizational resources that both mimic elite institutions (DiMaggio & Powell, 1985) and perpetuate inefficient allocative behavior (Armstrong, 2016; Christensen et al., 2011).

Among the resources created to support striving behavior, indirectly or directly, are boundary-spanning organizations such as CROs. While CROs in US institutions come in numerous forms (McCoy, 2011), they are all generally intended to fill gaps created by striving behavior through replacement of cost-shifted funds with R&D-

related funding and corporate philanthropy. As CROs evolve in response to internal and external pressures, organizations such as NACRO seek to professionalize the functions and identify common metrics. Establishment of such common measures in US institutions, to this point, has proven difficult, given the complexity of UBC (Galán-Muros & Davey, 2017), variations in office typology (McCoy, 2011), anchoring in philanthropic antecedence, and misalignments of other boundary-spanning organizations amidst the administrative lattice. Thus, questions of effectiveness and efficiency of CROs remain, particularly when assessed against institutional goals for prestige.

This study, therefore, seeks to address this issue and lays the groundwork for the establishment of more strategically- and institutionally-aligned metrics at a given institution. Through use of the Framework to establish a construct, it also addresses several key future research objectives noted by Galán-Muros and Davey (2017) including: empirical testing of Framework elements and their relationships; quantifying elements described in the Framework; applying the Framework within a US institutions context; exploration of efficient allocation of resources to maximize impact; expansion beyond current UBC literature that primarily explores innovation assets such as entrepreneurship and technology transfer; and establishment of a statistical framework for modeling interactions within the Framework.

Chapter 3: Research Design and Methodology

Research Design Overview

To assess interactions within the Framework as identified in Chapter 2, this study builds on previous UBC and higher education organizational research to advance a model that depicts conditional effects related to institutional resource development (both acquisition and allocation). Specifically, I focus on the indirect effect of R&D expenditures, arguably *the* key component of striving activity when assessed collectively, on the relationship between classification and corporate philanthropic investment. As noted, CROs serve as a proxy for boundary-spanning offices in this study. In US institutions, these offices act as a supporting mechanism, often held accountable for the acquisition of financial resources from corporations to foster enabling activities and research activity. This suggests that these offices act as a moderator in the model mentioned above.

Given the combined complexity of the construct, its underlying models, and the nascence of this concept, I spend more time detailing the process undertaken to advance the final model later in the chapter and refrain from depicting the model here. The remainder of this chapter provides obligatory background information with an exploration of the variables in the model, provides details on data sources when necessary, explains the development and analysis of the data panel, and provides an exploration of the various *conditional process analysis* models used in the observation. In both the variable exploration and data analysis sections, I align the hypotheses to the requisite elements in those sections as depicted in Table 3 below. Models identified in Table 3 indicate the mediation and moderation statistical models provided by Hayes

(2018) when using PROCESS for SPSS. This approach is different from traditional approaches and is employed in this study because, as noted in chapter 2, it is not enough to simply establish the relationship between the complex variables when holding all other variables constant in the UBC process. To best understand the interactions in the ecosystem, we have to investigate the effect of *X* on *Y* amidst the conditions of the interaction, which is to say that we have to explore how (under which influences) and when (under which circumstances) the effect occurs (Hayes, 2018).

Conceptually, the difference in the two approaches can be seen in Figures 7, 8, and 9 below. Note that in our case, it is possible to simply explore the direct effects of the variables on each other when controlling for the other variables (Figure 7). While this might give us some interesting insight, it likely overstates the effects by ignoring the *process* by which the relationship occurs. In isolation, the effect might be robust, but when taken as a function of a conditional process (i.e. one variable mediates the relationship between the others), that effect might not be substantial. That is to say that the initial direct effect possibly exists *only* when certain influences and circumstances exist as well. Isolating the interactions does not fully explore the phenomenon (Hayes, 2018), particularly when there is a high likelihood that an intervening variable (a mediator) might account for said interaction. In this study, classification (*X*) is expected to have an effect on corporate philanthropy (*Y*) that is mostly attributable to the influence and circumstance of R&D expenditures as a mediator (M_i) (Figure 8). Rather, the effect is indirect (conditional) through R&D. Additionally, the resulting conditional effects are expected to increase in strength based on the presence of a CRO (Figure 9), which acts as a moderator (*W*) of the conditional relationships.



Figure 7 - Traditional Linear Regression Approach

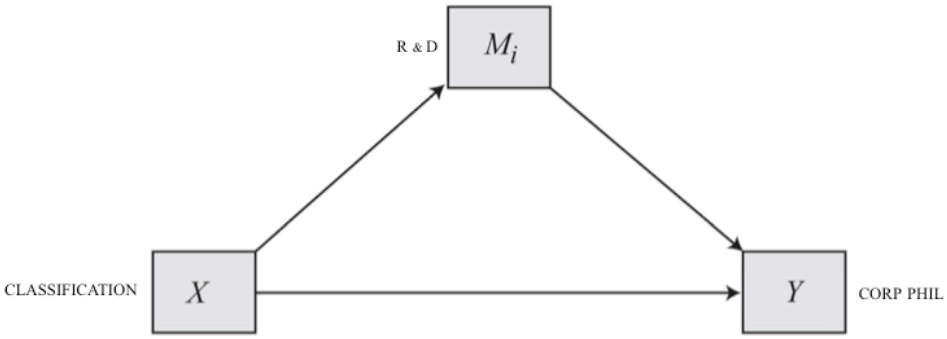


Figure 8 - Simple Mediation Approach

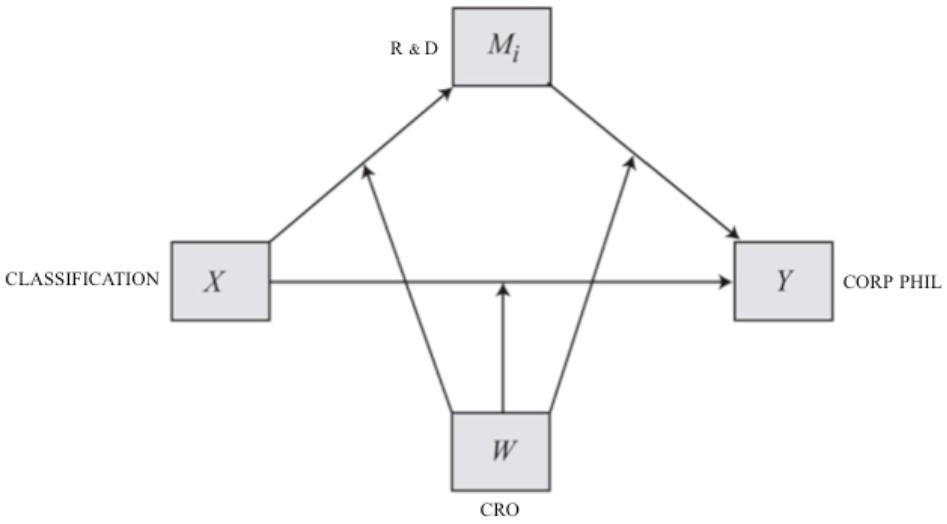


Figure 9 - Conditional Process Approach (Moderated Mediation)

Research Question	Test(s) & Models	Validation
H1 After accounting for covariation, research and development resource flows will have a significant indirect effect on the positive relationship between classification and philanthropic resource flows from industry.	Tests: 1-7 Model: 4	• Strong Positive Indirect Effect of R&D of Classification on Corporate Philanthropy • Potential Covariates Identified • Exploration of Alternate Models
H2 Taken together, the comprehensive conditional indirect effects are sequentially dependent.	Tests: 8a – 8b Models: 4 & 6	• Parallel or Serial Mediation Determined • Causal Priority Established • Covariates Partially Affirmed
H3 After accounting for covariation, the presence of a corporate relations office, regardless of type, will have a positive moderating effect of a) classification on research and development resource flows, b) research and development resource flows on philanthropic resource flows from industry, and c) classification on philanthropic resource flows from industry.	Tests: 9-10 Model: 59 & 92	• Parallel or Serial Moderated Mediation Determined • Covariates Affirmed

Table 3 - Research Questions, Tests, Models, and Validation

Population and Sample

This study drew upon data from numerous extant databases, aligned the data directly with the literature (for categorization) when necessary, and then engaged in several data reduction approaches to arrive at the most justifiable and robust panel dataset. Sources of data included the 2010 and 2015 Carnegie Classification(s) of

Institutions of Higher Education (CCIHE), 2007-2017 National Science Foundation (NSF) Higher Education Research and Development (HERD) surveys, the Council for Advancement and Support of Education (CASE) Voluntary Service to Education (VSE) 2007-2017 surveys, and data from the Network of Academic Corporate Relations Officers (NACRO) 2014, 2016, and 2017 annual member surveys. All universities that appeared in the 2010 CCIHE report were initially eligible for this study, which yielded an initial sample of 4,635 institutions within the Basic Classification.

In 2005, the CCIHE shifted its classification nomenclature away from a numeric identifier (i.e. R1, R2, R3) to a more descriptive identifier in an effort to combat comparisons or use of the classification as a tiered or status system among institutions. In 2015, the CCIHE reverted to the previous numeric sequences that reflect quantitative differences such that doctoral institutions are differentiated by research (R) activity and masters institutions (M) by degree conference. This infers that M institutions do not produce significant research activity, though to understand striving behavior, such universities cannot be summarily eliminated at the outset. Therefore, using research doctoral degree offerings as a proxy for potential research and development activity, all institutions that offered more than 20 research doctoral degrees were retained. Additionally, all institutions controlled as "for-profit" were eliminated under the assumption that their organizational behavior is specifically intended to be profit-driven, indicating the likelihood of more "business-like" approaches. Accordingly, only universities that were classified in one of six classifications were considered (Master's/S [M3], Master's/M [M2], Master's/L [M1], Doctoral University Moderate Research Activity [R3], Doctoral University High Research Activity [R2], and Doctoral

University Highest Research Activity [R1]. As a result, the 2010 CCIHE provided a list of 882 potential institutions.

To determine available institutions, the 2010 CCIHE list was compared to the 2015 CCIHE basic classification report. Though the exact formula for classifying has changed over the years, the core data elements remain generally the same, which allows for initial direct comparison between CCIHE reports without concern for sampling error. The 2015 data yielded 4,666 initially eligible institutions. Using the same technique used with the 2010 data resulted in 1017 potential institutions. The 2010 and 2015 reports were then compared using Microsoft Excel to establish a base institution set. Using the 2010 report as the anchor, a line-by-line comparison identified variations, including previously unclassified and/or merged institutions, closed institutions, reclassifications, and naming changes (e.g., "X State College" to "X State University"). The resulting institution list provided 953 potential institutions to be assessed for striving behavior.

To determine striving institutions, a step-wise approach was applied to the data. The initial segregation identified all institutions that received a 2015 CCIHE classification that were at least one level higher than the 2010, classification with the caveat that all previously unclassified institutions were considered nonstriving in the initial step, yielding 241 striving institutions and 76 nonstriving (they dropped at least one classification). However, the literature suggest striving behavior may be more prevalent than reclassification might indicate (O'Meara, 2007), so perhaps recreating the principal component analysis (PCA) approach used in the creation of the CCIHE indices might provide some indication of striving behavior among institutions within

classifications. Such an undertaking would likely prove inaccurate, however, due to the questionable accuracy of PCA, the relatively arbitrary nature of CCIHE segmentation indices, and because data used in PCA are not longitudinal but rather are point-in-time indicators (Harmon, 2017).

Agreement among researchers is consistent as it relates to organizational competitive behavior, with most suggesting that a) institutions are aware of and recognized by their classifications publicly (Morphew & Swanson, 2011; Sweitzer, 2008; Volkwein & Sweitzer, 2006) and as a result set strategies to a) ascend to the next classification (Morphew & Swanson, 2011; Bowman & Bastedo, 2011; Aldersly, 1995, O'Meara, 2007), or c) defend their relative position (Morphew & Baker, 2004; O'Meara, 2007), in out years. At a minimum then, we can realistically accept that all R1 institutions are actively defensive and therefore exhibit striving behaviors. This is less clear among the other five classifications, and as noted in chapter 2, we are really most interested in the characteristic behavior of striving as a control mechanism as it relates to institutional activity. Therefore, using PCA factors as a guide suggests that capturing data related to institutional R&D activity is relevant.

Using that logic, I then retrieved HERD data (R&D) for all R1-M3 institutions and resorted the output to align to the base institution list. I also retrieved and resorted VSE data to determine institutions reporting any corporate voluntary investment (CPHIL) from 2007-2017. I then sorted for institutions reporting $0 in R&D and $0 in CPHIL from 2007-2016 and retained only those institutions reporting research, leaving 612 available institutions. A sort by classification indicated significant inconsistency in

reporting from M2 and M3 institutions, so the remaining 116 were removed from the population.

Using combined data from NACRO surveys from 2014-2017 (3 total), 219 institutions were identified as having CROs (sometimes multiple within the same institution). These data were used in three ways. First, I used them to assume "activity" at the institution related to corporate relations, as participation in the professionalization of the administrative lattice could be seen as an indicator of prestige seeking (Zemsky & Massey, 1990). I recognize, however, many institutions might actively undertake these endeavors without participation in NACRO, but determining office type for non-NACRO participants would be a futile and inaccurate undertaking. These 219 institutions were sorted to identify the three office types important to this study (philanthropic, combined, hybrid) as noted in the variables section below. Finally, the list was resorted to align with the base list and non-NACRO institutions were subsequently removed. This left only 33 M1 institutions, a number that is significantly short of any relevant sample size (unsorted N=375 for M1 institutions following the 2010-2015 merge as noted above), so these institutions were also removed from the population.

The unscreened final list yielded 186 institutions for use in the study. Using the formula for simple random sampling on N=307 (R1-R3 institutions post 2010-2015 merge as noted above) research institutions reporting R&D expenditures and corporate philanthropy, required a minimum sample size of 171 institutions. In addition, given the parameters of this study, 109 institutions are needed to have adequate power (.80) to detect a small effect (f =.15; G*Power Software; Mayr, Erdfelder, Buchner, & Faul,

2007). Both parameters where met after accounting for reported office typology, leaving a base sample of 186 institutions available for data screening.

Variables, Data Sources, & Alignment to Research Questions

This section explores the nature, impact, and alignment of the variables identified for exploration in this study. There are four primary variable groups with multiple underlying derivatives within each for a total of 17 variables when counting the primary variables. I describe the primary variables in detail below and identify the derivatives in parentheses when appropriate. Importantly, during the course of this research, the number of variables actually leveraged in the model changed on numerous occasions until the appropriate combination was determined. After each adjustment, the data were rescreened as described below using the unscreened base dataset defined above for consistency. The final variable count applied in the study included 15 variables across the four primary groups with eight used to assess multicategorical impacts (CRO type and classification) and nine variables used for k-means and applied to the model as advanced. Also important to note is that each of the parent variables other than classification was evaluated for antecedence, dependence, mediation, and moderation to assess covariance and to "disentangle spurious and epiphenomenal association from potential causal association" (Hayes, 2018, p. 184). The variables presented below do not discuss this in detail, with the exception of CRO, and are presented in accordance with the Framework as described in Chapter 2.

