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Extending the 8 Forces Framework of Attachment and Voluntary Turnover

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Studies in business research have begun to utilize a framework of the "8 forces" of attachment and turnover (i.e., Maertz & Griffeth, 2004) categories that purportedly capture all of the distinct motives causing voluntary turnover decisions. This model's claim of comprehensiveness will be tested through incremental validity tests on four possible value-added turnover antecedents established in the literature, in two samples of hourly factory workers. The relevant 8 forces fully-mediate the effects of organizational identification, work satisfaction, and pay satisfaction on turnover intentions. However, location attachment demonstrates incremental validity beyond relevant 8 forces variables. Thus, the findings generally support the 8 forces model as a framework to understand why people stay or quit, with one notable need for extension. In order to fulfill the model's promise of comprehensiveness, with all attendant benefits to empirical and practical turnover research, a 9th force of location attachment including community embeddedness should be added.

Voluntary employee turnover has been one of the most popular topics in organizational research over the last 50 years (e.g., Griffeth & Hom, 2001; Lee et al., 2004; Mitchell, Holtom & Lee, 2001a; Steel, Griffeth & Hom, 2002). Despite the continuing importance of turnover research and considerable theoretical progress on *how* people quit (e.g., Lee & Mitchell, 1994), few models have truly strived for comprehensiveness in understanding *why* people quit their job (cf., Mobley et al., 1979; Price & Mueller, 1981). This failure to understand all the theoretical categories

for why people quit also inhibits a greater understanding of how to study and manage voluntary turnover for a number of reasons. First, most content models would suggest job satisfaction or organizational commitment as the main initiator or central mediator of effects on turnover (e.g., Price & Mueller, 1981), but a good number of antecedents have been shown to be conceptually distinct from these traditional antecedents and have demonstrated incremental validity beyond them (e.g., Becker, 1992; Lee et al., 2004; Mitchell et al., 2001b), so comprehensiveness of traditional predictive models is questionable. Second, many other predictors also overlap conceptually with these traditional attitude antecedents (Hom & Griffeth, 1991). Third, the deficiency and overlap in turnover content models leaves practitioners without an overall framework for how to think about influencing turnover intentions and final decisions. Therefore, for researchers and practitioners, a theoretical model is needed to guide which constructs to include in models to avoid both deficiency and the confounding of distinct psychological mechanisms for attachment and withdrawal.

Such a framework, called the "8 forces," has been proposed (Maertz & Griffeth, 2004). Although this 8 forces model synthesizes many established concepts from the commitment and turnover literatures and the authors claim that these categories are comprehensive, the claim is yet untested. The main purpose of this paper is to test the claim of comprehensiveness of this increasingly visible framework, and if changes are suggested by the tests, the model will be expanded to better achieve its promise of comprehensiveness.

The Importance of Theoretical Distinctiveness and Comprehensiveness

Content turnover models attempt to integrate and differentiate the "whys" for quitting an organization. Although multiple predictor constructs have been aggregated into prominent content models (e.g., Bluedorn, 1982; Hom & Griffeth, 1991; Meyer & Allen, 1991; Mobley et al., 1979; Price & Mueller, 1981), each omits key antecedents shown to be important in other theoretical or empirical studies. To be fair, none of these content models has claimed to fully capture the proximal motives for turnover and attachment. The lack of a complete content model has left researchers and practitioners who want a full set of antecedents to idiosyncratically pick a set of constructs/predictor scales that may be deficient. Conceptual overlap is a serious problem for theory and research as well (e.g., Bozeman & Perrewe, 2001; Hom & Griffeth, 1991; Morrow, 1983). Both of these problems can lead to specification errors in empirical models and ambiguity in terms of how to intervene practically based on survey responses. Thus, measuring all the main antecedent categories for turnover with some level of parsimony, while minimizing conceptual overlap, would be highly valuable, but doing this requires explicit theoretical guidance.

The 8 Forces Framework

In response to this issue, Maertz and Griffeth (2004) synthesized the model called the "8 Forces Framework" and proposed 8 general categories of motives for organizational attachment and withdrawal (Table 1). They also mustered considerable

evidence and arguments for the distinctiveness and non-overlap of the motivational mechanisms involved in each category. However, they also claimed that their framework was comprehensive in capturing the unique proximal motivational mechanisms that led to turnover decisions. Maertz and Griffeth (2004) further claimed that all turnover predictor scales were either antecedents of these forces or indicators of these 8 forces. In either case, this implied that one or more of their mechanisms fully mediated all causal effects on voluntary turnover intentions, and therefore, on actual turnover decisions (e.g., Mobley, 1977).

Table 1: *Summary of 8 Forces Framework*

Affective Forces	At any given point in time, an employee has an overall feeling about the organization and being a member in it, which initiates a hedonistic approach-avoidance mechanism. That is, comfort or feeling good at the organization motivates attachment to it, while discomfort or feeling bad motivates withdrawal. This is purportedly the primary common turnover motive captured in affective commitment and global satisfaction.
Contractual Forces	Psychological contract obligations to the organization, through a norm of reciprocity, can imply or explicitly include staying with that organization. Conversely, perceived contract violations by the organization reduce or eliminate any such obligations to stay, and thereby, motivate quitting.
Calculative Forces	Based on future-oriented self-interest, employees calculate their chances for achieving their goals and values at the current organization. If this calculation is favorable, the person becomes more motivated to stay. If the calculation is that important goals and values cannot be met there, the person becomes more motivated to quit.
Alternative Forces	Good or plentiful alternative job opportunities can psychologically pull and attract employees away from their current organizations for various reasons. Conversely, an employee who believes that there are few or low quality alternatives available will be less motivated to quit the current organization, ultimately fearing unemployment.
Behavioral Forces	Behavioral forces are the perceived tangible or psychological costs incurred by leaving, like side-bets or psychological dissonance, motivating attachment to the organization. Conversely, perceiving no costs of leaving (or dissonance of staying) motivates an employee to quit.
Normative Forces	Employees perceive expectations from family or friends about their remaining or quitting. Assuming that there is some motivation to comply with these expectations, a motive force is created. If the family member or friend's expectations favor staying, there is a motive to remain. If the expectations favor leaving, there is a motive to quit.
Moral Forces	Employees may also internalize a value about turnover behavior itself. This value may hold that quitting jobs shows weak character or fickleness, implying attachment. Or, this value may hold that changing jobs regularly is a virtue, implying withdrawal. The psychological motive force is to do the "right thing" by acting consistently with one's internalized values about turnover behavior.
Constituent Forces	Related to foci of commitment (Becker, 1992) and on-the-job embeddedness "linkages" (e.g., Lee et al., 2004), an employee may feel attached to or want to withdraw from various constituents (e.g., leaders, friends, coworkers, team) within the organization, apart from the organization itself. Because constituents are typically seen as embedded within the organization, attachment to them would typically imply attachment to the organization as well.

Recently this 8 Forces Framework has begun to be utilized in the literature as a tool to understand and summarize turnover motives (e.g., Harris, Kacmar & Witt, 2005; Holtom et al., 2008; Maertz & Campion, 2004; Maertz et al., 2007). Nevertheless, this model needs to be tested before these 8 forces can be considered a comprehensive set of constructs to guide future research and practice. In fact, it is quite possible that some distinctive motives for staying or leaving may have been confounded or omitted from this framework altogether. For example, satisfaction with the work itself and off-the-job/community embeddedness have demonstrated validity in predicting turnover behavior (Griffeth et al., 2000; Lee et al., 2004), but are not included in the framework. Extending the 8 Forces Framework to include key omitted constructs would provide a fuller conceptualization and understanding of the nomological network of causes surrounding voluntary turnover and psychological attachment to an organization.

Meaningfully Testing the Model

This 8 forces model synthesizes, clarifies, and helps theoretically refine the turnover antecedent literature, but it does not introduce any completely new concepts. This creates an interesting question of how to meaningfully test such a model. The obvious answer would be to focus on predictive validity. However, because the model is a synthesis based on many past studies, there is no doubt that some approximate measures of the model's forces have predicted turnover behavior in the past and would do so again (e.g., Griffeth, Hom & Gaertner, 2000; Griffeth et al., 2005; Lee et al., 2004; Meyer, Allen & Smith, 1993; Mitchell & Lee, 2001). In fact, Maertz and Griffeth (2004) offer support for the predictive validity of all forces except their "moral forces," although they criticized the imprecision of many measures. Testing the 8 Forces Framework, then, is not primarily about whether the forces predict turnover behavior. Instead, the key question is, "Are these 8 forces complete in capturing people's distinct motives?"

For testing the modeling hypotheses, turnover intentions are the criterion used to more closely reflect the theoretical causal sequence being modeled, where all antecedent effects on turnover behavior are fully mediated by turnover intentions (e.g., Azjen, 1991; Mobley, 1977). Continuous measures of turnover intentions also do not violate the assumptions of SEM modeling techniques and provide more power to detect incremental effects. Also, potential common method bias does not seriously threaten the validity of our hypothesized comparative nested-model tests between fully and partially-mediated models, as in the case of assessing predictive validity. For these reasons, it is believed that using intentions as the criterion in our SEM model comparisons is appropriate and not a flaw for the purpose of testing comprehensiveness.

Dimensions and Scales of the 8 Forces

To understand comprehensiveness, subdimensions of these force categories must be distinguished from truly distinct motivational mechanisms representing separate categories. Maertz and Griffeth (2004) freely acknowledged that their 8 categories were likely multi-dimensional. Before testing comprehensiveness, the dimensionality of the 8 forces must be addressed and measures of any subdimensions must be introduced. In

a recent paper, Maertz and Boyar (2010) developed a multi-dimensional survey of the 8 Forces Framework. They tested the dimensionality in competitive confirmatory factor analyses, supporting 18 total subdimensions across the 8 forces. They then calculated subsequent factor analyses, internal consistency reliabilities, and regression analyses using these 18 scales. Their results generally supported the psychometric properties and predictive validity of the scales used here. See Appendix 1 for dimensions and example items for each of the 18 scales measuring the 8 forces.

Hypotheses

Considering these subdimensions, the 8 Forces Framework may have wrongly omitted key antecedent motives not reflected in any of the forces. The key question for empirical modeling is whether these omitted constructs amount to additional forces with unique motivational effects on turnover decisions, or if their effects are fully mediated by the motive categories already identified. If other antecedents demonstrate significant incremental validity beyond the mediating forces (i.e., partial mediation), this is evidence that additional motivational forces are at work, implying that the model should be expanded. All constructs cannot be tested in one study with the potential to have incremental validity beyond the 8 forces. Instead, hypotheses for four (4) important turnover antecedents from the literature will be proposed.

Organizational Identification

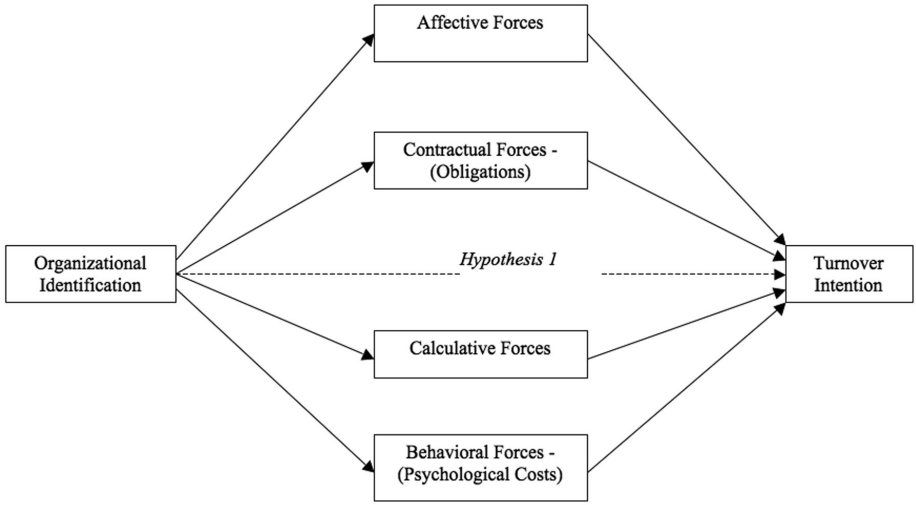
Organizational identification is a form of social identification where one's identity is partially defined by membership in the organization (Hogg & Terry, 2000). Positive feelings toward the organization likely result from this social identification process (e.g., Ashforth & Mael, 1989; Mowday, Steers & Porter, 1979), implying mediated effects on turnover intentions through affective forces. Further, an employee who identifies closely with the organization is more likely to feel a need to stay in order to fulfill obligations to that organization than an employee who has not identified with the organization. This relationship suggests mediation of organizational identification through contractual forces of obligation. Also, identification may make the employee see his/her future goals/values as more aligned with the organization's (e.g., O'Reilly & Chatman, 1986). This implies that employees should be motivated to stay with the organization in order to facilitate fulfillment of these goals. Thus, organizational identification effects should be mediated by calculative forces as well. Finally, leaving an organization with which one has identified implies some psychological cost (Salancik, 1977). Because behavioral forces include psychological costs of guilt/regret associated with leaving, organization identification should also be mediated by such behavioral forces.

Despite these likely mediated effects, we argue that organizational identification may still have incremental direct effects on turnover intentions beyond these mechanisms. This is because loss of one's identity (or part of it) could transcend simple negative affect, any conscious recognition of a "cost of leaving," or other proposed mediator effects. This potential threat could create a distinct motivation to protect one's self-concept through continued membership at a subconscious level that is not

reflected in any of the force constructs (Figure 1). Thus,

Hypothesis 1: Organizational identification effects on turnover intentions will be partially rather than fully mediated by affective, contractual (obligations), calculative, and behavioral (psychological costs) forces.

Figure 1: *Representation of Hypothesis 1*



Work Satisfaction and Pay Satisfaction

Work satisfaction and pay satisfaction have both been among the most consistently significant predictors of turnover behavior (Griffeth et al., 2000). Yet, Maertz and Griffeth (2004) do not mention these factors. Nevertheless, they would certainly link both of these constructs to turnover through several of their forces. First, work and pay cause emotion associated with the organization through attribution that the organization itself causes key work type and pay decisions. Thus, work and pay satisfaction effects on turnover decisions should be mediated through affective forces. Second, out of reciprocity for receiving satisfying work assignments and compensation, work and pay satisfaction could also be seen as creating some obligation to stay with the organization. This implies potential mediation of both these satisfaction effects through contractual forces as well. Current satisfaction with work or pay may act as a signal to the employee that his/her work goals can also be met in the future through continued membership in the organization. This also suggests that work and pay satisfaction would be mediated through calculative forces of attachment. Also, work satisfaction and pay satisfaction may translate into greater attachment by causing an employee to see other alternative jobs as relatively less attractive (i.e., mediated by alternative forces). Employees with high work and pay satisfaction would also likely experience some psychological dissonance cost that must be resolved whenever they

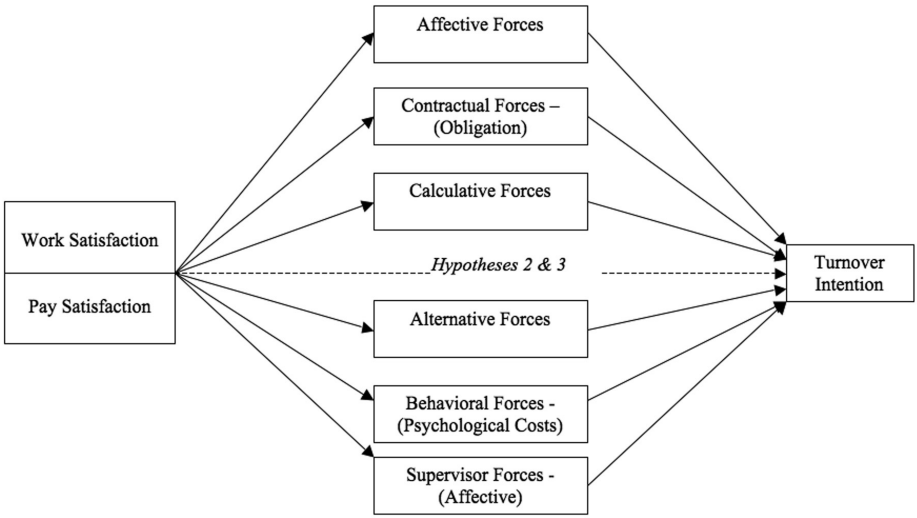
contemplate quitting (Salancik, 1977). This may cause them to reject or revise thoughts of leaving, thereby increasing psychological attachment. This implies that behavioral forces can mediate these two satisfaction effects on turnover intent. Finally, because the supervisor is often seen as controlling work assignments and pay decisions to some extent, work and pay satisfaction can create positive feelings toward the supervisor and thereby influence turnover intentions (Maertz et al., 2007). This means mediation through supervisor constituent forces in the form of positive affect.

Despite these likely mediated effects, it is suggested that a person's satisfaction with the work itself and compensation satisfaction may be so central to employee conceptions of organizational membership that these attitudes themselves have an independent influence on turnover decisions not portrayed in the 8 forces. That is, these mental categories concerning the work itself and compensation may be so ingrained in turnover cognitions that they become part of scripts, schemas, and implicit theories of staying and leaving. In this way, these aspects may operate as separate motive categories, exerting direct effects on turnover intentions beyond those mediated through the forces proposed above (Figure 2).