Carnegie Classification Variable

Chapter 2 provided historical detail related to the Carnegie Classification of Institutions of Higher Education and some detail regarding the literature around striving

behavior. Based on that review, the variable of classification, designated as CLASSR1, CLASSR2, CLASSR3, and CLASSALL in SPSS (dummy coded as R1 = 1, R2 = 2, R3 = 3), provides the basis for the independent variable in this study. The literature and CCIHE PCA values provide a mechanism to identify striving institutions, an important control variable in this study (designated STRIVE in SPSS) since institutions that successfully change classifications upwards have been shown to increase their R&D related expenditures substantially in hopes of greater prestige (Morphew & Baker, 2004; Bastedo & Bowman, 2011; Volkwein & Sweitzer, 2006; Iglesias, 2014; Sweitzer, 2008; O'Meara, 2007). Originally, this study sought to focus on striving institutions alone in an effort to understand resulting R&D from such investments. However, in the course of developing the data set, it became clear that all research institutions are striving in some manner when viewed through the lens of the PCA factors. Often, this is merely to sustain their current position and sometimes, despite best efforts, institutions increase relevant indicators yet still drop in classification (see Harmon, 2017).

Therefore, for this study, all research institutions were considered following an extensive analysis of striving and non-striving activity between 2010 and 2015 CCIHE reports. A cursory analysis of the 19 non-striving research universities indicated that comparative R&D expenditures combined with a drop (or relative drop) in humanities PhDs conferred was the primary factor for the 8 institutions that went from R1 to R2 status. For those that dropped from R2 to R3, the primary culprit was a shortage of non-faculty research staff, and for those that dropped from R3 to M1, a lack of R&D funding was the primary factor. Conversely, of the 66 striving research universities,

those M1 institutions that moved up to R3 (32) seemed to have done so through an investment in non-faculty R&D staff, while those moving from R3 to R2 (19) or R2 to R1 (15) all did so with substantial investment in reported total R&D expenditures and combined humanities and social sciences PhDs conferred. Across all institutions, 241 institutions moved upward at least one classification and 76 dropped at least one classification.

Figure 10 below provides an oveview of the increase in R1 institutions since the outset of the CCIHE classifications in 1972. Important to the visual is the continued rise in R1 from 52 in 1972 to 115 in 2015, despite the downward trend in federal funding (as a percent of total) during that same time frame. From the literature, it is clear the striving behavior begets more resources but, in turn, also incrementally increases operating costs (Volkwien & Sweitzer, 2006; Bastedo & Bowman, 2011; Alpert, 1985; Bowen, 1980; Morphew & Baker, 2004; Ehrenberg, 2000). The findings from Bastedo and Bowman (2011) are particularly important to this study, as they determined that classification has a causal relationship with resource providers, especially those in government who provide R&D support. This supports the notion that classification serves as the independent variable for this study while R&D expenditures serve as a significant mediator of other related institutional activity, including investment from industry.

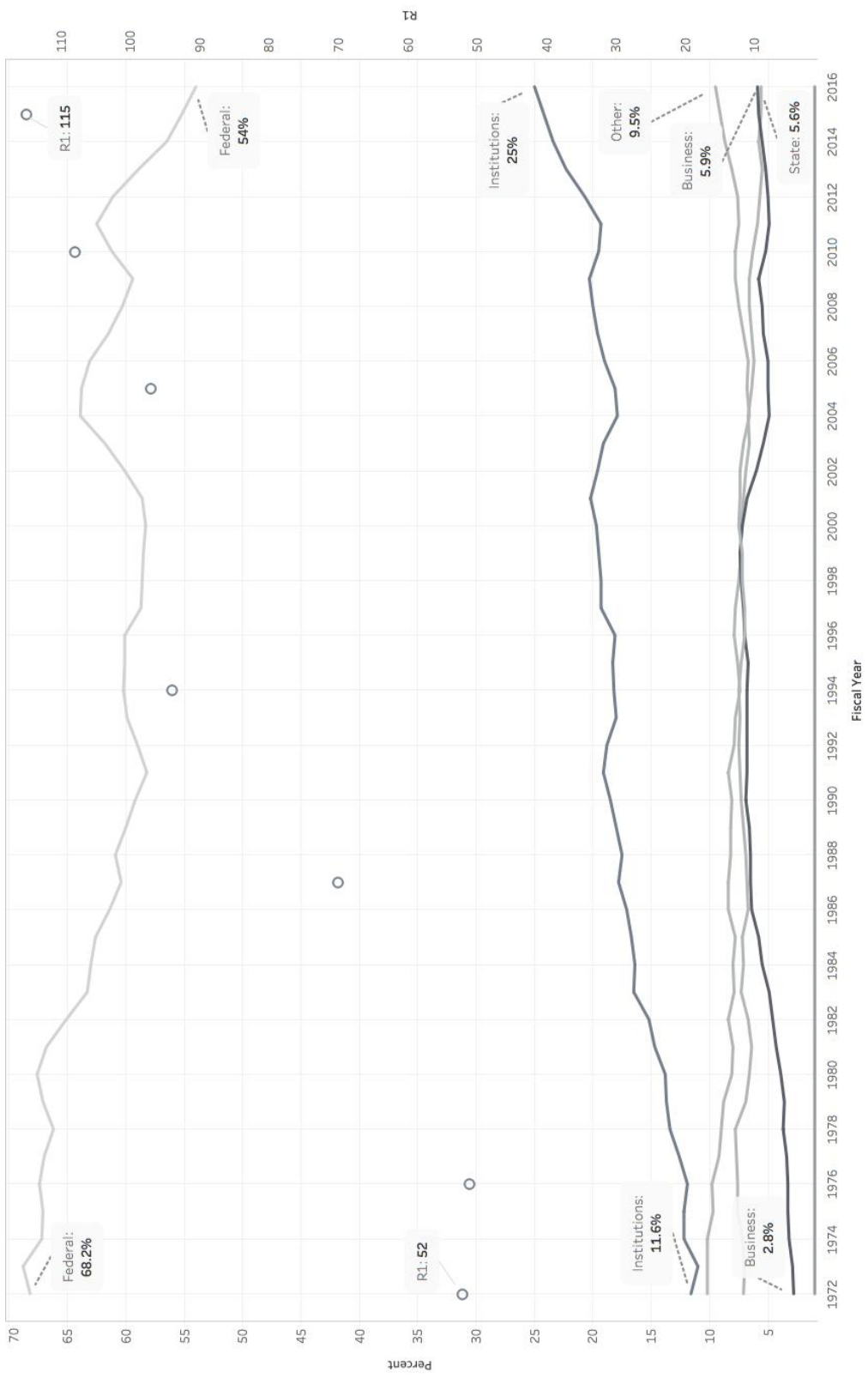


Figure 10 - Percent Contribution to Total R&D Expenditures by Source 1972-2016 with Carnegie Classification Growth Overlay
(NSF HERD, 2018; Indiana University, 2018; Shulman, 2001)

R&D Expenditure Variable

Corporate investment in R&D at universities has never been above 7.8% (FY2000) of total R&D funding and generally remains at just below 6% at current rates. While this is twice as much a share of the total investment than in 1972, in unadjusted dollars, corporate investment in R&D has grown from $2.9 Billion in 1972 to $4.2 Billion in 2016 (Britt, 2015; NSF, 2018). Meanwhile, in recent years the federal contribution has dwindled as a share of the total, down from 68.2% in 1972 to 54% in 2016, and though total dollar outlay is significantly greater (~$8b to $31b), the last decade has shown the longest steady and continuous decline since figures were recorded in 1972 (Britt, 2015). These indicators are demonstrated in Figure 10, where it is also evident that institutional investment in research has grown significantly during the same period, from 11.6% to 25% of the total. Not surprisingly, this upward trend also matches the upward trend in R1 institutions (also shown).

Without deeper exploration, it is justified to assess that on the low end, for every $100 in research spent at a university, $25 come from institutional coffers *before* accounting for capital and administrative expenses. This figure includes lost indirect cost recovery (overhead) and institutional direct investment towards research projects. When considering that since 2002, universities have contributed 64% of the cost of new science and engineering buildings alone (NSF, 2018), the financial picture is even more concerning. Add to that the fact that the top 100 universities in R&D expenditure receive 80% of the total federal distribution of R&D (Figure 11) and the opportunities to advance to R1 status are pretty bleak. It is not any wonder why technology transfer has received so much attention from researchers and practitioners alike or that

universities have pressed for CROs to pursue research funding or philanthropic support for research. The chances of recovering at least some of the expense allocated towards research are enticing, *if* an institution can do so without increasing its administrative expenses accordingly.

As provided by Morphew and Baker (2004), this doesn't appear to be the case, given their finding that rising R1 institutions spend considerably more on administrative costs (Leslie & Rhoades, 1995) in support of research. Holbrook and Sanberg present a rather dark picture of the effects and necessity of this increased institutional investment in R&D (and administrative support), concluding "A university's challenge is to reduce costs where there are unnecessary duplicate activities, to generate more revenue to support research (primarily by increasing the effective F&A rate)" (2013, p. 280). Morphew and Baker agree, suggesting that in accordance with Bowen (1980), universities should show that "new spending on institutional support is efficient, meaning that it contributes to important institutional outcomes in ways that reflect each university's goals and resources" (2004, p. 381).

A look at the role of corporate philanthropy, however, suggests that institutions are not biding this advice in their search for increased prestige. As shown below, the majority of real funding (cash) from corporations is directed towards student support. When considered alone, that appears to be a positive investment for both parties. When considered among conditions that include R&D expenditures, that investment appears to be a reactionary mechanism as a result of cost shift to recover student tuition increases as a result of increased R&D related expenses (Ehrenberg, 2000; Armstrong 2016).

The variable of R&D carries significant importance for universities wishing to rise in classifications to R1 or R2 status. The variable used in this study is defined as total R&D expenditures as provided by the NSF HERD survey (NSF, 2018) as reported by institutional research officers on a fiscal year (July to June) basis. This is because total R&D expenditure, rather than institutional outlay, represents a significant portion of PCA load factors in the Carnegie classification equation. Additionally, total expenditures serves as an apt proxy while not necessarily accounting for total financial cost related to increasing PhD graduates or non-faculty research staff. I have designated this variable R_D14, R_D15, and R_D16 in SPSS and associate the variable to UBC circumstances both as resource availability (driver) and funding (barrier) circumstance. Accordingly, R&D represents the primary mediating variable in this study.

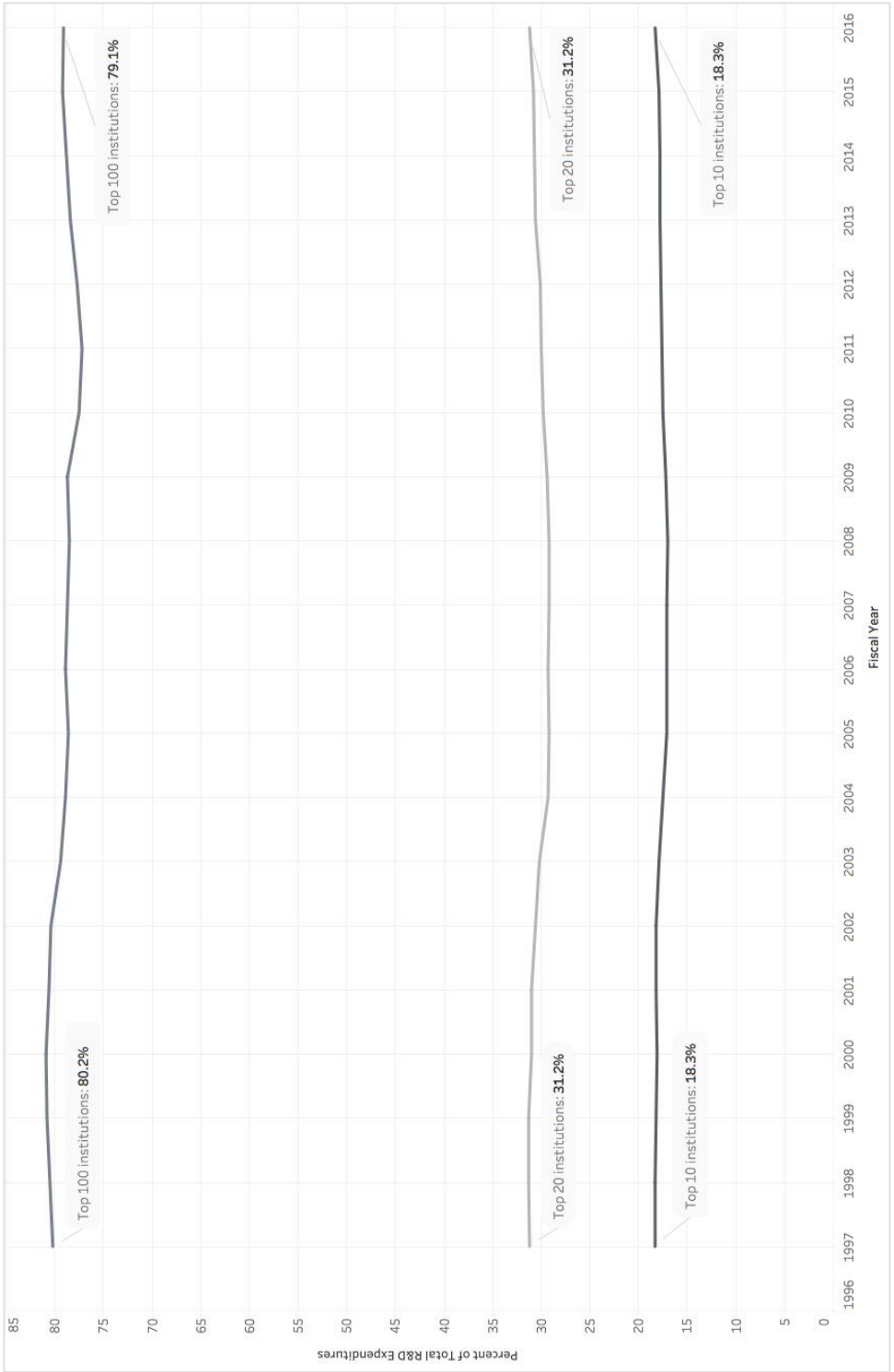


Figure 11 - Percent Distribution of Federal R&D Funds to Top 100 Spenders (NSF, 2018)

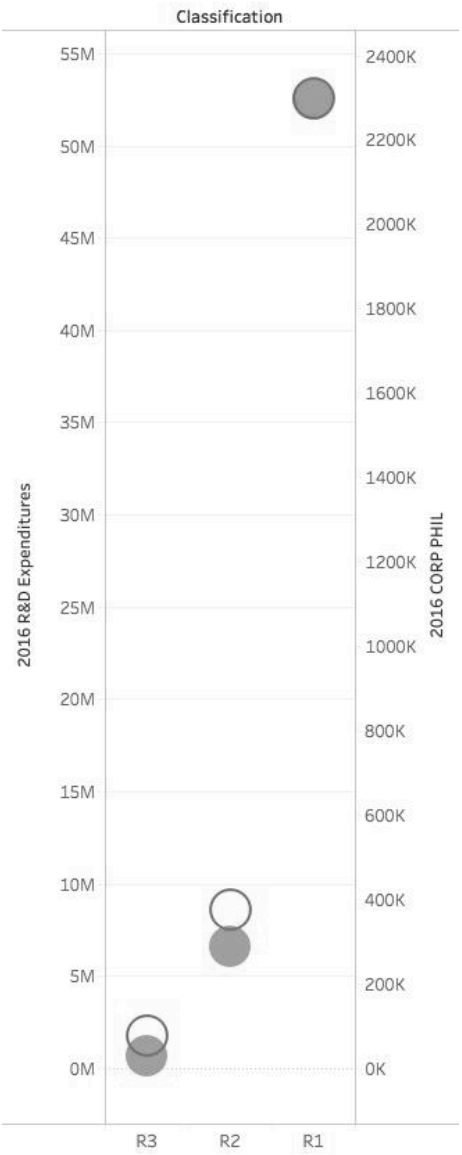


Figure 12 - 2016 R&D (filled circles) and 2016 Corporate Philanthropy (open circles) by Carnegie Classification (in 000s) (NSF, 2018; CASE VSE, 2018)

Corporate Philanthropy Variable

Just as increased institutional R&D expenditure is tied to increased R1 universities over time (Figure 7), so too can industry philanthropic investment be tied to both classification and R&D expenditures. Figure 12 shows total corporate philanthropy (open circles) and in relation to R&D (filled circles) by classification in

2016 for those universities with reported research activity greater than $0 since 2007. On average, R3 institutions reported $687m in research to $76m in corporate giving (11%), R2 institutions reported $6.5b to $375m (5.7%), and R1 schools reported $53.5b to $2.3b (4.4%). Nearly the exact same picture emerges regardless of year. However, from 2007–2016 percentage-wise, corporate philanthropy was 12% of R3, 5% of R2, and 4% of R1 institutional R&D respectively and, as reflected in Figure 7 and Figure 8, these distributions rarely change significantly over time.

The relationship at R1 status is remarkably correlated. However, it is important to note that Figure 12 represents all research institutions reporting research, not just those institutions used in this observation, so inferences shouldn't be drawn merely from the visualization. What does become obvious are the consistently high correlations of R&D, corporate giving, and classification, which suggests the necessity to conduct epiphenomenon (secondary, non-causal phenomenon), causal pathway, and confounding tests. For example, it is possible that corporate philanthropy causes R&D increases through direct investment in research, support of PhD programs, or direct support to faculty or faculty recruitment. Therefore, it is important to determine directionality and eliminate alternate relational pathways in this observation. Additionally, given the year-over-year consistency of the variables, it is important to explore the temporal influences. Assuming that prior-year corporate philanthropy influences current-year investment recognizes that industrial organizations are looking for some stability in their relationships and are likely to amortize an investment rather than provide support in a lump sum amount.

Finally, a delineation of industry philanthropic investment options is important to identify for this study. The VSE data reflect several options for corporate participation, including matching funds (where an individual donates and the company matches that donation at a designated percentage rate), company gifts in kind (property, products, software packages, or services), and cash and securities. IRS restrictions dictate how a university might recognize the value of these gifts, which provides some stability across institutions, though how these funds are used is a specific agreement between institutions. These funds can be designated as restricted (designated for a specific purpose) or unrestricted (for use as the university sees fit) support. Restricted funds typically account for 57% of support, with funding directed towards academic departments (13%) and research (21%) making up the bulk of those restricted gifts.

There are two points about this type of support that are important to note here. First, much of the support to departments either comes in cash to support a faculty member with high research funding (and potential intellectual property) or in products the company would like used during the course of research. Second, research-realted support reported as a gift typically does not have indirect cost recovery included, providing the funding partner with a much less expensive pathway toward research access. These points, considered with the fact that unrestricted gifts make up just 2% of the total support, indicate that corporations are purposeful about where they designate support.

To collect these data, reports were run using the Council for Aid on Education (CAE) Voluntary Support of Education (VSE) (CAE, 2018) reporting tool. Data reported to CAE for the VSE tool are provided by advancement (fundraising)

professionals at each institution and are aligned with an agreed upon set of standards as determined in the CASE Management and Reporting Standards Policy (CASE, 2018). These data are reported annually by institutions and reflect fiscal year (July to June) results. These are the data typically used to assess institutional performance and external validation.

The variable of corporate philanthropy, recorded in SPSS as CPHIL14, CPHIL15, CPHIL16 respectively and defined from the 2016 VSE report as corporate total, includes all gifts regardless of designation or type. This is done because it aligns best with metrics associated to CROs who are responsible for pursuing and recording industry philanthropic support, depending on office type. While this approach does not specifically explore efforts to replace lost R&D expenditures, it recognizes the current common approach at universities and thus serves as the dependent variable in this study. As with R&D however, corporate philanthropy may mediate future philanthropy as well, so this variable is also explored as a mediator in this study.

Corporate Relations Offices Variable

As provided in Chapter 2, McCoy (2011) formalizes office typology in the literature, building off of the work of Johnson (2008) and affirmed by Clevenger and MacGregor (2015). However, none of the parties makes a clear distinction as to how an office might identify itself, much less how those designations might be used in empirical research. In this study, I attempt to do so as described in the previous section (first, by stated type, affirmed by reporting relationship, and further qualified by outcome objectives). As McCoy (2011) describes, organizations may view themselves as centralized, decentralized, and/or holistic. These terms are somewhat at odds since

an office might be centralized and holistic (e.g., perform multiple functions) but report to the fundraising element of an institution. Another might report to the provost and consider itself holistic and centralized but not have a primary philanthropic responsibility. Both are correct interpretations but fail to accurately describe for what these offices are actually accountable and therefore make it challenging to determine a particular "type" for use in organizational studies.

Therefore, in this study, I define three primary types of offices: 1) those that focus purely on philanthropy regardless of reporting relationship; 2) those that focus on a combination of research and philanthropy (one outcome is often at odds with the other); and, 3) those "hybrid" offices that are holistic but sit outside of either research or philanthropy (from a reporting perspective), and that are intended, in fact, to be moderators and or mediators of any given relationship. The latter is a very small subset of office type, though it may be the direction most universities want to go in the future.

NACRO conducted a series of surveys from 2014-2017 in order to gather information from its membership. In the survey process, questions regarding reporting relationships, responsibilities, and type were asked. The three surveys were combined for this study and office types by institution were identified based on the combined results. For this observation, the NACRO data were dummy coded as 1 (philanthropic), 2 (dual report), or 3 (hybrid) as above. Those offices that identified as purely research were assigned a 2 under the assumption that there was also a philanthropic office at the same institution.

Collectively, CROs are likely to moderate R&D through science-related philanthropy, by securing research-related contracts as a result of awareness

development, by structuring collaborations and partnerships to move at the "speed of business" (master and template agreements, internal collaborations, risk management, etc), and by acting as the proverbial "front door" to the institution while actively exploiting existing comprehensive relationships (McCoy, 2011; NACRO, 2012). Meanwhile, any collective philanthropic moderation is likely the result of institutional awareness development, active pursuit of funding opportunities with faculty through proposal development, and efforts to leverage alumni to support student endeavors via corporate giving. Figure 13 below provides a graphic representation of where each office type is likely to have greatest moderation as currently organized (based on assigned outcomes) in a simple mediation model.

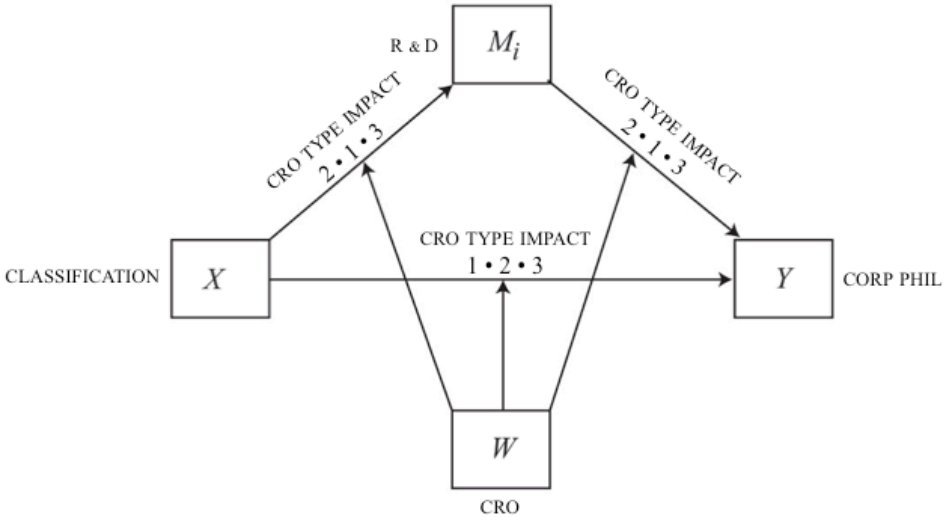


Figure 13 - CRO Projected Moderation Strength by Identified Office Type

Note that the hybrid office, type 3, shows the least moderation impact on each relationship. This is due, primarily, to the limited number of these types of offices and, secondarily, to the fact they are not directly responsible for either philanthropy or research engagement. This should not infer that they do not do this work, but rather

they are not directly accountable for the outcomes in those areas. Such an approach would likely show moderation effects equally across all areas. For this analysis of moderated mediation, the outcomes explored are research and philanthropy, which may not be the best use of these types of offices if those outcomes are not purposefully aligned with university operations. For example, we could see that Type 3 offices in this study, by the nature of their small representative numbers, have the least impact for outcomes on philanthropy and research, *but* another follow on study might show these offices have the greatest impact at driving out institutional capital expenditures to enable research growth in a fiscally responsible manner (i.e., lowering the cost of research by x cents on the dollar or via public-private partnership facilitation).

Models 1 and 2 are the most prevalent office types, at 64% and 32% of total offices represented in this study respectively. As a result, the data should reflect impact on R&D and philanthropic outcomes positively. The point to make here is that these offices are (typically) directly responsible for UBC activities related to research and building capacity. If such direction is effective when considering the boundary conditions in the process, the moderating effects should be positive. If there is no indication of moderation, then it is possible that these offices are not oriented towards institutional success in an effective manner or they are not measured appropriately (i.e., they should be measured on items related to UBC circumstances rather than UBC results).

The effectiveness of these offices is a significant vacancy in the literature, with no empirical studies found that specifically identify US type models and/or explore their role(s) in the UBC ecosystem. With no prior studies from which to draw inference, I

test for mediation and direct effects in this study as well. The variable of office type, identified in SPSS as CRO1, CRO2, CRO3, and CRO_A accordingly, is specific to answering hypothesis 3, though the tests for mediation and direct effect (CRO as *X*) are important to affirming hypothesis 1 as well.

Data Analysis

Methodology & Procedures

The UBC *ecosystem* Framework was developed to reflect the associative patterns related to UBC within the *triple helix*, a theoretical construct that specifically emphasizes interactions – an ecosystem at work (Galán-Muros & Davey, 2017; Etzkowitz & Leyesdorff, 2000). As we have seen in Chapter 2, the Framework provides the boundaries of this dissertation and as just described, allows for the identification of processional relationships based on a set of conditions. In essence, the ecosystem *is* a conditional process, built on a foundation of substantial scholarship as a mechanism to understand the interactions "at work generating the pattern(s) of association observed" (Hayes, 2018, p. 64). Whereas in more recognized regression approaches, the effort is intended to control a set of conditions in order to isolate an interaction for further interpretation, Conditional Process Analysis seeks to explore the processes and conditions *"linking inputs to outputs*" (Hayes, 2018, p. 65; Galán-Muros & Davey, 2017).

The examples from Galán-Muros (2015) reviewed in the previous chapter reflect a concerted effort to use the Framework to understand such inputs, interactions, linkages, and outputs. Many others have produced empirical evidence exploring these as well, with particularly robust scholarship towards exploring barriers and drivers

(Bruneel et al., 2010; D'Esta and Perkmann, 2011; Plewa, Korff, Baaken, & Macpherson, 2013). Yet, there is surprisingly limited integration of boundary objects (organizations, conditions, or objects) found in the empirical record, which is perhaps due to the previous limitations of enabling methodology or related to correlative concerns. This approach, while completely acceptable, tends to ignore indirect effects that might be at work, searching instead for total effects. Hayes (2018) submits that total effects likely have *less* power than indirect effects due to the mechanism of calculation and sampling error (i.e., total effects are tougher to detect as different than zero), posing questions as to why we would create conditions to control indirect effects for the sake of total effects?

In so doing, we attempt to generalize inferences within a given population, isolated in a controlled environment. This is not to suggest a lack of validity in that approach but instead to suggest that, at least in the case of the UBC ecosystem and with this study, such tactics would limit inferences related to progressions in prestige, resource development, and UBC. For example, a test for mediation using traditional linear regression in this study suggests a series of direct regressions on *Y* (CPHIL) and then a series of polynomial regression equations in hopes of completely controlling out the effects of various variables. Let us take the first portion of that series and look at the corresponding significances of the preconditional associations between *X* and *Y* without covariates: *X* = Class (p = < .007); *X* = R&D (p = < .0001); *X* = CRO_A (p = < .268). We are e done, right? CROs obviously lack a strong correlation with corporate philanthropy. Therefore, we can infer no causality, and certainly no moderation or mediation. Not really, as that would imply that an entire profession is being built to

have absolutely no effect other than to increase administrative costs (Leslie & Rhoades, 1995). Perhaps that is indeed the case, but the inference ignores contemporary patterns in institutions and the possibility that the effect of CROs might be accounted for through one of the other variables.

The popular maxim cautions that "correlation does not imply causality," but methodologists like Hayes (2018) and numerous others, have embraced the idea that "lack of correlation does not disprove causation" and "correlation is neither a necessary nor a sufficient condition of causality." (Bollen, 1989, p. 52 as quoted in Hayes, 2018, p. 80). Indeed, a simple mediation analysis using CRO as *X* finds strong effect ($p = < .05$) of CRO on R&D, and strong positive indirect effect of R&D on the relationship of CRO and philanthropy ($p = <.001$). This implies that CROs do indeed have an effect on corporate philanthropy, though that effect might be through some direct mechanisms. This brings us to two important points. The first is that conventional models of assessing interactions in the UBC ecosystem *might* be ignoring indirect effects for the sake of direct. The second is that mediation analyses are intended to explore causality (Hayes, 2018) within the boundary conditions. Using traditional means in our example, we would have determined no causality for CROs and missed that such offices might, in fact, be enabling those elements to which we would normally assign all causality (in this case CLASS and R&D). In other words, their influence is via a conditional process.

Therefore, to examine the research questions, a series of mediation and moderated mediation analyses were conducted using the PROCESS Macro for SPSS as provided by Hayes (2018) to assess, 1) if R&D mediates the relationship between

classification and corporate philanthropy, whether the presence of a CRO increases the strength of those interactions (moderates), and 2) to establish a logical temporal progression for the processional effects. Traditional approaches to mediation analysis, similar to the example above, suggest a serial approach. Contemporary approaches, however, have determined that this is not necessary to explorations of mediation, and go so far as to suggest that submission of an article for publication is likely to be summarily rejected for using the traditional Baron & Kenny approach (1989) (Hayes, 2018). This idea and the implementation of PROCESS do make this undertaking significantly less complicated. However, I have chosen to present a more robust step-wise approach to advance the logic towards the final model. This does not apply "traditional" Baron & Kenny techniques, but rather is intended to show the evolution of the observation for validity and process transparency. This is important given the novelty of this methodology to the UBC ecosystem, to reflect my process of discovery (if only for replicability rather than validation), and to alleviate epiphenomenal and confounding concerns and to account for causal ordering alternatives (Hayes, 2018).

For simplicity, bulleted descriptions of phases, PROCESS Models used, hypothesized outcomes, and associated research question(s) are provided in Tables 5 (mediation) and 6 (moderation). Note that the tests are numbered in the order of logical though not necessarily in the order of flow of the observations undertaken in PROCESS. I provide more in-depth exploration of key models below to illustrate their conceptual application to this study. The explained models include the simple mediation model (Model 4), a parallel simple mediation model ("duplicate" Model 4), two versions of serial mediation (Model 6), and two moderated mediation models

(Model 59 & 92). The templates for these models and many others, including more substantially sophisticated models, can be found in Hayes' *Introduction to Mediation, Moderation, and Conditional Process Analysis, 2nd Edition*, (2017, pgs. 584-612).