Hypothesis 2: Work satisfaction effects on turnover intentions will be partially rather than fully mediated by affective, contractual (obligations), calculative, alternative, behavioral (psychological costs), and supervisor (affective) forces.

Hypothesis 3: Pay satisfaction effects on turnover intentions will be partially rather than fully mediated by affective, contractual (obligations), calculative, alternative, behavioral (psychological costs), and supervisor (affective) forces.

Figure 2: *Representation of Hypotheses 2 and 3*



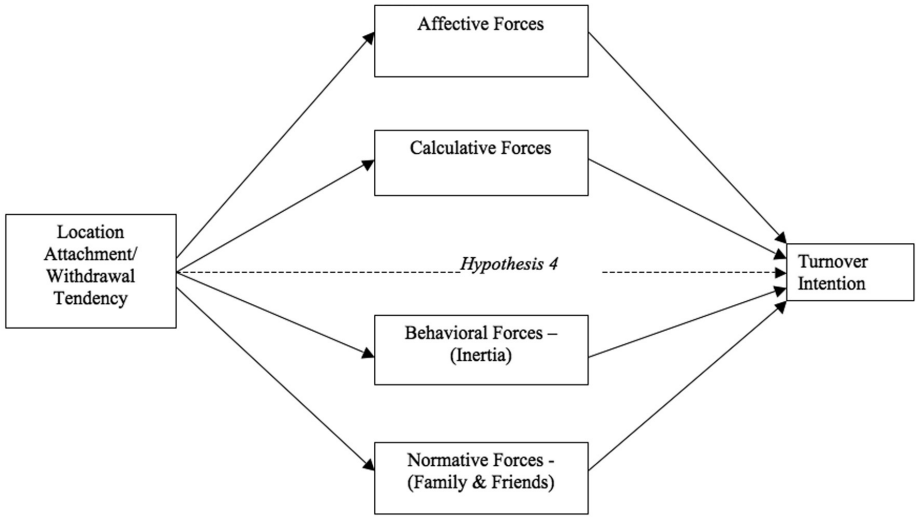
Location Forces

There is considerable anecdotal evidence that geographic location matters significantly in people's job choices and turnover decisions. Moreover, Mitchell et al. (2001) found that embeddedness variables had incremental effects in explaining turnover behavior beyond established predictors. However, Maertz and Griffeth (2004) did not mention location attachment within the 8 Forces Framework, although they did claim that several of their forces mediate location effects. First, being attached to the location may also involve attachments to the organization itself, if it is only located within the same community or if it is the main employment opportunity that allows one to remain there. In this way, being attached to the community could cause positive feelings to spill over toward the organization (i.e., mediation by affective forces). Second, the general location where one works and resides is likely relevant to the employee's calculations about the likelihood of attaining key goals (e.g., working in a top corporation in a big city). If the current location allows goals to be met, this should increase calculations that goals can be met by staying at the current organization. This suggests mediation through calculative forces. Third, attachment to the community implies thinking about what could be sacrificed by leaving it (Mitchell & Lee, 2001). This creates behavioral inertia costs against movement from both the community and organization (e.g., company benefits providing access to country club), which reflects mediation through these behavioral forces. Finally, whether an employee leaves or stays within the current location is certainly relevant to both family members and friends of the employee, who form expectations about his/her staying or leaving the location. If the employee's own attachment to the location is shared by friends or family, these people are likely to have salient expectations for the employee about turnover in the form of normative forces. Thus, normative forces involving both family and friends could also mediate location attachment effects on the employee's turnover decision.

As with work and pay, community/geographic location is so central to many employees' concept of their life and work that it may be endemic to turnover deliberations (e.g., Campion, 1991; Mitchell & Lee, 2001). Employees may even rule out or accept job offers primarily on the basis of the location. Thus, the location of a job opportunity may be considered so naturally and so readily in turnover deliberation that it constitutes a separate category of motivation from the mediating forces proposed above (Figure 3).

Hypothesis 4: Location effects on turnover intentions will be partially rather than fully mediated by affective, calculative, behavioral (inertia), and normative (family and friends) forces.

Figure 3: *Representation of Hypothesis 4*



Method

Surveys were distributed to two samples of semi-skilled workers from two different organizations: a furniture manufacturing plant and a poultry processing plant (both in the southern United States). In each sample, surveys with all scales were distributed in common break rooms during work hours and respondents were entered into a drawing for 3 prizes of $100 for their participation. They were also assured that no responses would be shared with management.

For the furniture plant workers, 550 surveys were distributed and collected 434 for a response rate of 78.5%. The average age was 37 years (*sd* = 10.5). Twenty-two percent (22.6%) of respondents had not graduated from high school, 58.5% were high school graduates, 13.8% graduated from junior college or technical school or had some 4-year college, and 5.1% were 4-year college graduates; they were 38% African-American, 54% White, 2.5% Latino, and 5.2% Native American, 68.8% female, and 64.4% married.

For the poultry processing workers, 350 surveys were distributed (a very small unknown number were lost) and 175 were collected for an approximate response rate of 50%. The average age was 34 (*sd* = 9.96). Nineteen percent (19.2%) had not graduated from high school, 45.3% were high school grads, 25% graduated from junior college or technical school or had some 4-year college, and 10.4% were 4-year college graduates; they were 84.8% African-American, 11.7% White, 1.2% Latino, and 2.3% Native American, 69.8% female, and 33.1% married.

Measures

All responses to items on the 8 forces and the other scales were given in the following response format: 1=Strongly disagree; 2=Disagree; 3=Slightly disagree; 4=Neither agree nor disagree; 5=Slightly agree; 6=Agree; 7=Strongly agree. The 18 different scales, number of items, and example items from Maertz and Boyar's (2010) scales are depicted in Appendix 1. Besides the 18 forces, the 5 other scales on the distributed survey were:

Turnover intentions. Turnover intentions were measured with 4 items on a 7-point Likert-type scale. Example items were "as soon as I get another acceptable job I will quit" and "I intend to quit this organization someday soon."

Organizational identification. This construct was measured with 5 items on a 7-point, disagree, Likert-type scale. Example items were "I belong at ____(the company name) more than at other organizations" and "I see myself as an important part of _____ (the company name)."

Work satisfaction. This was measured with 6 items on a 7-point, Likert-type scale. Example items were "I like the activities I do at work" and "I am satisfied with the work I do."

Pay satisfaction. Pay satisfaction was measured with 6 items on a 7-point, Likert-type scale. Example items were "I am satisfied with the pay level that _____ (the company name) offers" and "I am satisfied with the amount of benefits that _____ (the company name) offers."

Location attachment. This construct was measured with 4 items on a 7-point, Likert-type scale. Items were phrased in terms of withdrawal tendency and were recoded such that higher scores reflect attachment. Example items were "I do not like the city where I live now" and "I would like to move away from this place."

Analyses

The SEM measurement and structural models were estimated using maximum likelihood in LISREL 8 (Joreskog & Sorbom, 1996) and covariance matrices. All scales except alternative forces and location forces were coded positively, in the direction of attachment to the organization. That is, negative relationships were expected between all the forces scales and turnover intentions/behavior except for these. A structural model where items representing the latent construct were averaged to create a scale (i.e., a single indicator) was tested. This practice is used with small samples that have numerous items and variables. Research suggests that such adjusted single indicators produce similar structural results to estimated measurement models (Netemeyer, Johnston & Burton, 1990). The manifest variable loadings were set to "1" (Hayduk, 1987) and the error terms set to = (1- reliability) x item variance. We used SEM chi-square difference tests of nested models and *t*-tests on path coefficients to compare partially- vs. fully-mediated models to test the 4 additional antecedents.

Because the purpose was to test incremental validity beyond the 8 Forces Framework, and because turnover base rates were low as in many turnover studies (lowering power), the Type II error was a relatively bigger threat in this study than

Type I. After all, it is difficult to statistically demonstrate incremental validity at all with many other proven predictors in a single equation. It is more likely that potentially important additions to the model would be missed than erroneous relationships found. This latter possibility is further diminished through our variables all being included based on theory and past findings. Thus, to maximize power to detect incremental effects, path coefficients for significance at the $p<.10$ level in this early stage of modeling (see Hosmer & Lemeshow, 1989) were evaluated.

Results

Table 2 shows all scales' alpha reliabilities. Only two of the 18 scales did not meet the typical .80 standard for new scales in at least one sample. Tables 3a and 3b reflect scale means, standard deviations, and correlations for study variables in both samples. All turnover predictor scales were significantly correlated with turnover intentions ($p < .05$) in both samples in the expected direction.

Table 2: *Alpha Internal Consistency Reliabilities for All Study Scales*

Scale	Alpha Coefficient: Poultry Plant	Alpha Coefficient: Furniture Plant
Affective	.94	.93
Contractual-Obligations	.89	.90
Contractual-Violations	.87	.89
Calculative	.95	.94
Alternative	.84	.89
Behavioral-Tangible costs	.79	.76
Behavioral-Inertia	.84	.81
Behavioral-Psychological costs	.88	.81
Normative-Family	.81	.87
Normative-Friends	.86	.91
Moral-Attachment	.80	.80
Moral-Withdrawal	.74	.80
Supervisor-Affective	.92	.92
Supervisor-Continuance	.92	.87
Supervisor-Normative	.89	.90
Coworker-Affective	.90	.89
Coworker-Continuance	.75	.76
Coworker-Normative	.90	.89
Turnover intentions	.88	.90
Organization identification	.87	.83
Work satisfaction	.90	.90
Pay satisfaction	.93	.91
Location attachment	.84	.82

Table 3a: *Means, Standard Deviations, and Correlations among Study Variables for Furniture Sample*

	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1Affective	5.40	1.28																							
2Contractual--ob	4.22	1.51	.59																						
3Contractual--vio	4.79	1.56	.31	.39																					
4Calculative	4.45	1.58	.61	.62	.41																				
5Alternative	3.99	1.52	-.38	-.38	-.33	-.39																			
6Beh.--tangible	4.58	1.33	.34	.41	.07	.33	-.21																		
7Beh.--Inertia	4.59	1.46	.49	.53	.22	.47	-.42	.57																	
8Beh.--psych	4.94	1.30	.65	.63	.25	.60	-.37	.44	.59																
9Norm--family	5.18	1.28	.17	.15	.32	.17	-.32	.04	.21	.18															
10Norm--friends	5.29	1.41	.31	.24	.36	.35	-.50	.16	.30	.27	.51														
11Moral--attach	5.37	1.15	.41	.43	.14	.39	-.17	.34	.43	.50	.20	.16													
12Moral--withdraw	5.33	1.11	.31	.28	.41	.29	-.34	.17	.28	.35	.51	.46	.35												
13Cons. Sup. Aff	4.87	1.52	.43	.48	.31	.40	-.20	.19	.25	.39	.17	.15	.26	.14											
14Cons. Sup. Cont	4.04	1.65	.42	.53	.27	.40	-.25	.18	.26	.38	.13	.10	.22	.13	.79										
15Cons. Sup. Norm	4.14	1.60	.46	.60	.21	.47	-.24	.24	.40	.39	.07	.12	.26	.08	.66	.74									
16Cons. Cow. Aff	5.05	1.31	.28	.36	.14	.25	-.03	.17	.17	.33	.06	.05	.28	.21	.28	.28	.25								
17Cons. Cow. Cont	4.18	1.42	.28	.41	.11	.27	-.08	.21	.25	.28	-.07	-.01	.19	.12	.24	.34	.40	.60							
18Cons. Cow. Norm	4.01	1.52	.30	.46	.12	.34	-.16	.24	.33	.32	-.04	.04	.23	.14	.21	.32	.46	.56	.79						
19Location	5.15	1.47	.30	.26	.25	.28	-.23	.20	.21	.30	.27	.26	.21	.30	.12	.06	.06	.14	.01	.06					
20Pay Satisfaction	4.59	1.57	.61	.52	.32	.55	-.39	.24	.40	.50	.15	.33	.29	.22	.35	.42	.41	.19	.20	.25	.24				
21Work Satisfaction	5.20	1.33	.68	.55	.35	.58	-.32	.37	.47	.56	.16	.29	.39	.29	.39	.35	.39	.30	.26	.27	.30	.48			
22Org. Indent.	3.94	1.49	.63	.59	.28	.56	-.34	.38	.43	.56	.11	.19	.38	.19	.41	.45	.51	.30	.36	.38	.17	.55	.54		
23Intent to Quit	2.56	1.46	-.58	-.42	-.39	-.46	.50	-.23	-.46	-.46	-.38	-.49	-.30	-.50	-.31	-.30	-.33	-.15	-.11	-.20	-.35	-.40	-.44	-.38	

n = 406

p < .05 for *r* > .09; p < .001 for *r* > .13

Table 3b: *Means, Standard Deviations, and Correlations among Study Variables for Poultry Sample*

	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1Affective	4.61	1.85																							
2Contractual--ob	3.63	1.81	.63																						
3Contractual--vio	4.21	1.97	.18	.14																					
4Calculative	4.32	1.93	.74	.72	.17																				
5Alternative	4.51	1.58	-.18	-.14	-.25	-.16																			
6Beh.--tangible	4.19	1.62	.46	.48	.01	.46	-.09																		
7Beh.--Inertia	3.95	1.80	.52	.50	.05	.53	-.20	.68																	
8Beh.--psych	4.30	1.82	.68	.68	.16	.64	-.24	.46	.57																
9Norm--family	4.14	1.64	.06	.01	.37	.11	-.32	-.21	-.15	.03															
10Norm--friends	4.47	1.72	.25	.16	.31	.25	-.31	-.07	-.01	.19	.54														
11Moral--attach	5.12	1.46	.34	.46	.06	.37	-.08	.28	.26	.34	.13	.16													
12Moral--withdraw	4.94	1.33	.20	.07	.30	.21	-.29	.00	.03	.17	.41	.46	.26												
13Cons. Sup. Aff	4.70	1.82	.45	.51	-.01	.54	-.11	.29	.33	.49	.04	.03	.35	.09											
14Cons. Sup. Cont	4.08	2.02	.40	.53	-.01	.53	.00	.29	.35	.48	-.03	-.02	.35	.01	.84										
15Cons. Sup. Norm	4.23	1.84	.43	.59	.04	.61	.00	.33	.40	.53	-.02	.06	.38	.04	.72	.81									
16Cons. Cow. Aff	4.99	1.64	.53	.43	.03	.46	-.12	.43	.43	.49	-.04	.13	.39	.18	.42	.37	.41								
17Cons. Cow. Cont	4.16	1.71	.43	.52	-.08	.47	-.07	.39	.43	.52	-.18	-.01	.39	.07	.40	.55	.54	.59							
18Cons. Cow. Norm	4.08	1.77	.49	.61	-.05	.53	-.14	.35	.43	.58	-.06	.12	.46	.11	.37	.47	.56	.63	.80						
19Location	4.75	1.79	.12	-.04	.21	.06	-.19	-.08	-.05	.06	.21	.28	.03	.21	-.04	-.04	.01	-.03	-.03	.06					
20Pay Satisfaction	3.76	1.91	.71	.59	.21	.61	-.24	.36	.40	.58	-.01	.16	.22	.08	.33	.31	.35	.34	.35	.36	-.04				
21Work Satisfaction	5.30	1.61	.63	.41	.04	.47	-.19	.40	.37	.52	.03	.19	.29	.13	.45	.32	.31	.45	.31	.36	.08	.41			
22Org. Satisfaction	3.64	1.82	.73	.68	.13	.72	-.10	.34	.42	.66	.06	.21	.34	.12	.46	.50	.54	.43	.47	.56	.07	.57	.52		
23Intent to Quit	3.60	1.90	-.51	-.40	-.35	-.50	.32	-.23	-.35	-.57	-.33	-.36	-.24	-.33	-.32	-.29	-.31	-.41	-.37	-.41	-.19	-.35	-.32	-.39	

n = 164

p < .05 for *r* > .12; p < .001 for *r* > .20

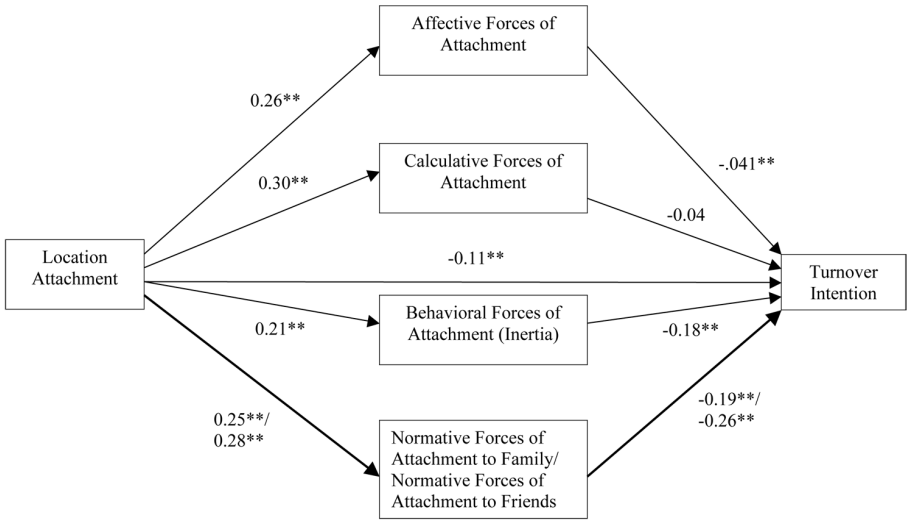
Hypothesis Tests

To test the hypotheses, fully- vs. partially-mediated models were compared for each additional construct in each sample (Table 4). In general, the hypothesized mediated effects were supported. All paths between the 4 antecedent constructs and their hypothesized force mediators were significant in both samples with only 2 exceptions. Namely, location attachment was not significantly related to calculative forces, nor to behavioral forces (inertia) in the poultry plant sample. See Figure 4 for coefficients in furniture plant sample.