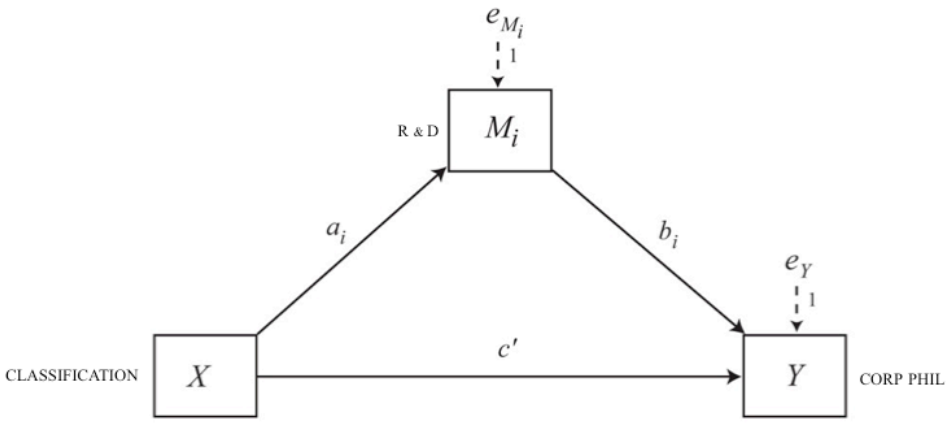


Figure 14 - Model 4 Simple Mediation (adapted from Hayes 2018)

Model 4 (Figure 14) represents a simple mediation model wherein the effect of *X* on *Y* occurs through the mediating variable, *M*. For this study, simple mediation provides the base assessment model for tests 1-7 as identified in Table 4 below. Unlike the causal steps approach, it is not necessary to assess the direct effects of the variables on each other to perform this test. This is because it is possible, though not the case here, that *X* might have a direct effect on *Y* that is not zero but *X* might still effect *Y* via *M*. As described below in more detail, the concern in running tests with this model is whether there is significance of a_1 (the effect of *X* on *M*), whether there is significance of b_1 (*M* on *Y*), whether $c^{'}$ is different from *c* (the direct effect of *X* on *Y*), and whether the bootstrapped confidence interval does not include zero (i.e., both the lower and upper bootstrapped interactions for the total effect are the same sign). From that combination, it is possible to infer directionality in a causal process. However, there are some other data that come from running these tests that are also helpful in explaining

the interactions, such as the standard effect, so those are reported as well when discussing the test results.

In this study, I provide a logical pathway that reflects Model 4 was run seven times. This understates the number of tests run by a significant number, but the others results are not relevant to the full advanced model and therefore are not discussed. Test 1 and 2 are intended to determine whether classification affects corporate philanthropy through R&D and/or through prior-year philanthropy. Tests 3-6 examine the role of CROs as *X, Y,* or *M* to account for concerns of confounding or causal pathways. Test 7 also explores confounding and confirms causal pathways by testing if classification affects R&D through corporate philanthropy. Together, these seven tests using Model 4 allow for initial affirmation of hypothesis 1 and determine whether parallel or serial mediation are potential pathways.

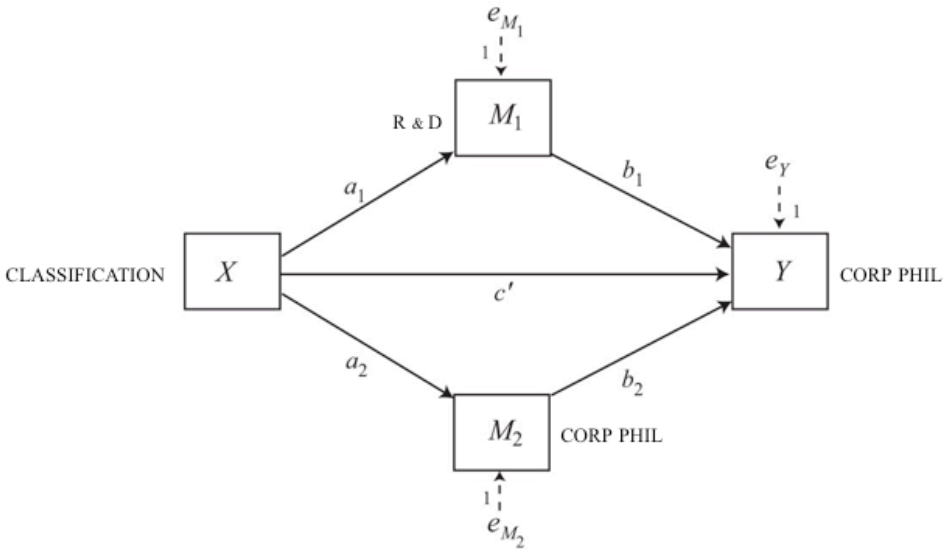


Figure 15 - Model 4 *Parallel* Serial Mediation (adapted from Hayes, 2018)

Surprisingly, Hayes (2018) provides that parallel mediation (as shown in Figure 15) is more common than serial mediation. The key difference between the two lies in the limitation of relationship between the mediators. For *parallel* mediation, the mediators must have no correlative relationship. Whereas, "in the *serial* multiple mediator model, the assumption of no causal association between two or more mediators is not only relaxed, it is rejected outright a priori" (Hayes, 2018, p. 167). At this point in the process, we have a determination as to whether the mediators have a causal association from tests 1, 2, and 7. Therefore, we can make a decision regarding test 8a or 8b and can also apply some causal priority.

Putting it in context, once we have affirmed that an institution's classification determines its potential for corporate philanthropic investment, that R&D resources mediate that relationship, *and* have eliminated the most plausible alternative model (Hypothesis 1), we will be able to model for parallel or serial mediation. However, in the determination of the above, we will also have determined directionality to affirm Hypothesis 2. A parallel model will have some causal sequence, where both mediators (M_1 & M_2) must be antecedents to consequent value (Y), but there is not a requirement for sequentiality between the mediators. For example, M_1 (R&D as illustrated) and M_2 (CPHIL as illustrated) might both be from 2015 and (CPHIL as illustrated) might both be from 2015 and therefore Y (also CPHIL, as illustrated) must be from some sequence after 2015.

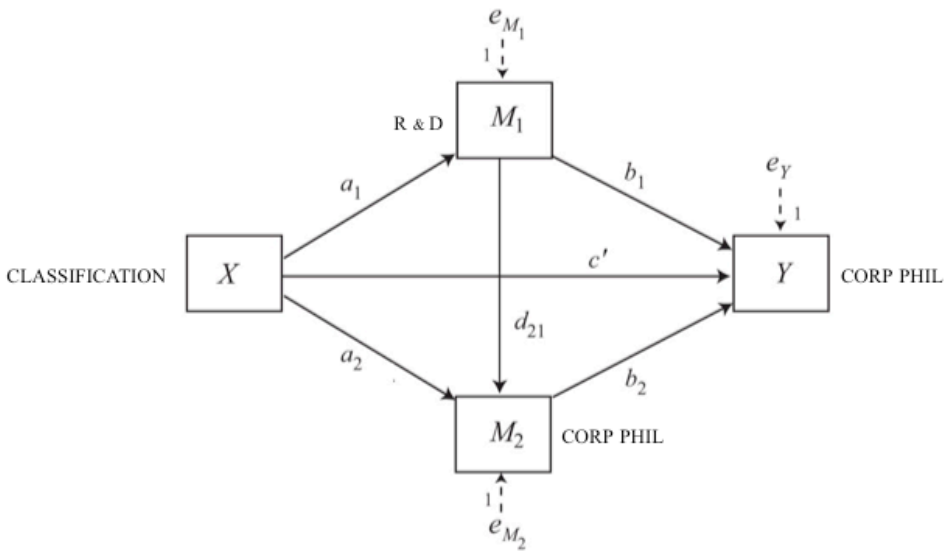


Figure 16 - Transition from Model 4 *Parallel* Multiple Mediation to Model 6 *Serial* Multiple Mediation (adapted from Hayes, 2018)

However, if H1 is accurate, then we know that R&D has causal priority to corporate philanthropy (in this example $CPHIL_{15}$), as shown in Figure 16 above. Logically, R&D effect on CPHIL is less likely to occur in the same year, particularly since reporting for HERD data lag reporting for CPHIL. In other words, universities are better equipped to accurately count philanthropic resource acquisition than R&D awards immediately after fiscal year end. This implies it would be impossible to successfully depend on reputational influences from R&D awards in the same year, at least consistently. The data shown in Figure 12 above support this notion as well, showing that there is some latent impact of R&D on CPHIL. Therefore, R&D data for use in this study must come from before 2015.

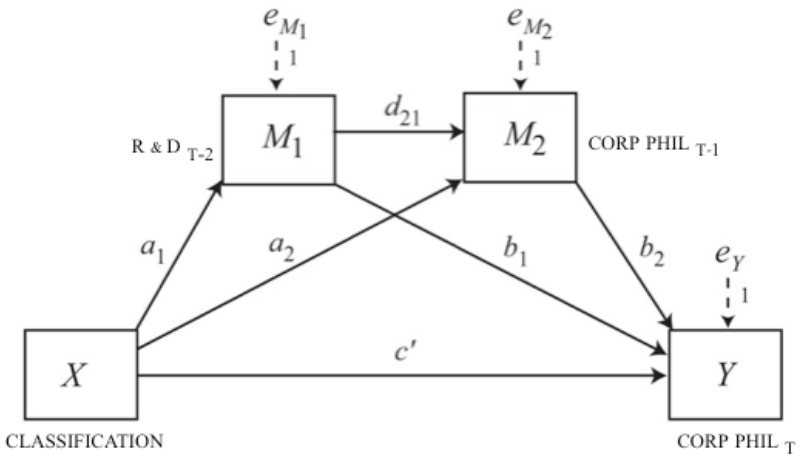


Figure 17 - Model 6 *Serial* Multiple Mediation (adapted from Hayes, 2018)

Shown in its more common statistical diagram, Figure 17, is the same equation as Figure 16. Both represent Model 6, a serial multiple mediator model. The goal when estimating this model in this study is to investigate the direct and indirect effects of *Classification* on *Corporate Philanthropy 2016* while modeling a process in which *Classification* causes *R&D 2014*, which in turn causes *Corporate Philanthropy 2015*, concluding with *Corporate Philanthropy 2016* as the final consequent (Hayes, 2018). This examination (Test 9) translates into three primary equations, because the model contains R&D14, CPHIL15, and CPHIL16 as consequent variables, plus any additional covariates having shown significant indirect of direct effect in tests 1-7.

Mathematically, a model for serial mediation can get complex very quickly, as the equations multiply with each additional mediator. Thankfully, the PROCESS Macro for SPSS (Hayes, 2018) makes the statistical calculation "easy" as long as one can determine which variable should cause the next, and so on. In Figure 14, the

indirect effects of *X* on *Y* are shown as (1) CLASS → R&D → $CPHIL_T$; (2) CLASS → R&D → $CPHIL_{T-1}$ → $CPHIL_T$; and (3) CLASS → $CPHIL_{T-1}$ → $CPHIL_T$ and the direct effect of *X* on *Y* as CLASS → $CPHIL_T$. In the data in Chapter 4, these calculations also include covariates ($CPHIL_{T-2}$, STRIVE, and possibly CROs) and implement a calculation for X^3 to account for curvilinear regression. Combined, the evaluation aims to support H2.

This leaves us with the question of moderation, as defined in H3, corporate relations offices strengthen the effects of classification on R&D, R&D on corporate philanthropy, and classification on corporate philanthropy. This conceptual model, reflected in Figure 18 (Model 59 as provided in Hayes, 2018), is provided to examine H3 if serial mediation is not proven, though the causal sequence is not necessary in this model. Essentially, if there is no serial mediation or parallel mediation, we can still assess H3 using Model 59 using either R&D or CPHIL as the mediator value and CRO as the *W* value (tests 9a and 9b in Table 6). It is acceptable to perform a moderation assessment after tests 1-7. However, the chosen approach allows assessment of moderation on any or all of the interactions after a more robust understanding of covariates and causal priority has developed. Accordingly, Figure 19 provides a conceptual model of test 10 for moderated mediation using Model 92 (Hayes, 2018), should test 8b prove significant.

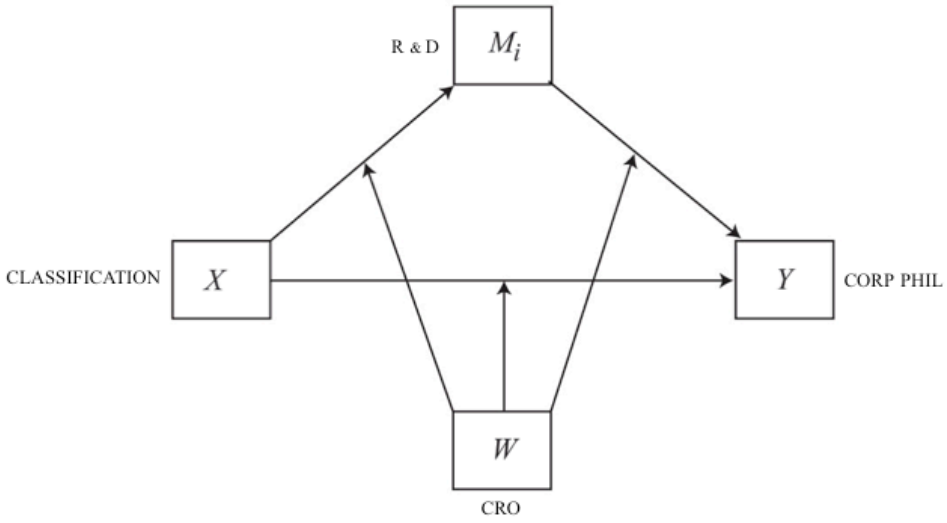


Figure 18 - Model 59 Moderated Mediation of Model 4 (adapted from Hayes, 2018)

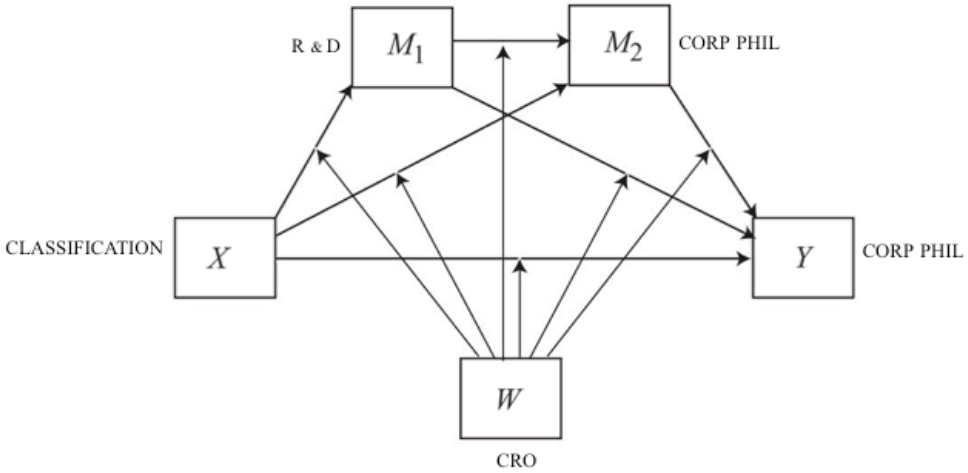
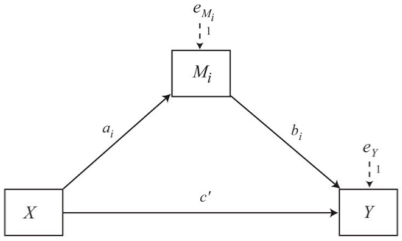


Figure 19 - Model 92 *Serial* Moderated Mediation of Model 6 (adapted from Hayes, 2018)

<table>
<tr>
<td>Model 4
Simple Mediation


NOTES:
*No non-striving institutions remained in panel, so variable was withheld in tests.
**Expected Outcome
***All tests use1yr latency assumption for Y
**** All tests use a polynomial hack for X^3</td>
<td>Test 1: X: CLASS • M₁: R&D • Y: CPHIL
by year & classification • *C: STRIVE
***Outcome: Strong Positive Indirect Effect

Test 2: X: CLASS • M₁: CPHIL • Y: CPHIL***
by year & classification • C: STRIVE
Outcome: Strong Positive Indirect Effect

Test 3: X: CLASS • M₁: CRO • Y: CPHIL
by year & classification • C: STRIVE
Outcome: No Significant Indirect Effect

Test 4: X: CLASS • M₁: CRO • Y: R&D
by year & classification • C: STRIVE
Outcome: No Significant Indirect Effect

Test 5: X: CRO • M₁: R&D • Y: CPHIL
by year • C: CLASS • C₂: STRIVE
Outcome: No Significant Indirect Effect

Test 6: X: CRO • M₁: CPHIL • Y: R&D
by year • C: CLASS • C₂: STRIVE
Outcome: No Significant Indirect Effect

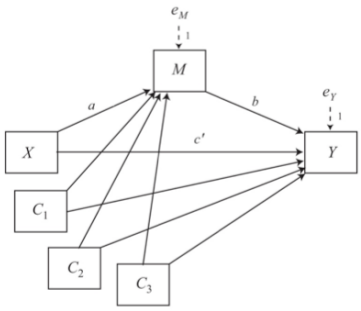
Test 7: X: CLASS • M₁: CPHIL • Y: R&D
by year & classification • C: STRIVE
Outcome: No Significant Indirect Effect</td>
</tr>
<tr>
<td>Model 4 with Covariates

</td>
<td>Provided to illustrate covariate effects in Model 4 as used in all tests above</td>
</tr>
<tr>
<td colspan="2">This series examines Hypothesis 1: R&D as mediator for CLASS & CPHIL</td>
</tr>
</table>

Table 4 - List of Mediation Tests Using PROCESS Model 4 with Covariates
(models as provided by Hayes, 2018)

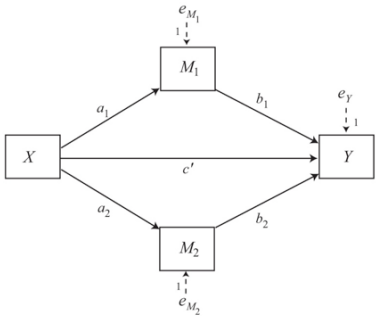
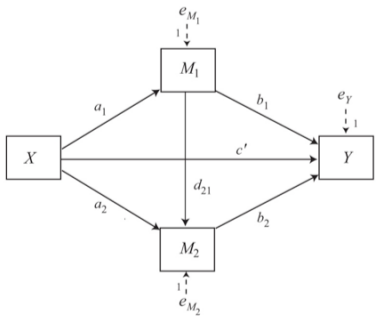
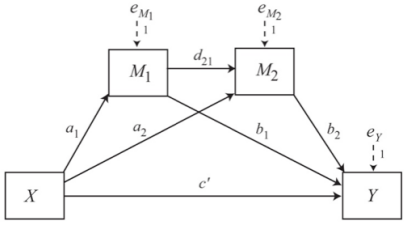
Model 4 Parallel Mediation  	**Test 8a**: Parallel Mediation ***X**:* CLASS • ***M₁**:* R&D • ***M₂**:* CPHIL • ***Y**:* CPHIL by classification *C:* STRIVE • C_2*:* CPHIL • C_3*:* R&D *Outcome: Should not be performed if Test 1 shows significant indirect effect & Test 7 shows no indirect effect*
Model 4 Parallel Mediation Modified  	Provided to illustrate transition from Model 4 to Model 6 (serial mediation)
Model 6 Serial Mediation  	**Test 8b**: Serial Mediation ***X**:* CLASS • ***M₁**:* R&D • ***M₂**:* CPHIL • ***Y**:* CPHIL by classification *C:* STRIVE • C_2*:* CPHIL • C_3*:* CRO *Outcome: Strong Positive Indirect Effects* **Test 8c**: Serial Mediation ***X**:* CLASS • ***M₁**:* R&D • ***M₂**:* R&D • ***Y**:* CPHIL by classification *C:* STRIVE • C_2*:* CPHIL • C_3*:* CRO *Outcome: No Significant Indirect Effects*
This series examines Hypothesis 2: Sequential Progression of Conditional Effects	

Table 5 - List of Mediation Tests to Determine Parallel or Serial Mediation with Covariates (models as provided by Hayes, 2018)

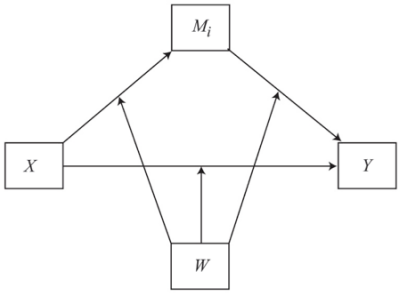
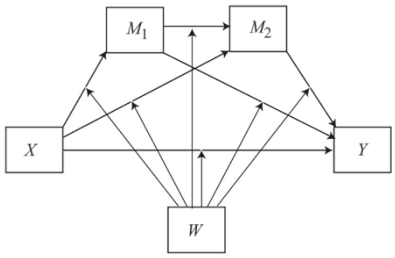
Model 59 Moderation of Model 4  	**Test 9a**: Simple Multiple Moderation ***X****:* CLASS • ***M*$_1$*:* R&D • ***Y****:* CPHIL • *W:* CRO by classification • *C:* STRIVE *Outcome: Should not be performed if Test 8b performed & shows significant indirect effect* **Test 9b**: Simple Multiple Moderation ***X****:* CLASS • ***M*$_1$*:* CPHIL • ***Y****:* CPHIL • *W:* CRO by classification • *C:* STRIVE *Outcome: Should not be performed if Test 8b performed & shows significant indirect effect*
Model 92 Moderation of Model 6  	**Test 10**: Serial Multiple Moderation ***X****:* CLASS • ***M*$_1$*:* R&D • ***M*$_2$*:* CPHIL • ***Y****:* CPHIL by classification *C:* STRIVE • *C*$_2$*:* CPHIL • *W:* CRO* *Outcome: Insignificant Positive Moderating Effect* **Assumes CRO is not a covariate as in Test 8b & 8c*
This series examines Hypothesis 3: CRO does/does not moderate mediated relationship(s)	

Table 6 - List of Tests to Determine Moderated Mediation
(models as provided by Hayes, 2018)

Methodology Limitations, Delimitations, and Alleviations

Modern mediation methodology, as noted previously, grants some allowances that are seemingly antithetical to typical research processes as taught in most graduate programs. Among those are ideas about inferential causality, acceptance of highly correlated relationships, and no requirement to prove any direct effect of *X* on *Y*, *X* on *M* (mediating variable), or *M* on *Y* in order to conduct the study. Hayes (2018) suggests

the use of three common sense ideas when deciding to conduct a study regarding inference and conditional processes. Summarized from p. 115 of his 2017 work, those include that 1) claims about a phenomenon should be based on some quantitative measure of the phenomenon most directly relevant to the claim (the indirect effect); 2) investigators should take the least steps possible to support said claim; and 3) any uncertainty about the inference should be addressed, either through experimental procedures or candor (an inference with confidence).

Based on these logical points, Hayes (ibid) quickly points out that the more traditional causal steps approach neither meets requirement 1 or requirement 3 *and* consists of a significant number of qualifying steps during the process that allow for the introduction of error. In the Baron and Kenny methodology, the initial process requires validating direct effects on *Y* in order to infer that there must be some indirect effect, because all variables directly affect the dependent variable and the independent variable also directly affects the mediator. There are two problems with this approach. The first is that the inference is not based off of any quantification of the indirect effect itself; for Baron and Kenny investigators, it is merely a dichotomous yes or no answer to "full" mediation based on an effort to validate related hypotheses. The second issue is that error is introduced through the increased number of steps (must reject three null hypotheses) and should the investigator fail to reject the null, the experiment stops (Hayes, 2018).

In the case of this study, I want to understand whether the relationship between classification and philanthropy has an indirect relationship through R&D expenditures. In other words, does philanthropy go up as R&D expenditures go up? If so, is there a

causal order and what role does a CRO play in influencing those relationships accordingly? As long as all traditional data stability requirements are addressed and alleviated, then there is no reason to stop the observation in the event that CRO has no apparent direct relationship with classification. This study should show a justifiable causal order based on common sense, quantification of the indirect effects (as observed through changes in *p*), and demonstrate a high level of confidence that the effects are repeatable given the same conditions (as observed through bootstrapped confidence intervals).

Of course, no methodology is without concern. Among the common criticisms about conditional process analysis from traditionalists are issues regarding complete and partial mediation. Hayes (2018) notes that in real life, we don't dismiss an outcome because of partial mediation or ignore other mediators for the sake of one that most fully mediates. Accordingly, it would not be logical to dismiss the effects of R&D on the relationship between classification and philanthropy because it may only account for 87% of said relationship (note: this is an arbitrary % for the sake of argument only). Some other variable might importantly account for the other 13% and shouldn't be ignored among the operational conditions.

Hayes (ibid) adds that, in addition, the pursuit of partial mediation improperly celebrates that all models are wrong at some level while also allowing for biased interpretations. The first issue, degrees of mediation, relies on inferences drawn from the causal steps process (aka. Baron and Kenny). As already noted, causal steps requires several rejections of null hypotheses to determine mediation. Following that process to determine partial mediation *may* exclude a valid mediator variable because

there was no direct effect that was greater than zero. Second, drawing inference from a partial mediation result through causal steps approach leaves potential for biased interpretations. For example, one research might determine that R&D mediating 87% of the relationship between classification and philanthropy means that there is no need for a CRO if you are willing to accept a 13% potential drop in financial support. Indeed, it might actually cost more than that 13% to support the CRO in the first place. Meanwhile, another might determine that, since 13% is left to influence beyond R&D, perhaps the institution should double down on its CRO because some other university is seeing 20% influence. Who is to say either is right, if the model does not allow for a formal quantified inferential test and it relies on qualitative (notional) interpretations rather than a demonstrated confidence test?

Of course, using conditional process methodology suggests the majority (if not all) of the covariates in the process be identified. That may not always be possible, as any number might not be identifiable or quantified. In the case of the UBC Ecosystem Framework, significant work provides the foundation for identifying the categorical elements. However, for this study, it would be unreasonable to document all of the various approaches each university might take towards improving classification. It is quite feasible that some series of training protocol provides sufficient moderation of organizational culture or that documented efforts towards improved institutional efficiency when working with industry serve as moderators and mediators accordingly. Unfortunately, there is not a construct that suggests capturing all of the elements is worthwhile or compulsory, given the quantified extant elements of CCIHE, R&D, and VSE that are present. Therefore, it is important to accept those as facts in this analysis

with the recognition that, at some future point, the findings from this study might be called to question by the newfound presence of quantified data within the Framework.

What is compulsory in this study has to do with addressing other epiphenomenal, alternative process, and confounding concerns. Epiphenomenal concerns relate to the idea just presented, that there may be some other causal element that is masked by the variables in use in the study but that variable is not included. Where possible, those concerns are addressed in the procedures outlined below and throughout the study. Alternative process concerns relate more to the fact that all of the variables are highly correlated, which suggests that the causal order might be something other than as presented in the study. Again, where possible, these concerns are alleviated via the design of the study as outlined in Tables 4-6. Specifically, I tested multiple models (including some not mentioned in this write up) to verify the process was the most explanatory possible. For example, I explored corporate philanthropy as the mediator and moderator, I explored a pathway that included R&D to R&D to philanthropy, and I explored a pathway that included R&D as a moderator. None of these tests (or others) provided the most logical explanation of the causal process when considering all data and boundary conditions.

Finally, issues of spurious association (confounding), similar to epiphenomenal issues, relate to associations of variables in the model that are not accounted for in the inference. For example, it may be that CROs do not moderate the relationships because their current orientation is one of direct effect on R&D or on corporate philanthropy (as identified in their metrics). Simply removing them from the model would be a mistake, as would not testing other pathways with CROs in roles. This situation is worse when *X*

is not manipulated or *X* is not dichotomous, as is the case with this study. Fortunately, Hayes (2018) offers two options to address this concern and this study uses both. The first option is to use all logically identifiable covariates, which I do as explained in the previous section. The second is to base the causal pathway (for non-random samples in particular) on sound logic or previous empirical data. This study does so through the identified causal direction from the work of Bowman and Bastedo (2011) and through several alternate pathway studies.

In sum, challenges to this methodology generally relate to either preference or familiarity with the causal steps approach or with a preference for more traditional regression approaches. I have chosen neither and have provided relevant alleviations in the study to provide high confidence in the outcomes. Where many are concerned with high correlation, this study expects them. Where other studies are concerned with standardizing results, this methodology argues against that approach and I follow suit. Where other approaches are concerned with power (with focus on standard errors), this study and methodology focus on confidence intervals while also providing a power analysis in the data screening below. This study and this methodology are focused primarily on causal order, quantifying mediation (and moderation where viable), and justifying inference with *p* values and bootstrap confidence intervals.

Data Screening

Prior to hypothesis testing, I conducted a series of data screening tests to examine the quality and completeness of the data set, after sorting data in the three-year window of 2014-2016 for both recency and completeness of data reasons. This screening was conducted in order to provide the most accurate results and so as not to

skew the data inadvertently. The first in the series was an examination of accuracy to screen for typographical errors and to assess whether minimums and maximums were within range. Since the data were drawn from extant data, the range was limited by the largest and smallest results of R&D expenditures and corporate philanthropy. All data were within range and no typos were found. Second, the data were examined for missingness using pattern analysis in SPSS. No variable was found to have more than 10% missing values with 1.4% missing values across 7.5% of cases. Pattern analysis indicated randomness and no monotonicity in the data, and the pattern frequency graph suggested no values missing across all variables and that missing values were equally distributed. PROCESS requires a complete data set to produce the most accurate results. As such, I first reviewed the data sources to determine if errors occurred in the reporting procedures that might have eliminated the necessary data. Second, I attempted to retrieve data from the institutions directly. Finally, because I hypothesize a significant correlation between R&D and philanthropy, I employed an estimated means process in SPSS to replace any remaining missing values. This was chosen after initial attempts to use multiple imputations proved to significantly skew results at the institutional level and given that the data replacement was for less than a dozen values.

Next, I checked the data for multivariate outliers using a linear regression with CPHIL16 as the dependent variable to screen for Mahalanobis, Cook's, and Leverage distances. K was set to 9 and $p = <.001$, conservatively, leaving a max range of 27.88 for Mahalanobis, .023 for Cook's, and .11 for Leverage. Any case outside of the range on two or more of these tests was filtered from the data set after visual assessment of the cases. Twelve cases were filtered using this process resulting in 174 available cases

to review for multicolinearity. I used a bivariate test to produce a correlation table that showed significant correlation ($p = < .01$) across most variables, which is to be expected for data used in a conditional process analysis. Controlling for variable type (e.g., R&D, philanthropy, classification, or office type) and temporality, I found no correlations above .621 (R&D15 and CPHIL15), suggesting an acceptable rate of correlation. A calculation of Cronbach's α indicated the coefficient for the eight items is .787, suggesting a relatively high internal consistency.