Table 4: *Model Comparisons to Assess Incremental Validity of Four Additional Variables*

Hypothesis/ Additional Variable	Fully-Mediated Model		Partially-Mediated Model			Non-mediated Path Coefficient w/Intent
	χ^2	df	χ^2	df	$\Delta\chi^2$	
Hypothesis 1: Organization identification-Poultry sample	178.5	7	170.1	6	8.4**	.29
Hypothesis 1: Organization identification-Furniture plant	438.8	7	432.5	6	5.3**	.15
Hypothesis 2: Work satisfaction-Poultry plant	453.7	16	452.3	15	1.4	.09
Hypothesis 2: Work satisfaction-Furniture plant	387.3	16	387.3	15	0	.01
Hypothesis 3: Pay satisfaction- Poultry plant	391.4	16	383.7	15	7.7**	.19
Hypothesis 3: Pay satisfaction- Furniture plant	743.0	16	738.0	15	5.0**	.11
Hypothesis 4: Location attachment-Poultry plant	267.2	11	265.9	10	1.3	-.06
Hypothesis 4: Location attachment-Furniture plant	536.3	11	524.1	10	12.2**	-.11*

Figure 4: *Coefficients in the furniture plant sample*



All hypothesized mediators to turnover intention paths in the 4 models were significant in at least one of the samples, with two exceptions. In the models of work satisfaction and pay satisfaction effects, paths from contractual forces (obligations) and from supervisor affective attachment to turnover intentions failed to achieve significance, and thus, were not supported as mediators of work and pay satisfaction. To demonstrate incremental validity beyond the relevant force mediators and to justify adding a new construct and associated scale to the forces framework, we required that the chi-square difference between the models be significant at the $p < .05$ level, favoring the partially-mediated model and that the direct path coefficient from the additional construct to turnover intentions be significant in at least one sample. Only location attachment met these criteria. Thus, location attachment successfully demonstrated incremental validity beyond the 8 forces scales and Hypothesis 4 was supported.

In contrast, it appears that organizational identification, work satisfaction and pay satisfaction's negative effects on turnover intent may be fully mediated through a subset of the 8 forces, failing to support Hypotheses 1, 2, and 3. Although chi-squared change was significant in both samples for organizational identification and for pay satisfaction, in all cases apart from location attachment, coefficients were positively related to turnover intentions. These effects run contrary to all theory and past empirical findings. These findings add to our confidence that these other constructs do not add incrementally beyond the 8 forces in explaining variance in turnover intentions.

Discussion

Overall this study provides support for the 8 Forces Model as a promising

framework for understanding why employees stay with and quit organizations. In particular, these forces can be thought of as central mediators and the proximal causes of turnover intentions, and thereby, subsequent turnover behavior. Here the hypothesized mediated effects for the four antecedents were largely supported, adding to our understanding about how the 8 forces are engaged and operate to produce turnover intentions.

First, organizational identification effects on turnover intention were fully mediated by affective, contractual (obligations), calculative, and behavioral (psychological costs) forces motives. It seems that perceiving that one's identity is linked with that of the organization causes positive feelings toward the organization and feelings of obligation to stay, as well as simultaneous positive cognitions/beliefs regarding future opportunities there. This, in turn, creates the perception that costs would be incurred to their psychological well-being by quitting. Future research should investigate whether there are other mediating mechanisms that may help further explain how organizational identification can influence turnover decisions. Studies should also address when organizational identities are activated during turnover deliberations vs. other identities linked to the organization (e.g., team, union, function/division) or non-work identities.

Work satisfaction and pay satisfaction effects on turnover intentions each appear to be fully mediated by affective, calculative, and behavioral (psychological costs) forces. Both attitudes evidently operate to create turnover intentions through feelings toward the organization and through a signal sent by the organization that the employee has opportunities to fulfill future goals there. Less familiar is the idea that work and pay satisfaction could induce psychological costs of leaving. Reporting high satisfaction by itself could create behavioral commitment to staying (e.g., Salancik, 1977). Contractual forces were not a mediator though. This seems to indicate that pay and work content satisfaction do not translate into feelings of psychological contract obligation, as much as they do into a signal of future opportunity, sense of leaving costs, and affective attraction. The affective supervisor attachment was also not a mediator, contrary to our hypothesis. Perhaps, in the large 'factory-type' organizations from where our samples are drawn, it is likely that the organization itself was seen to control pay and work content to a large extent rather than the supervisor. There may be other relevant mediators of these forms of satisfaction depending on how work content and pay decisions are made and attributed for the employee sample in question. For example, in other settings it would be expected that immediate supervisors would be more in control of pay and coworkers would be more in control of work content. Thus, future research should investigate whether supervisor or coworker constituent forces may mediate these satisfaction effects on turnover decisions elsewhere.

Regarding the two manufacturing settings, these were particularly appropriate and relevant partly because of the long tradition of research on turnover in manufacturing (e.g., Slichter, 1919). This intense interest is largely because turnover has been seen to be particularly high and disruptive for manufacturing organizations. For example, according to Arthur (1994), high employee turnover can result in worse overall manufacturing performance. High turnover also negatively impacts performance and the ability of manufacturers to remain agile (Quintana, 1998). Additionally, turnover

was found to be lower in manufacturers that increased commitment levels rather than enhancing control mechanisms (Arthur, 1994). Thus, voluntary turnover is particularly important to study within manufacturing, and also possible to impact using humane methods in such settings.

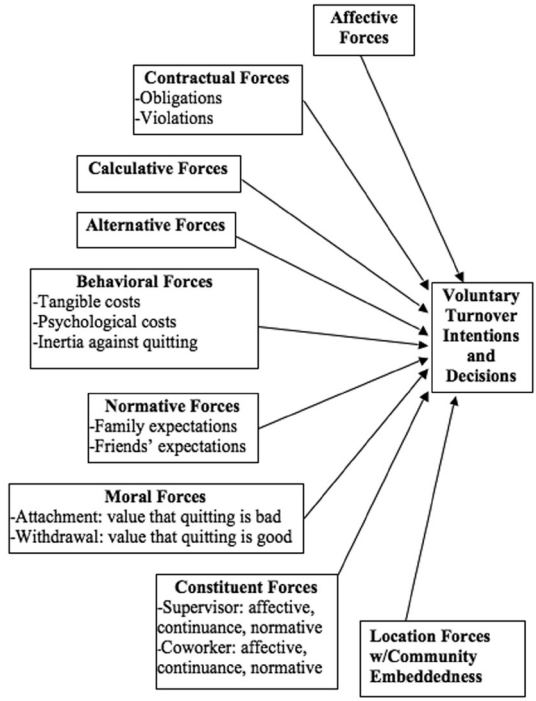
However, the findings are not necessarily automatically generalizable to other industry sectors. Low to semi-skilled manufacturing jobs are different from many others in the economy. This study is only a single, preliminary test and the results must be replicated before any can be taken as definitive. In sum, before this model and the incremental validity findings can be readily accepted, they must be validated and expanded if necessary, in other types of jobs, organizations, and industry sectors.

The "9th Force"

The findings do indicate that the 8 Forces Framework needs expansion to include at least one new force category. Specifically, the framework is deficient in that it fails to fully consider location/community attachment, reflected in the currently popular community embeddeness construct (e.g., Mitchell & Lee, 2001). The short location scale demonstrated incremental validity in explaining variance in turnover intentions beyond the hypothesized force mediators. The findings supplement the current research by countering some null findings of community embeddedness in predicting turnover decisions (i.e., Mitchell & Lee, 2001) and by bolstering other significant findings (Lee et al., 2004). It seems clear now that measures of attachment to location/community can predict variance in employee withdrawal propensity, even beyond and controlling for multiple other categories of motives.

These findings suggest that location is so central to turnover deliberations that it represents a separate category of motivation distinguishable from key mediating forces. It seems that, considering where one will be living geographically and around what people and institutions, is endemic to most any careful consideration of employment change. Still, location attachment would not be as relevant to turnover decisions, where organizational turnover does not require relocation. This is perhaps the case for those living within large metropolitan areas that support many companies with many employment opportunities all within commuting distance. In such cases, location attachment to an organization should largely be a function of commute times and convenience rather than community embeddedness. Empirical research should look to measure and expand investigation of the full effects of this motive category to include these more geographic location-specific aspects influencing turnover decisions, along with the attachments to people and institutions in the location captured in community embeddedness. Nevertheless, our findings and some findings on embeddedness suggest that location forces are pervasive and salient for employment decisions. Thus, the 8 forces should be theoretically expanded to include location forces as the "9th force" (Figure 5).