Finally, I tested assumptions by assessing normality, linearity, homogeneity, and homoscedasticity. The data were found to follow a normal distribution, followed a normal curve, and as such were acceptable. To assess linearity, a scatterplot reflected a cubic relationship across variables. However, this is tolerable using PROCESS with some modification to the equation and as such, the linearity result was accepted. A visual examination of the standard residuals showed some heteroscedastic clustering of the data on both sides of zero, which is to be expected given the sampling mechanism that included longitudinal data and the significant collinearity. Conditional process analysis is intended to recognize the collinearity to assess hypotheses that are assessable in more realistic conditions (Hayes, 2018). Accordingly, heteroscedasticity-consistent inference controls are enabled in the macro to control for clustered effects. Given the controls built into the PROCESS macro and the limited nature of the clustering, issues related to homogeneity or homoscedasticity were accepted for this analysis.

Chapter 4: Analysis of Data

This chapter generally follows the flow of Tables 4-6 in Chapter 3 with some exceptions. First, the methodology used in this study recognizes that mediation often occurs with data that are highly correlated, and as in this case, are not experimentally manipulated. This study was conducted using extant data to explore causal pathways and not a study built on random sampling methods. As such, the intent is to make inferences based in logic and "constitute a sensible causal process" (Hayes, 2018, p. 520). Where possible, I present theory and context to frame the results with a focus on the indirect effects, direct effects, and unseeded bootstrapping confidence intervals for inference of the total model.

Second, as provided by Hayes (2018), it is not necessary to follow the causal steps approach to report mediation results. Tables 4-6 show a series of tests that provide the logic pathway towards the final advanced model. This is slightly different than taking the causal steps approach, where one would examine the relationships of $X \rightarrow Y$, then $X \rightarrow M_i$, then $M_i \rightarrow Y$ to establish direct effects prior to exploring mediation. However, there is a risk of "overreporting" (ibid) that distracts from the primary results of concern and risks inference that these were the only tests run in this observation. I can assure that they are not, as hundreds of different pathways and variations were explored and numerous covariants were examined. Therefore, as possible, I simplify the presentation of the initial tests using Table 9 and present written results by exception, making a point to present key alternative pathway results to confront causal pathway, spurious association, and epiphenomenal concerns.

Finally, I also provide the data regarding pathways (a_1, b_1, d_{21}, c', etc.) with p values for each of the models reported. This is more informative than is necessary when drawing final inference regarding the existence of indirect effect(s), but it is interesting that all pathways in the study were significant at $p < .001$. More time is spent on exploring the coefficients in context and, importantly, presenting the inferential tests, signs (positive or negative), and the point estimate of the product of the indirect path (Hayes, 2018). As both classification and CRO office type are multicategorical, I report any significant variances by category where relevant and by exception in the descriptive text, but provide the overall categorical data in the statistical tables.

All analyses were conducted using IBM SPSS Statistics 25 for Mac (IBM Corp. Released 2017. Armonk, NY: IBM Corp.). Additionally, as recommended by Hayes (2018), the path coefficients are presented in their unstandardized form since there is little substantive interpretation from standardizing the coefficients in this methodology. All bootstrap confidence intervals of the conditional direct effects are bias-corrected as recommended by Preacher and Hayes (2008).

Results

Preliminary Tests

Tables 7-10 present the various results of tests 1-7 with antecedents and consequents identified along with the corresponding data and outcome verification (bootstrapping). As noted, there were no non-striving institutions in the data panel, so the variable was withheld from the tests. All tests also included X^3 as recommended by Hayes (2017) to account for curvilinearity, all tests consider one-year causal priority, and each included the relevant covariates where applicable.

												Bootstrapping		
				Consequent								95% BC Confidence Interval, 5000 Samples		
Antecedent		Coeff.	*SE*(HC0)	*t*	*p*		Coeff.	*SE*(HC0)	*t*	*p*	Effect	SE	Lower	Upper
Test 1: Y =CPHIL15														
X (CLASSALL)	a_1	(582.37)	52.22	(11.15)	< .001	c'	(3.21)	3.8	(.845)	.3989				
M_1 (R&D 2014)		---	---	---	---	b_1	.055	.008	6.97	< .001	(32.26)	5.44	(43.77)	(22.81)
C_1 (STRIVE)	f_1	(173.74)	34.89	(4.98)	< .001	g_1	.917	1.56	.587	.558				
C_2 (CRO_A)	f_2	33.33	27.31	1.22	.224	g_2	(.661)	2.02	(.328)	.743				
Constant	i_{M_1}	954.39	81.07	11.77	< .001	i_Y	9.37	7.74	1.21	.228	*Total Effect of X on Y*			
$ in m, n = 174			R^2 = .4532					R^2 = .5742			R^2 = .2853			
Unstandard SE			$F(4, 169) = 45.58, p < .001$					$F(5, 168) = 34.73, p < .001$			$F(4,169) = 24.64, p < .001$			

Table 7 - Test 1 Classification on Corporate Philanthropy through R&D
(Strong Positive Effect)

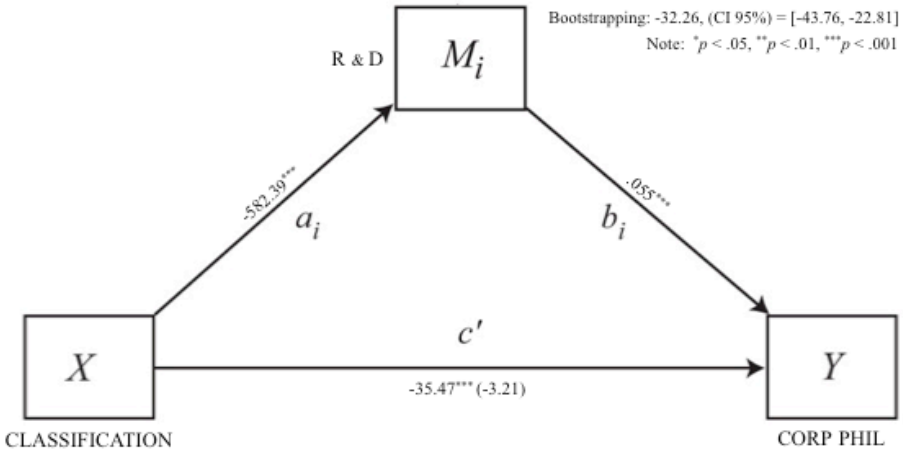


Figure 20 - Test 1 Classification on Corporate Philanthropy through R&D
(Strong Positive Effect) *Note: signs indicate drop in classification*

Using a simple mediation model (Model 4) to assess OLS path analysis with Huber-White heteroscedasticity consistent inference, institutional Carnegie classification indirectly influenced 2015 industry philanthropic investment through its influence on 2014 total R&D expenditures when controlling for striving behavior. As shown in Table 7 and in Figure 20, for every one-category increase in Carnegie classification (R3 to R2, R2 to R1), an expected 582% increase in R&D expenditures was necessary (a = -582.39) and institutions with greater expenditures saw a 5.5% *decrease* in total corporate giving (b = .055) as a percent of R&D. A 95% bootstrap confidence interval for the indirect effect (ab = -32.26) based on 5,000 bootstrap samples was entirely below zero (-43.76 to -22.81). The results suggest no evidence that classification influences corporate philanthropy independent of its effect on R&D expenditures ($c^{'}$ = -3.21; p = .399). This relationship generally held true regardless of R&D expense year.

It is important to note the large coefficient slope where every class change requires $582m in R&D. This seems like a huge number because it is. Two items important to remember here are 1) *X* has not been randomized but that does not make the analysis invalid because the data are not random and 2) these are unstandardized values, the preferred reporting style. For context, using his 2017 CCIHE analysis, Harmon shows via https://paulharmon.shinyapps.io/Carnegie2/ that when holding all other factors and other institutions constant, Montana State University *still* would not have remained an R1 institution in 2015 if it had grown R&D expenditures by $890m to a total of $1b annually. Of course, not all institutions in R1 are billion dollar research enterprises, so I interpret this as likely spending over a period of time.

The striving covariate is built off of change in Carnegie classification, a report that is produced every five years, and the variables included a one-year delayed effect, so we can infer that, over the course of five to six years, a university with $1 in research would have to report more than $582m in R&D expenditures to go from R3 to R2 and from R2 to R1, etc. One other point to make is related to the sign of the effects (*a* and *ab)*. Note that Carnegie classifications are in reverse order where R1 = 15, R2 = 16, and R3 = 17, so the interpretation above could also have been expressed in the reverse: as a loss of R&D expenditures results in loss in classification and a bigger ratio of philanthropy to R&D. Again, all of this is context, as the proof of indirect effect in the models lies in the values of *p* combined with the bootstrapped confidence intervals.

		Consequent								Bootstrapping			
										95% BC Confidence Interval, 5000 Samples			
Antecedent		Coeff.	*SE*(HC0)	*t*	*p*		Coeff.	*SE*(HC0)	*t*	*p*	Effect	SE	Lower	Upper
Test 2: Y = CPHIL16														
X (CLASSALL)	a_1	(35.48)	4.30	(8.25)	< .001	c'	(5.38)	2.42	(2.22)	< .05				
M_1 (CPHIL15)		---	---	---	---	b_1	1.01	.064	15.59	< .001	(35.68)	4.94	(46.09)	(26.41)
C_1 (STRIVE)	f_1	(8.71)	2.20	(3.97)	< .001	g_1	(1.36)	.979	(1.39)	.168				
C_2 (CRO_A)	f_2	1.19	2.88	.411	.681	g_2	(1.07)	1.39	(.766)	.445				
Constant	i_{M_1}	62.24	6.97	8.93	< .001	i_Y	10.38	5.05	2.05	< .05	*Total Effect of X on Y*			
$ in m, n = 174			R^2 = .2853					R^2 = .8751			R^2 = .3020			
Unstandard SE			$F(4, 169) = 24.64, p < .001$					$F(5, 168) = 131.74, p < .001$			$F(4,169) = 26.90, p < .001$			

Table 8 - Test 2 Classification on Corporate Philanthropy through Prior-Year Giving
(Positive Indirect Effect)

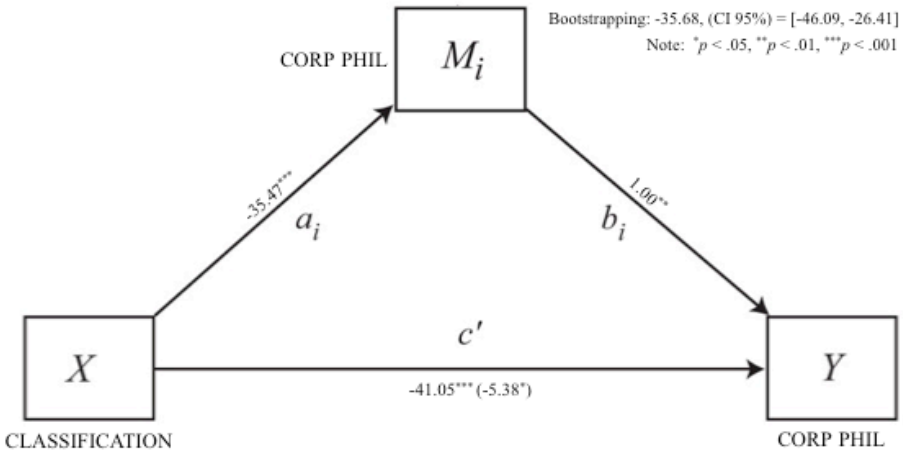


Figure 21 - Test 2 Classification on Corporate Philanthropy through Prior-Year Giving (Positive Indirect Effect) *Note: signs indicate drop in classification*

To better understand total corporate philanthropic investment gains, an examination with the same base parameters showed institutional Carnegie classification indirectly influenced 2016 industry philanthropic investment through its influence on prior-year industry philanthropic investment. As reflected in Figure 21 and Table 8, every increase in classification category resulted a 35.5% increase in philanthropic investment (a = -35.47) and growth holds steady year over year (b = 1.00). The 95% bootstrap confidence interval for the indirect effect (ab = -35.68) based on 5,000 samples was entirely negative (-45.85 to -26.18). The results suggest limited influence of classification on industry philanthropic investment without its effect on prior-year philanthropy ($c^{'}$ = -5.38, p = .028). This outcome remains valid when holding 2014 corporate giving constant (a = -4.86, b = 6.43, ab = -3.12, (CI 95%) = [-6.5, -.779], $c^{'}$ = -4.72, p = .0232).

However, one concern of this study is logically determining how corporate relations offices impact industry investment when considering the boundary conditions

that may also impact giving. It is not entirely illogical that classification might determine CRO type, but a quick glance at the dataset says this is not the likely case. It is also not entirely illogical that determining office type might be a function of R&D or philanthropic success (or relative lack thereof), as we have seen that universities crave the acquisition of resources to get more resources (Bowen, 1980; Lombardi, 2013). In any case, we should certainly expect a particular office type to have direct effect on R&D or philanthropic outcomes. As there are no empirical studies to draw reference and the data do not allow for a manipulation of *X*, an exploration of CRO as other-than moderator (as hypothesized) is a necessary endeavor.

Using a simple mediation model, tests 3 & 4 provided no evidence that CRO type played a role in the relationship of classification on corporate philanthropy or classification on R&D. Similarly, test 5 provided evidence that CROs as a group exhibited no indirect effects on corporate philanthropy through influence on R&D expenditures and test 6 showed no evidence of CRO indirect effect on R&D expenditures through corporate philanthropy. The results of tests 3-6 are shown in Table 9. Type 1 CROs (philanthropic) exhibited strong direct effects on R&D and philanthropy when the tests were run with CRO as a serial multicategorical variable and when controlling for class, but none of those tests presented a qualified confidence interval, meaning that the overall effect was not reliable. From this we can surmise that CRO might serve as a covariate or as a moderator as they exhibit no effects, indirect or direct, on either R&D or philanthropy, when considered as *X* or M_i.