Figure 5: *Revised 9 Forces model of attachment and withdrawal*



The overall implication of this study for empirical researchers is that to have fully-specified models, they should measure the subdimensions of the 8 forces and explicitly add location forces measures in models going forward. Even though many of these foundational findings were from U.S. samples, there is reason to believe that location forces may be more salient to turnover decisions. Specifically, in countries where collectivism is the norm, this force category may take on even more significance. The country, geographic region, community, or one's extended family and social network within a community may act as important in-group identities that have a relatively higher influence on behavior than in individualist cultures such as the U.S. (Triandis, 1989). We expect that normative and constituent forces along with community influences would be more salient for turnover decisions in collectivist cultures. More generally, future international research should test the comprehensiveness and relative predictive strength of the expanded 9 forces across countries and cultures.

Practical Implication

The advice for practitioners from this study is that they need to include all such measures in regular morale surveys to ensure that major motivations are not overlooked. Good comprehensive information on why employees are attached or considering turnover will certainly help managers design more effective interventions

to promote retention. With respect to the 9th force of location attachments, management can facilitate attachments to the community. This could include offering country club memberships as perks, introducing employees to organizations such as the Rotary, sponsoring a softball team in a community league, or having joint organization-community social events. In some cases where applicants are plentiful and the organization highly values retention, managers can even include selection/placement criteria that indicate attachment to the location. This might mean adding application blank or structured interview questions to tap such attractions to the perceived culture of the area, leisure activities available, natural wonders nearby, weather, or other location-based factors. For organizations in locations not seen as "destinations," the emphasis should be more on building attachment to local people as in community embeddedness.

Limitations and Conclusion

Common method bias is typically seen as a threat for models involving turnover intention. However, any inflation of path relationships would not have affected our hypothesis results in a meaningful way. This is because competitive nested model tests are not directly susceptible to consistency and priming biases and because there is already empirical and theoretical evidence that variants of all the 8 forces constructs relate to turnover behavior. Still, the data clearly did not allow assessment causation. Some would criticize our intended purpose of seeking a comprehensive content turnover model in the first place. They may see this as unrealistic, reasoning that no parsimonious set of constructs can capture the motive effects in the multitude of turnover predictors. If turnover theory-building focuses on proximal motives instead of thinking in terms of predictors, forming a parsimonious set of theoretical categories is possible. The main limitation is that this study does not completely accomplish this objective. It is only one step in a process of carefully refining, and if necessary, expanding the forces framework to ensure that all the distinct motives are represented in theoretical models and empirical studies. Despite these limitations, this study does meaningfully expand the emerging 8 forces to formulate the most theoretically comprehensive framework to date in the literature.

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Appendix 1

Example items from Maertz and Boyar's (2010) Scales

1.) Affective Forces (5 items)
I feel good about working at "the company name".

2.) Contractual Forces

Obligations (4 items)
I owe "the company name" my loyalty for what it has given to me.

Violations (3 items)
"The company name" has broken promises to me about assignments.

3.) Calculative Forces (6 items)
At "the company name" I can achieve my career goals.

4.) Alternative Forces (6 items)
I could easily find another job as good as mine.

5.) Behavioral Forces

Tangible Costs of Leaving (6 items)
It would be costly for me to leave "the company name" now.

Behavioral Inertia (4 items)
Leaving "the company name" would take too much energy.

Psychological Costs (5 items)
I freely chose "the company name" instead of other organizations.

6.) Normative Forces

Family (5 items)
My family wants me to find a different job where I can spend more time at home.

Friends (5 items)
A friend at another organization wants me to go work with him/her.

7.) Moral Forces

Attachment (4 items)
I believe that it is bad when people move from job to job.

Withdrawal (5 items)
Staying at one organization hurts a person's career.

8a.) Constituent - Supervisor

Affective (4 items)
I like my supervisor a lot.

Continuance (3 items)
I would lose a valuable relationship with my supervisor by quitting.

Normative (4 items)
I feel obligated to stay with my supervisor at "the company name".

8b.) Constituent - Coworkers

Affective (4 items)
I like my coworkers a lot.

Continuance (3 items)
I feel I would lose valuable relationships with the people at work by quitting.

Normative (4 items)
I feel obligated to keep working with my coworkers at "the company name".

Appendix 2

Location Scale to Supplement Maertz and Boyar's (2010) Scales

9.) Location Attachment/Withdrawal Tendency
I do not like the city where I live now.
The city where I live is boring.
I would like to move away from this place.
I hate living in this part of the country.

Factors Affecting the Governance of Innovation Commercialization: A Theoretical Model

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The ability to commercialize innovations is central to firm survival and success and despite research on parts of the process, there is no overarching framework. Successful commercialization can include retaining ownership of the innovation and bringing it to market, sharing it by licensing or developing it with partners, or by selling it. A firm-level model is constructed that goes from innovation sourcing, through assessment of viability, to selection of the optimum form of governance. External networks and absorptive capacity at the meso level, plus micro- and macro-level factors, as moderators affecting the strength of the relationship between viability and governance are identified. Propositions are generated on these relationships for empirical testing and further theoretical insight.

Would an author of today find a publisher for a book that advocated the conservation of our natural resources because "We can see our forests vanishing, our innovation is a complex notion and to truly see the inherent value in it in a corporate setting, one must see innovation manifested in outcomes such as commercialized products" (Schendel & Hill, 2007). In 2008, Nokia and Sony-Ericsson each successfully introduced over seventy models of cellular phones, thus penetrating many market niches. That pace of commercialization allowed the innovators to be successful

with introduced products, and it raised barriers for potential competitors. Successful commercialization of innovations is not only of strategic importance to firms (Nerkar & Shane, 2007), but it is also a key driver of economic growth (Cohen & Levinthal, 1990; Eisenhardt & Martin, 2000; Sorensen & Stuart, 2000; Zahra & Nielsen, 2002). Schendel and Hitt (2007) argued that economic growth is related to entrepreneurial activities. Entrepreneurial activities such as selection of partners, forming alliances, and creating subsidiaries and spinouts are often centered around the commercial potential of innovations and assessments of the related capabilities of firms. The ability to commercialize innovations can help firms penetrate existing markets or create new markets, which contributes to the attainment of sustained leadership and firm longevity, which, in turn, positively impacts the health of the economy (Salamenkaita & Salo, 2002; Wallsten, 2000).

It is therefore no surprise that governments at nearly all levels attempt to mitigate market and other systemic failures that act as a barrier to innovation and subsequent commercialization. A better understanding of the process of innovation commercialization is therefore important at multiple levels. It has become generally accepted that, on average, it takes about three thousand raw ideas to result in a commercially successful product (Stevens & Burley, 1997). That statistic is far worse in some industries such as pharmaceuticals where only one out of 10,000 compounds succeeds as a new product, with an overall time from discovery to market of over a decade and a total cost approaching $1 billion. Even worse, those statistics hide the fact that more products could be successful but fail because of flaws in the process of commercialization. Despite such a low probability to success, firms have to bring new products to market because the alternative is the demise of the firm.

Firms typically depend on products developed three to five years ago for large portions of their current sales, which means that they are aiming three to five years in the future at a target that is both elusive and competitive in nature. Additionally, globalization of markets has put more pressure on firms to commercialize innovations in order to fend off global competition, to expand into global markets, or both (Collin & Porras, 1997; Hamel & Getz, 2004 ; Hamel & Prahalad, 2002; Huber & Glick, 1993; Huygens et al., 2001; March, 1991). As the global environment continues to grow at a faster pace, innovation is a requirement for ongoing organizational survival and continuing success (Schendel & Hill, 2007). In addition to these global stimuli, there are other environmental factors, such as rapid technological development, which simultaneously enhance and exacerbate the need for successful commercialization. Advances in information technology, and greater ease of use of these technologies, have led to shorter cycle times in developing new technology applications. These changes have resulted in greater process improvements and more efficient generation of new products and product changes (Brynjolfsson & Mendelson, 1993; Gulati, Sawhney & Paoni, 2002), which has further increased the speed with which firms and their competitors need to innovate and commercialize. Clearly, innovation and subsequent commercialization both are important, but where the former has received substantial attention in the literature (Damanpour, 1991; Dougerty & Hardy, 1996; McGrath et al., 1996; Pennings & Harianto, 1992; Teece, Pisano & Shuen, 1997), the latter has not, some seminal pieces notwithstanding (Andrew & Sirkin, 2003; Kelm, Narayanan &

Pinches, 1995; Kwak, 2002; Narayanan et al., 2000; Nerkar & Shane, 2007). Thus, the research question is posed: *What are the determinants of success in commercialization of innovations?* In order to address this question, we explore the related questions of a) *what resources and capabilities are necessary to innovate and commercialize,* and b) *what forms of governance help to maximize returns from innovation commercialization?*

To answer these questions, a review of the literature on innovation and commercialization is made. Then a baseline model of the innovation-commercialization process that starts with sourcing of innovations is built, followed by an assessment of viability, and finish with selection of the best governance form. The foundation for this baseline model came from Schendel and Hitt's (2007) contention that sources of innovation are complex and multiple, and the value potential is difficult to assess. It can be assusmed that the firm has the necessary motivation to innovate. The study also adopts the view that innovation is a necessary, but not sufficient, condition for successful commercialization. Having innovated and found it to be viable not only legally, but also in terms of profitability and access to the necessary capabilities for commercialization, we then address the thesis that success in the ability to commercialize is contained within selection of one of three forms of governance: own, partner, or sell. The strength of the relationship between viability and governance is affected by four moderators, two of which are firm level (external networks and absorptive capacity), one of which is a micro-level factor (previous managerial experience), and one of which is a macro-level factor (dynamism, munificence, and complexity in the operating environment). To ease the process of identifying these main and moderating effects, this paper assumes that there is demand for the innovation. It is also assumed that success in commercialization arises from a rational and managed process, and that luck is not counted upon as a factor input. Finally, the discussion is bound by limiting ourselves to established firms that have cash flows or access to any needed capital that allows them to make the expenditures that are necessary for commercialization.

Prior Research

The innovation process is defined as the combined activities leading to new, marketable products and services, or new product-delivery systems (Burgelman, Christensen & Wheelright, 2006), and a firm's ability to innovate is dependent upon its capabilities (Damanpour, 1991; Dougerty & Hardy, 1996; McGrath et al., 1996; Pennings & Harianto, 1992; Teece et al., 1997), its human resource practices (Nerkar, McGrath & MacMillan, 1996; Scott & Bruce, 1994), the nature of the top management team (Bantel & Jackson, 1989; Howell & Higgins, 1990), and the external environment within which the firm operates (Abrahamson & Rosenkopf, 1993; Keats & Hitt, 1988; Milliken, 1987; Wade, 1996). Other seminal work on innovation has concentrated on the types of innovations: product versus process innovations (Burgelman et al., 2006; Cooper, 1985; Cooper & Kleinschmidt, 1986; Danneels, 2002; Dougerty & Hardy, 1996; Herstatt & Von Hippel, 1992; Schilling, 2006); radical versus incremental innovations (Burgelman et al., 2006; Dahlin & Behrens, 2005; Golder, Shacham & Mitra, 2008; Majchrzak, Cooper & Neece, 2004; Schilling, 2006); competence enhancing versus competence destroying innovations (Burgelman et al., 2006; Schilling, 2006);

architectural versus component innovations (Christensen, 1992a; Christensen, 1992b; Christensen & Bower, 1996; Henderson & Clark, 1990; Wade, 1996).

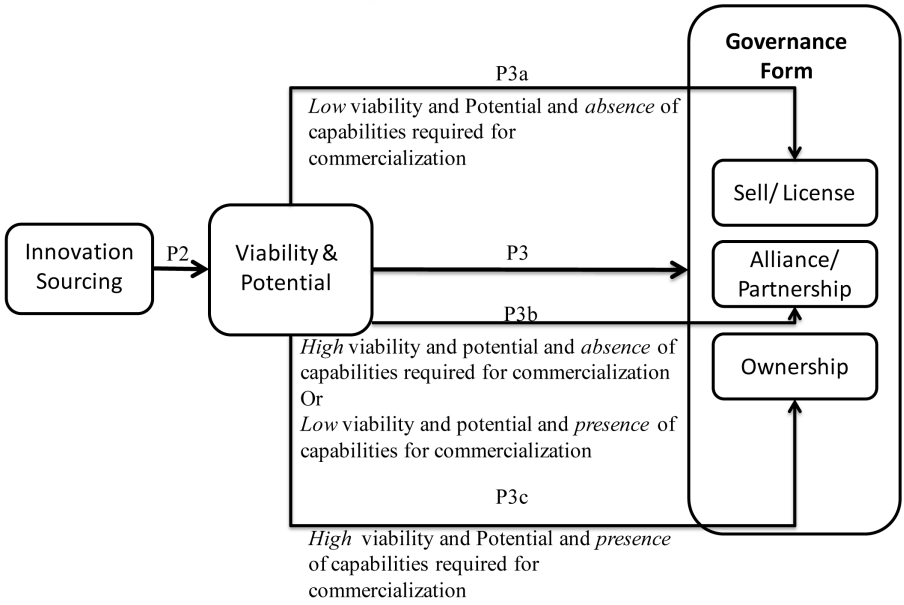
Much of the literature just cited however, has treated innovation and its commercialization as the same construct. In fact, commercialization in many cases was assumed. While innovation characteristics are a necessary component of future market success, innovation itself is not sufficient enough to ensure that success. Instead, innovations generally lead to market success through the process of commercialization (Drucker, 1985). While this growing body of work undoubtedly contributes to our understanding of successful commercialization, it remains that a dedicated model of the factors affecting commercialization is needed. That being said, a few scholars have kept innovation and commercialization as separate and distinct constructs. Commercialization of innovation has been defined as the act or activities required for introducing an innovation to market (Andrew & Sirkin, 2003; Kelm et al., 1995; Kwak, 2002; Narayanan et al., 2000; Nerkar & Shane, 2007). Nerkar & Shane (2007) operationalized commercialization as the first sale of a given product or service. However, when an innovation is introduced in the market, only technology enthusiasts adopt it initially, and such enthusiasts comprise less than three percent of the market (Moore, 1991, 2000). The larger mainstream market is comprised of pragmatists and conservatives, so it can be argued that a successful commercialization is one that also captures this mainstream market. Fully capturing the mainstream market is difficult, therefore the threshold for 'successful' commercialization of an innovation will lie somewhere between these two extremes—a single sale on the one hand and saturating the mainstream of a market on the other (Moore, 1991, 2000).

New Product Development (NPD) has emerged in the literature as a complementary dimension of commercialization of innovations and includes the selection of projects for new product development (Cooper, 1985; Hansen, 1999; Herstatt & Von Hippel, 1992). The extant literature includes investigation into processes of NPD (Cooper & Kleinschmidt, 1986; Hansen, 1999; Herstatt & Von Hippel, 1992; Johne & Snelson, 1989; Spivey, Munson & Wolcottl, 1997; Zirger & Maidique, 1990), the effects of path dependency and leveraging of primary and second-order competencies (Danneels, 2002), identifying suppliers for NPD (Ragatz, Handfield & Scannell, 1997), predicting success of NPD based on the type of idea and the circumstances of its emergence (Goldenberg, Lehmann & Mazursky, 2001), and the role of network alliances in information acquisition and its lagged effect on the new-product performance of the firm (Soh, 2003). As a body of work, this research assumes, either explicitly or implicitly, that the developed product does not violate existing intellectual property rights, it will serve a viable market, and that the firm has the wherewithal to bring the product to market either by itself (hierarchy) or with partners (alliances). Here, those assumptions make explicit in a baseline model which then becomes the vehicle for identifying the effect of other moderating factors that contribute to success in commercialization.

Baseline Model

The baseline model is comprised of three constructs: *innovation sourcing, viability and potential,* and *governance form*. Sources of innovation can be internal or external to the firm, and strategies to manage those sources are deliberate and emergent. Viability and potential looks at the legal feasibility and profit potential of the innovation. Viability and potential are linked with three forms governance: own, partner, or sell. Figure 1 depicts the constructs are linked and their relationships.

Figure 1: *Baseline Model*



Innovation Sourcing

Whereas the innovation process is defined as the combined activities that lead to new, marketable products (Burgleman et al., 2006), innovation itself is defined as the practical implementation of an *idea* into a new product (Markham, 2000; Schilling, 2006). As such, innovation sourcing means being aware of the disparate sources of ideas and being willing and able to use them.

Sources of ideas for innovations can be internal or external to the firm. The internal generation of ideas arises from organizational creativity, which can range from being a one-off organizational aberration, to a formalized process that is embedded in the culture or supported as a separate R&D function. The creativity of the organization is a function of the creativity of individuals, social processes, and contextual factors that shape the way individuals interact and behave (Woodman, Sawyer & Griffin, 1993). Firm R&D intensity has been shown to have a positive correlation with sales from new products, sales growth rate, and profitability (Roberts, 2001; Schilling, 2006). Thus,

as a source of ideas for innovation, the R&D function, whether internally funded or externally contracted, is key (Acs & Audretsch, 1988; Cassiman & Veugelers, 2002; Hagedoorn, 2002; Iwasa & Odagiri, 2004; Katila, 2002; Kelm et al., 1995; Kortum & Lerner, 2000; Lane & Lubatkin, 1998; Levin, 1988; Penner-Hahn & Shaver, 2005; Veugelers, 1997; Wallsten, 2000). It also is a readily apparent source and, as such, does not need further elaboration aside from noting that it is the norm to have processes in place for moving ideas forward for assessment for commercialization.