						Bootstrapping			
						95% BC Confidence Interval, 5000 Samples			
$ in m, n = 174 Unstandard SE		Coeff.	*SE*(HC0)	*t*	*p*	Effect	SE	Lower	Upper
Test 3: Y = CPHIL16									
X (CLASSALL)	a_1	(.091)	.220	(.414)	.679				
	$^iM_{\parallel}$	1.61	.230	7.01	< .001	(.012)	.646	(1.57)	1.29
	c'	(41.05)	4.80	(8.55)	< .001				
M_1 (CRO)	b_1	.126	2.59	.049	.961	*Total Effect of X on Y*			
	^iY	72.96	7.95	9.17	< .001	R^2 = .3020 $F(3,170)$ = 35.59, p < .001			
Test 4: Y = R&D15									
X (CLASSALL)	a_1	(.091)	.220	(.414)	.679				
	$^iM_{\parallel}$	1.61	.230	7.01	< .001	(-3.29)	11.02	(31.59)	16.44
	c'	(596)	53.65	(11.11)	<.001				
M_1 (CRO)	b_1	36.07	28.08	1.28	.201	*Total Effect of X on Y*			
	^iY	973	82.55	11.79	<.001	R^2 = .4461 $F(3,170)$ = 59.33, p < .001			
Test 5: Y = CPHIL16									
X (CRO)	a_1	36.07	28.08	1.28	.201				
	$^iM_{\parallel}$	9318	823.38	11.32	< .001	2.17	1.75	(.9834)	5.95
	c'	(2.04)	1.82	(1.12)	.2642				
M_1 (R&D15)	b_1	.060	.008	7.18	< .001	*Total Effect of X on Y*			
	^iY	88.48	65.49	1.35	.1785	R^2 = .3020 $F(4,169)$ = 26.90, p < .001			
Test 6: Y = R&D15									
X (CRO)	a_1	.738	2.67	.277	.783				
	$^iM_{\parallel}$	582	70.99	8.19	< .001	4.56	17.51	(26.43)	42.33
	c'	31.52	21.71	1.45	.148				
M_1 (CPHIL14)	b_1	6.17	1.03	6.01	< .001	*Total Effect of X on Y*			
	^iY	5728	774	7.40	<.001	R^2 = .4508 $F(4,169)$ = 45.34, p < .001			

Table 9 - Tests 3, 4, 5, & 6 Variations of Alternative Models

Possibility of Alternative Models of Preliminary Tests

Tests 3-6 also provide evidence that limits epiphenomenal concerns in the model(s). In both tests 1 and 2, we can be certain that CRO is not a factor because it is clear that classification does not have an effect through CRO type that might account for either classification's effect on R&D or on corporate philanthropy. CRO type does not causally affect either R&D or philanthropy in any model reliably and therefore there is not a validity concern due to confounding issues. Of course, both of these alleviations assume that there are not any variables that are left unconsidered, or rather,

that somewhere in the boundary conditions, there is not another variable that would either affect R&D and philanthropy directly or through which classification might exhibit indirect effects on *Y*. A review of the UBC ecosystem suggests that there are some possibilities so, as suggested in Chapter 5, a more complex model might be necessary in the future. However, it is possible to present some statistical control to strengthen the current model (Hayes, 2017). In this instance, should CRO not prove to moderate any of the effects (a, b_1, b_2, ab, c', d_{21}), it could be held constant as a covariate to account for the effect of offices on the outcomes. As presented, both test 1 and 2 hold CRO and striving constant.

Finally, as it concerns causal order, it is not possible to manipulate *X,* so causal order must be established by empirical examination in the current observation or by some prior literature. Bowman and Bastedo (2011) provide evidence that rankings influence resource providers as long as those providers are vulnerable to the status hierarchy of higher education. From their findings, we can infer that classification has causal priority on R&D. However, they note that industry does not appear susceptible to this influence. This study is not concerned specifically with industry investment in university R&D, though such funding is considered among both total R&D expenditures and philanthropic investment. Importantly, the Bastedo and Bowman (2011) study was not conducted using the methodology in this study, suggesting that there may be some susceptibility for industry investment. The question that remains is related to causal priority – does R&D cause philanthropic investment or vice versa?

											Bootstrapping		
				Consequent							95% BC Confidence Interval, 5000 Samples		
Antecedent		Coeff.	*SE*(HC0)	*t*	*p*		Coeff.	*SE*(HC0)	*t*	*p*	Effect	SE	Lower	Upper
Test 7: Y = R&D15														
X (CLASSALL)	a_1	(36.94)	4.60	(8.04)	< .001	c'	(368)	50.04	(7.35)	<.001				
M_1 (CPHIL14)		---	---	---	---	b_1	6.17	1.03	6.01	<.001	(228.06)	37.39	(310.92)	(164.91)
C_1 (STRIVE)	f_1	(7.80)	2.70	(2.88)	< .01	g_1	(128)	29.81	(4.30)	<.001				
C_2 (CRO_A)	f_2	.738	2.67	.277	.783	g_2	31.52	21.71	1.45	.148				
Constant	i_{M_1}	64.32	7.66	8.39	< .001	i_Y	576	80.23	7.18	<.001	*Total Effect of X on Y*			
$ in m, n = 174			R^2 = .2580					R^2 = .6305			R^2 = .4508			
Unstandard SE			$F(4, 169) = 22.94, p < .001$					$F(5, 168) = 55.59, p < .001$			$F(4,169) = 45.34, p < .001$			

Table 10 - Test 7 Classification on R&D through Corporate Philanthropy
(no Significant Indirect Effect)

As shown in Figure 22 and Table 10, test 7 provides a reliable answer (*ab* = -228, -310.92 to -164.91) after considering the 95% bootstrap confidence interval based on 5,000 samples. Classification does not indirectly influence R&D expenditures through its influence on corporate philanthropic investment. Note that despite the high confidence in the model, c' (-368) remains significant at $p < .001$, which indicates classification's direct effect on R&D is not beholden to philanthropic investment, thereby validating the proposed causal order to this point.

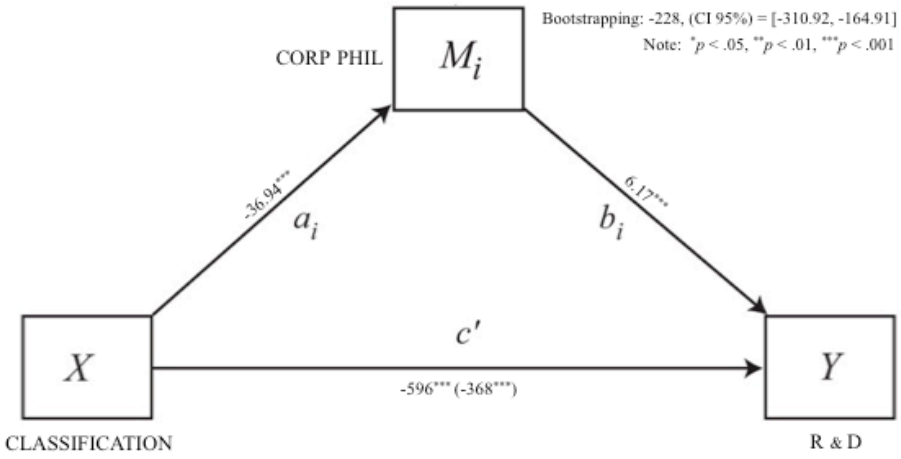


Figure 22 - Test 7 Classification on R&D through Corporate Philanthropy (No Significant Indirect Effect) *Note: signs indicate drop in classification*

Integrated Test of the Study's Hypotheses

The results of tests 1, 2, and 7 determine that test 8a is not a likely pathway since, as shown in table 7, R&D (M_1) has a causal priority to corporate philanthropic investment (M_2) and as I have just shown, philanthropy does not have an equivalent causal influence on R&D. Therefore, classification does not have a parallel indirect effect through both philanthropy and R&D, but might have a serial indirect effect. To

examine this phenomenon, two observations were conducted to assess whether the second mediator was R&D or philanthropy.

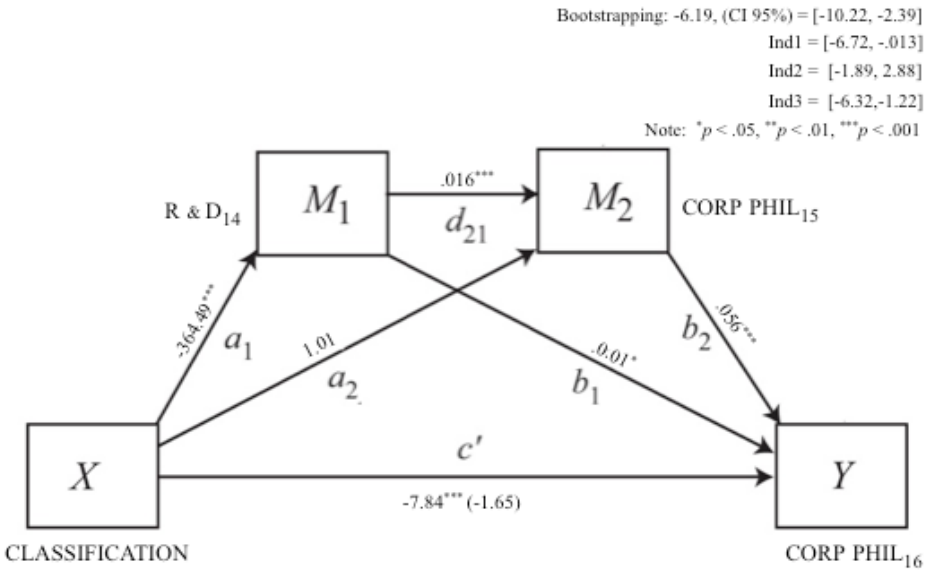


Figure 23 - Test 8b Classification on Corporate Philanthropy through Serial Mediation of R&D and Prior Philanthropy (Strong Positive Indirect Effect on Path 3)
Note: signs indication drop in classification

Employing a serial mediation model (Model 6) to assess OLS path analysis with Huber-White heteroscedasticity consistent inference, institutional Carnegie classification indirectly influenced 2016 industry philanthropic investment through its influence on 2014 total R&D 2014 expenditures and 2015 corporate philanthropic investment, holding striving behavior, office type, and 2014 philanthropy steady. As shown in table 11 and in Figure 23, for every one-category increase in Carnegie classification, an expected 365% increase in R&D expenditures was necessary (a = -364.49), resulting in 1.6% (d_{21} = .016) and 5.6% (b_2 = .056) decreases in corporate giving as a percent of R&D. This does not indicate a decrease in total giving but rather a decrease in the ratio of philanthropy to R&D. Classification indirectly influenced

2016 corporate philanthropy through 2104 R&D as well. However, at less than 1%, this was negligible (b_1 = .009), and while the bootstrap confidence interval was entirely negative (-6.73 to -.004), it was very close to containing zero, which indicates that one cannot infer directionality of the influence.

A 95% bootstrap confidence interval for the total indirect effect (ab = -6.19) based on 20,000 bootstrap samples was entirely below zero (-10.20 to -2.43). The increase to 20,000 bootstrap samples was not necessary as the results were sufficient at 5,000 and 10,000 sample. However, for greater confidence in the full model, the largest sample size is presented. Pairwise contrast of the three indirect effects confirms that classification is unrelated to future corporate philanthropy independent of the effect of R&D expenditures and prior corporate giving (two and one years prior, respectively), and the indirect pathway through both mediators is the only comparison to not contain zero in the confidence interval (2.81 to 8.46). The results also confirm no evidence that classification influences corporate philanthropy independent of the specific and total effects (c' = -1.65; p = .510). This integrated test infers hypotheses 1 and 2, in that R&D expenditures play a primary role in the relationship between classification and industry philanthropic investment and that such a relationship has a time-ordered causal pathway (i.e., sequentially progressive).

Model = 6 n = 174	Consequent														
	M_1 (R&D 2014)					M_2 (CPHIL 2015)					Y (CPHIL 2016)				
Antecedent	Coeff.	*SE*(HC0)	*t*	*p*		Coeff.	*SE*(HC0)	*t*	*p*		Coeff.	*SE*(HC0)	*t*	*p*
X (CLASSALL)	a_1 (364.48)	48.51	(7.51)	< .001	a_2	1.01	1.92	.529	.598	c'	(1.66)	2.51	(.659)	.510
M_1 (R&D 2014)	---	---	---	---	d_{21}	.016	.005	3.53	< .001	b_1	.009	.005	2.09	< .05
M_2 (CPHIL 2015)	---	---	---	---		---	---	---	---	b_2	.566	.156	3.63	< .001
C_1 (STRIVE)	f_1 (127.75)	28.85	(4.43)	< .001	g_1	(.183)	1.24	(.148)	.883	h_1	(.627)	.967	(.648)	.517
C_2 (CRO_A)	f_2 28.98	21.3	1.36	.176	g_2	.107	1.25	.085	.932	h_2	(1.14)	1.15	(.991)	.323
C_3 (CPHIL 2014)	f^3 5.89	.975	6.05	< .001	g_3	.734	.06	12.00	< .001	h_3	.374	.139	2.69	< .01
Constant	i_{M_1} 575.02	77.80	7.39	< .001	i_{M_2}	(.336)	3.91	(.086)	.932	i_Y	4.66	4.39	1.06	.290
$ in m Unstandard SE	R^2 = .6259 $F(5, 168) = 55.11, p < .001$					R^2 = .889 $F(6, 167) = 126.31, p < .001$					R^2 = .895 $F(7,166) = 148.39, p < .001$				

Table 11 - Test 8b Classification on Corporate Philanthropy through Serial Mediation of R&D and Prior Philanthropy (Strong Positive Indirect Effect on Path 3)

Possibility of Alternative Models of Integrated Tests

Prior testing eliminated most concerns related to alternative models, confounding, and epiphenomena. However, two possibilities present themselves with respect to alternate models, one with respect to the role of CROs and the other R&D-related pathways. The latter draw on the possibility that the serial mediation model might follow a sequential R&D to R&D model rather than the pathway previously analyzed. There is indeed evidence of an indirect effect of classification on 2016 corporate philanthropy through 2015 R&D, yet 2015 R&D was not included in the previous model. As a reminder, this is not a search for complete mediation but rather an evaluation of complex conditional processes. This means 2015 R&D still has a role in relation to 2016 corporate giving, which would require a substantially more complicated model to assess, one that is not explored here.

If we accept that 2015 R&D cannot be included as a covariate in the last model as developed, since it would have a retroactive influence on 2014 R&D and it is not logical to conclude causality of 2015 R&D on 2015 corporate giving, then we need a different mechanism to inspect. These facts also eliminate a serial mediation model with three mediators. The last option is to examine Model 6 with two R&D mediators while holding striving, CRO, and philanthropy constant, as suggested in Table 5 as test 8c. The results of test 8c (p <.05) provided no evidence that classification influences corporate philanthropy, through either total or any specific indirect effects of R&D, as there were no confidence intervals that did not include zero (ab = -6.19, CI 95% [-6.08, .214]) based on 5,000 bootstrap samples.

Of note is that CRO type was held constant in test 8b and 8c based on tests 3-6, which indicated that the presence of a CRO did not influence the strength of the relationships between variables significantly. To be clear, there was no inference drawn with respect to directionality of CROs influence because of the indicated significance in all tests. However, in conditional process analyses such as these, it is always possible that a variable's effect is fully dependent on the entirety of conditions considered together. The simple mediation models presented in tests 1-7 do not do so, in much the same manner as a simple linear regression might not. Therefore, an assessment of CRO as a moderating variable on the serial mediation model already presented was necessary. The results of test 10 (Model 59) for moderated mediation provided no evidence that CROs, regardless of type, had any significant effect on the relationships in the model, as no value for *p* was ever below .289 in the tests for highest order unconditional interactions and all confidence intervals contained zero. This suggests that it is not possible to make a meaningful inference in support of hypothesis 3 regarding the role of a CRO, beyond that their impact is potentially expressed through an initial relationship with R&D expenditures without further exploration.

Summary

A comprehensive examination of the non-linear causal pathways among Carnegie classification, institutional R&D expenditures, and corporate philanthropic investment was undertaken in this chapter. Additionally, the role of corporate relations offices acting within the conditional process was explored, finding no measurable impact of offices as currently derived. Using a sequence of simple mediation models to assess OLS path analysis with Huber-White heteroscedasticity-consistent interference,

it was determined with high confidence that classification significantly influenced philanthropic investment indirectly through both R&D expenditures and prior-year philanthropic success. This finding also considered alternate pathways, spurious association, and epiphenomenal concerns, resulting in an affirmation of the results.

A secondary set of examinations then explored an integrated test of the study's hypotheses, from which it was determined that Carnegie classification only significantly affects corporate philanthropy with high confidence in temporal sequence through R&D expenditures two years prior and then through corporate philanthropy one year prior. This finding was robust (R^2 = .849, (p<.001) and supported by a fully negative bootstrap confidence interval based on 20,000 samples. Accordingly, hypotheses 1 and 2 can be confirmed, that R&D provides the sequentially progressive indirect pathway for classification to influence philanthropy when holding striving, office type, and previous philanthropy constant. In short, as institutions rise in classification, R&D expenditures rise accordingly, and although there is a decrease in philanthropy as a percent of R&D, the net philanthropic investments from industry rise accordingly. However, the findings are unable to provide clear evidence regarding the role of CROs as a moderator in this conditional process, regardless of office type considered.

Chapter 5: Findings, Conclusions, and Recommendations

Discussion of Findings

In an effort to understand antecedents of university-business cooperation, research has traditionally emphasized institutional barriers and drivers in facilitation of technology commercialization (Bruneel et al., 2010; Plewa et al., 2013; Perkmann et al., 2012, Galán-Muros & Davey, 2017; D'Esta and Perkmann 2011; Plewa, 2006). With the advent of a new UBC Ecosystem Framework, developed on the basis of such scholarship, there is new evidence that UBC research must incorporate a methodology that evaluates interactions according to the boundary conditions that influence the UBC process. Galán-Muros (2015) was the first to leverage the Framework for empirical research, using more traditional linear regression methods. While such research provides significant insight, the methodology assumes that UBC-supporting mechanisms and UBC circumstances (as provided by Galán-Muros & Davey, 2017) do not interact with each other in the ecosystem. The results of the present study suggest that may not be accurate.

The primary aim of the present study was to extend research leveraging the UBC ecosystem to align US UBC research with global perspectives, through the incorporation of US contexts related to corporate philanthropy and prestige seeking. In so doing, a secondary aim was to advance a new model for use of the UBC ecosystem in research to enhance consideration of boundary conditions and strengthen the nascent Framework. The simultaneous consideration of these objectives provides an additional benefit through the assessment of the role of boundary-spanning organizations in UBC using US style corporate relations offices as a proxy. The integration of these concepts

normalizes UBC research globally, allowing US institutions to better incorporate global learning while leveraging empirical evidence for more efficacious decision-making towards institutional outcomes.

The results make further meaningful contributions by illustrating that isomorphic behavior and resource dependence are antecedents to increased administrative spending (Morphew & Baker, 2004) related to US CROs. The data demonstrate the extent to which directing CROs to focus on corporate philanthropy or industry-supported research may not be an effective use of existing resources, as increases in either are more dependent on classification and total R&D expense than on the presence of a CRO. This runs counter to contemporary lessons repeated by professional intermediary organizations (Metcalfe, 2010), which tend to bolster the administrative lattice (Zemsky & Massey, 1990). This finding provides a substantial basis for organizations such as NACRO, and perhaps AUTM, to break traditional patterns and develop a cohesive metric system and support functionally converged organizational structures that are more acutely aligned to institutional objectives. These objectives, while often unstated, include addressing costs associated to pursuing increased prestige.

As such, a refined UBC Ecosystem, as shown in Figure 21, provides an excellent guide for institutional evolution related to UBC. For example, I found no direct, indirect, or moderating effect for CROs when considered with the conditions presented. Seemingly these offices provide some meaningful contribution beyond isomorphism. Removing CROs from the equation had no discernable effect (per tests 3, 4, 5, 6, and 10), though office type 3 has so few implementations that it is difficult to

surmise any meaningful interpretation. The only effect found when assessing any office type was the dual report (philanthropy and research) but this was insignificant when tested using the final valid pathway. Perhaps it is helpful to revisit the roles of CROs with an eye toward moderating UBC barriers and drivers and away from attempts to primarily influence the UBC process directly.

Contributions & Implications for Theory and Practice

To my knowledge, this is the first study to apply conditional process analysis to the UBC ecosystem or to studies related to the Triple Helix of Higher Education (Etzkowitz & Leyesdorff, 1997; 2000). It is also the first to explore the relationship of classification to R&D and corporate philanthropy, regardless of methodology.
The integrated schema used in this study is both complex and more elaborate than prior research methodology, yet this was necessary to enable a more accurate perspective.

From an applied perspective, the results normalize UBC research to apply to a US context by elimination of constraints related to philanthropy allowing for development of more aligned, impactful, and comparable UBC metrics. The data also call into question the focus of UBC structures (CROs) directly toward resource acquisition in the UBC process. The caveat there is that any resource pursuit should be directed at institutional efficiency related to research and reputation, rather than current CRO approaches of pursuit of philanthropic or research funds. It also, frankly, suggests that universities might have the wrong incentives for people in Corporate Relations and could likely reallocate their efforts towards more relational metrics, resource allocation efficiency/recovery, and perhaps towards institutional innovation. Still, someone has to "ask" for a gift, but the onus (and said successful result) relies more on other players at

the institution and thus should not be the main priority of a CR officer. This generally falls in line with NACRO proposals but steps away from simple financial metrics such as corporate gifts and sponsored research.

Consider that the process of classification influencing corporate philanthropy has temporal and causal priority. For optimal mediation, the pathway must be R&D then CPHIL then CPHIL, so considering time, if Y = CPHIL at time T, then the pathway is R&D t-2 —> CPHIL t-1 —> CPHIL. This means that there is a lag on influence that we can see in the data where the combination of R&D 2 years ago + corporate giving last year has the greatest mediation of current classification (reputation) on corporate giving this year. Yet nearly every CRO is measured on annual outcomes that are arbitrarily determined by figuring "common" percentages (isomorphism) developed by intermediary groups (Metcalfe, 2010) that suggest what percentage of the annual goal should come from CFR and the annual goal is just an escalation of last year's goal (Johnson, 2008b; CASE, 2018; NACRO, 2012). So even if focus does not change away from specific (direct) responsibility toward philanthropy, universities should at least consider changing/improving the stochastic variables that set goals *and* recognize the necessary relationship between R&D and giving.

CROs and the professionals that operate them are talented, versatile professionals who are uniquely positioned to communicate inside and outside the university. Using their skills effectively requires "alternate measures of excellence" (Alpert, 1985, p.277). This study did not assess effectiveness of employees but explored whether their work was indirectly enabled by variables not within their control. Such as it seems, it might be a more effective challenge to a CR officer to

reduce the cost of research rather than pursue a philanthropic gift. If that were the question, the CRO would have substantially more arrows in his or her quiver, up to and including the ability to write a compelling gift proposal.

In a scholarly context, assimilation of this study's results with the work of other UBC researchers, particularly that of Galán-Muros and Davey (2017), provides growing evidence that there is indeed an ecosystem at work. This assertion reveals that meso-level analysis is valid and warranted, particularly when considering causal processes and the considerable boundary conditions within the *triple helix*. Appropriately, this contribution may lead to new topics of UBC research, and certainly could help shift the focus away from technology transfer outcomes as the sole indicator of escalated university prominence in the knowledge economy. We can certainly affirm that conditional process analysis is a valid methodology within the ecosystem, and perhaps go further to suggest that the UBC ecosystem *is* a robust conditional process. To that end, I provide a modified Framework to guide future researchers accordingly.

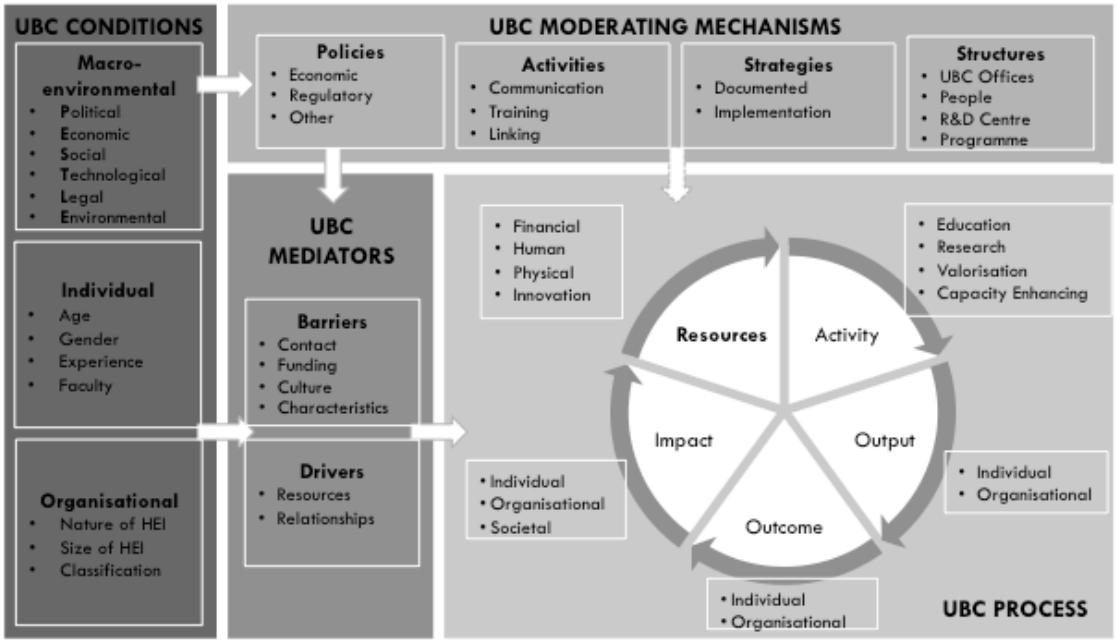


Figure 24 - Revised UBC Ecosystem Framework (adapted from Galán-Muros & Davey, 2017)

The Conditional Process UBC Ecosystem Framework

This study has shown that the conditional process approach is a valid methodology to studying interactions in the UBC Ecosystem because the ecosystem *is* a conditional process. The revised version of the UBC Ecosystem in Figure 21 reflects both the literature review and the outcomes of this study. It reflects several key adjustments from the original Galán-Muros and Davey (2017) Framework. As noted in Chapter 2, innovation has been added as a resource, inputs has changed to resources, and capacity enhancing has been added as an activity. However, the results of this dissertation provide two important foundational factors to the adjusted Framework. The most glaring difference in this version is the adjustment of the model to show directionality, which is an intentional shift based on the findings herein regarding causal priority. Second, the categories have been renamed to reflect the model proven in this study and some sub-categories have been renamed while others have been shuffled to

logical connection to other categories. UBC context is now UBC conditions and what was called environmental is now clarified as macro-environmental and the underlying PESTLE (a business environment assessment acronym) is clearer. This sub-category is moved up to align with the moderating mechanisms, and the other two categories (individual and organizational) are more clearly aligned with UBC mediators. As mentioned, UBC moderating mechanisms replaces UBC supporting mechanisms and the subcategories redistributed to reflect focus areas in the UBC process. This is not intended to indicate that moderators should have direct effect on the UBC Process, rather to note that there are areas in the process where moderators may be more focused on strengthening indirect effects. Finally, UBC circumstances is renamed UBC mediators. It is the intent of this designation to both indicate that all UBC conditions indirectly effect the UBC process through UBC mediators and to indicate that the focus on moderators should be directed towards making the mediators more effective (i.e., removing barriers and improving drivers).

As now drawn, the Framework also intimates a causal priority wherein UBC conditions have an indirect effect through UBC mediators on the UBC process. Those interactions are sometimes strengthened by UBC moderating mechanisms. In fact, considering the premise that the Framework is an Ecosystem, it is hard to imagine a case where there is an interaction that is not influenced by the other variables in the Framework. Therefore, researchers, practitioners, and higher education administrators should purposefully orient policies, activities, strategies, and structures to positively moderate direct and indirect effects for both efficiency and effectiveness in the UBC process.

Limitations & Recommendations for Future Research

As with all studies, this one is not without limitations. As noted in Chapter 1, there are some data-related challenges that make this study less robust than it otherwise might be. Among those concerns are bias in identification of office type, limited data related to office staffing and resources, and the nature of the Carnegie classifications. While I did not identify any common-method variance given the extant data sources, there may be some inaccuracies in the data that I could not account for in the study. In addition, the data assessment revealed the need for some modest controls when conducting the conditional process analysis for mediation and moderation (Hayes, 2018). The controls employed (i.e., Huber-White heteroscedaticity-consistent approach) help minimize any concerns in the outcomes. When considered with the generalizable results noted in Chapter 3, I believe any concerns related to limitations are significantly lessened.

Methodological concerns related to epiphenomena, causal pathways, and spurious association were all substantially addressed in the conduct of the observation as demonstrated. Nevertheless, there is still a strong possibility that alternate patterns are a reality given the nascence of the Framework. These should be explored in future research. In that process, it is also likely that additional covariates may be identified that were not addressed in this study, despite the robustness of the data leveraged herein. Finally, I would be remiss to not note that I am both a practitioner and researcher in the field of university-industry interactions (aka UBC). This may present some bias in the assessment of the data so I have overreported the mediation analyses (Hayes, 2018) to allow for transparency and objectivity accordingly.

Aside from addressing these limitations, the results of this study avail some interesting pathways for future research. Noting that this construct is not exhaustive in the consideration of variables that might be identified in the UBC ecosystem, future research could explore additional mediators through which classification might have indirect effects or moderators that might strengthen those effects accordingly. Similarly, it would be interesting to explore other boundary-spanning organizations in the conditional process, whether as a consideration of the current model or as boundary-spanning organizations in their own right. For example, a study that explores the indirect effect of classification on technology transfer revenues through R&D expenditures would be alluring and might enable enquiry into the moderating effect of TTOs. The same could be modeled using any other boundary-spanning structure that engages with UBC, if the necessary data could be gathered.

It might also be worthwhile to consider using conditional process analysis to explore intervening activities among other variables in the Framework. Research suggests that drivers and barriers (Bruneel et al., 2010; Plewa et al., 2013; Perkmann et al., 2012, Galán-Muros & Davey, 2017; D'Esta and Perkmann 2011; Plewa, 2006) are key to fostering UBC, and the model advanced in this study enables a further exploration of those mediating elements when considering all conditions acting together. Such studies might also give rise to studies exploring a variety of structures, polices, strategies, and practices and their moderating efficacy when considering circumstances outside of the institution and objectives of UBC together. Concurrent investigation of these phenomena, including multiple mediators and moderators, would

enable investigators to provide a more realistic and detailed representation of interactions in the UBC ecosystem.

Finally, there are few studies that incorporate econometric analysis of outcomes and impact of the resulting UBC process. As provided, Solerno (2002) produced a study exploring allocative efficiency at universities toward the efficient production of education and research. In that respect, a similar study directed toward the UBC Process might provide deepened perspectives for administrators looking to increase prestige. For example, it is one thing to explore how many licenses have been signed by a TTO or to assess how much philanthropic funding has been acquired by a CRO. It is a wholly different exploration to determine the impact of those acquisitions and then to apply efficiency findings to organizational decision making as a result. Such a study, when combined with further conditional process analyses (or perhaps incorporated within) might encourage institutions to acquire and allocate resources more efficiently and effectively.

Conclusions

The results of this study show that there is a casual pathway that is observable using conditional process analysis and that this pathway is sequential when considering the indirect effect of institutional classification on corporate philanthropy through R&D expenditures. The presence of a corporate relations office, intended by institutions to foster relationships with industry partners to enable financial support, has no effect on the causal pathway when considering the boundary conditions. These findings contribute to the field of UBC study, and by association to studies using *triple helix* theory, by demonstrating the use of conditional process analysis in the nascent UBC

Ecosystem Framework (Galán-Muros & Davey, 2017), and subsequently by elucidating how and under what circumstances classification has bearing on industry philanthropic investment in universities. Important investigations remain to identify indirect and direct effects within the UBC ecosystem, for both researchers and practitioners, such that the deployment of resources to enable UBC can be optimized towards institutional goals. It is hoped, therefore, that this work will be leveraged by others to explore other antecedents and consequences of university-industry interaction and to reframe objectives of corporate relations offices.

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