Discovery of entrepreneurial opportunities is somewhat probabilistic in nature, as opposed to the result of a systematic search effort (Kirzner, 1997). Entrepreneurs seem best able to "discover" opportunities for commercialization that directly relate to their previous knowledge of markets, knowledge of how to serve those markets, and knowledge of specific customer problems (Shane, 2000). This knowledge is not equally distributed across all entrepreneurs and therefore, is necessarily a function of their relationships with innovators, and funders (Anderson, 2008). Thus, recognition of an opportunity to commercialize an innovation is more likely to happen within a network of these entities (Seppanen & Skates, 2001) through knowledge sharing and transfer.

Networks with customers, suppliers, complementors, and competitors also are valuable sources of new product ideas (Cooper & Kleinschmidt, 1986; Yoon & Lilien, 1988). External sources of information also complement in-house R&D by increasing a firm's absorptive capacity (Chen, 2004; Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Zahra & George, 2002). These sources include new ventures, licensing arrangements, sourcing agreements, research associations, and government-sponsored, joint research programs for technical and scientific interchange, as well as informal networks (Ahuja & Lampert, 2001; Allen, 1977; Burt, 1992; Freeman, 1991; Hargadon & Sutton, 1997, 2000). Such networks are especially important in high-technology sectors where it is unlikely that an individual firm will possess all the capabilities necessary to develop a significant innovation (Hagedoorn, 2002). Additionally, technology spillovers, which are defined as a positive externality from R&D resulting from the spread of knowledge across organization and regional boundaries (Cohen & Levinthal, 1990; Schilling, 2006), also provide ideas for innovation. Technology spillovers not only have a significant influence on innovation activities (Henderson, Jaffe & Trajtenberg, 1998; Jaffe, 1986; Jaffe, Trajtenberg & Henderson, 1993), they also increase a firm's absorptive capacity (Cohen & Levinthal, 1990).

Strategies to Manage Sources of Ideas: Deliberate and Emergent

Strategy has been distinguished as deliberate and emergent (Bodwell & Chermack, 2009; Fuller-Love & Cooper, 2000; Mintzberg, 1978; Mintzberg, Ahlstrand & Lampel, 1998; Mintzberg & Waters, 1985). While deliberate strategies tend to emphasize central direction and hierarchy, emergent ones open the way for collective action and convergent behavior (Bodwell & Chermack, 2009; Mintzberg & Waters, 1985). Deliberate strategy is the specification of intended actions the firm plans to take to achieve its goals, whereas emergent strategy happens when companies engage in actions that evolve unplanned from past patterns or newly recognized patterns in the business environment (Bodwell & Chermack, 2009). Few strategies are purely deliberate or

purely emergent (Mintzberg et al., 1998). One means no learning, the other means no control. As Mintzberg et al. (1998) argued, all real-world strategies need to mix these in some way, which means exercising control while fostering learning. That means being willing to use (or combine) ideas from R&D (deliberate) along with those that arise from other sources of organizational creativity (emergent), or those from collaborations (deliberate), along with those from networks and spillovers (emergent). Thus,

> *Proposition 1: Firms that have processes in place for monitoring both internal and external sources and deliberate and emergent sources of ideas for innovation will capture more ideas than those that rely on single sources.*

Viability

The viability and potential of an innovation for development and commercialization is determined through a series of legal searches and business decisions. A legal search is required to determine whether or not the innovation infringes upon existing patents and if so, whether or not those patents can be challenged. The business part of the process is a series of decisions ranging from the tactical, such as whether to kill an innovation project or support it, to the strategic, with the latter depending on assessments of the potential market, barriers to entry into that market, fit with existing products and service platforms, trends in the industry, externalities and installed base, and the availability of complements. These issues are well described by Schilling (1998) and do not need further discussion here. Instead, we simply assume that the strategy of commercialization is viable and that the firm can profit in one way or another from that commercialization.

It was Schumpeter (1934) who originally noted that because innovations can be protected from imitation, they can provide superior returns. Those superior returns generally are considered in terms of economic rents (Schumpeter, 1934). They can occur in the form of monopoly rents, which arise from barriers to competition and barriers to entry that prohibit existing and potential competitors from satisfying excess demand. They can occur in the form of Ricardian rents, which arise from owning scarce resources that permit development of the innovation. They can also occur in the form of entrepreneurial rents, which are received by bringing to market a new product or service. The latter are naturally self-destructive because, with patenting or bringing to market a new product or service, the underlying knowledge is revealed (Mahoney & Pandian, 1992).

Instead of earning rents from commercialization, there may be private benefits from bringing an innovation to market, such as when it is a complementary product or service that supports other existing activities. Thus, an innovation may be commercialized even if it loses money, as long as the combined public and private returns are positive. Any discussion of rents implies supernormal profits, but it long has been argued that all that is needed to induce an entrepreneur to bring an innovation to market is the guarantee of an irreducible minimum amount of profit (Marshall, 1967), such as that which can be found be investing in zero-risk government securities. Extending that thinking to managers in firms,

Proposition 2: In the absence of the potential for economic rents or private benefits, firms will still be willing to commercialize innovations that have positive but low levels of return.

Governance

Governance deals with the form of structure required for commercialization. Essentially, it is a choice among three options: ownership of the technology with its development and commercialization being in-house, commercializing the innovation with others either through an alliance or via licensing, or selling it for others to commercialize. Usually, commercialization is thought of in terms of the first two forms, but electing to sell an innovation also allows the firm to secure a return and arguably is also a form of commercialization. The choice of which form to adopt is governed by: (a) the amount of profit available from commercialization, and (b) the distance between a firm's existing capabilities and those required for it to be able to commercialize the innovation. In the following discussion, we build on Teece's (1986) contention that regimes of appropriability must be in place and on the thesis that economic gain rests critically upon a firm's ability to create and transfer technology more quickly than it is imitated in the market.

When the returns from an innovation are high and the firm already has the requisite capabilities to build the assets that are required for commercialization then, logically, development will be through hierarchy (in-house). If the capabilities are not available internally, then sourcing them externally will reduce the firm's ability to earn rents from the innovation because suppliers of those resources will bid up prices, or they may turn into potential competitors. An alternative is to develop the capabilities internally. That requires an assessment of the effects on the current stock of knowledge and capabilities (Kogut & Zander, 1992, 1996) because long-term strategies of building new capabilities can require a tradeoff between current and future profitability. Such a choice is viable only when the firm's survival is not at stake and it has the necessary short-term cash flows to undertake learning initiatives and bear the associated risks (Decarolis & Deeds, 1999; Kogut & Zander, 1992, 1996). Conversely, too much reliance on exploiting current profitability may deter a firm from developing capabilities for the future (Kogut & Zander, 1992; Stiglitz, 1987). The decision of maintaining and developing some capabilities over others is influenced by the current knowledge of the firm and expectations from economic gain by exploring newer technologies and organizing principles into future market developments (Kogut & Zander, 1992). Thus, the promise of economic rents is usually sufficient to convince firms that developing new capabilities is a worthwhile activity (Decarolis & Deeds, 1999; Kogut & Zander, 1992, 1996). The most significant determinant of 'make' or 'buy' and 'within firm' or 'with suppliers' has been found to be the transaction costs associated with relying on outside suppliers (Kogut & Zander, 1992; Monteverde & Teece, 1982; Walker & Weber, 1984). It has been shown that volume and technological uncertainties, and the production capability of the buyer, reduce the advantage of buy over make, while supplier production cost advantage, competitiveness of a supplier market, and the size of supplier market increases the advantage of 'buy' over 'make' (Walker & Weber, 1984). While boundaries of firms are

influenced by transaction costs (Williamson, 1981, 1991, 2000), performance relies mostly on owned capabilities (Kogut & Zander, 1992).

An innovation can be contracted, licensed, or developed with alliances when the firm does not have the necessary capabilities required to bring it to market, when there are uncertain cash flows, and when imitators and competitors are better positioned (Teece, 1986). Specifically, when an innovation has the potential to earn high returns, but the firm does not have the capabilities to develop the assets necessary for bringing the innovation to market, the available options are to develop the innovation with partners or license it out (Friedman, 2006). It also means that when the firm has the requisite capabilities to develop the assets that are critical for commercialization but the innovation only has the potential for low returns, commercialization via partnership is also preferable. Choosing between alliances for joint development or licensing depends upon several factors beyond profit potential and capabilities. For example, the short-term profitability needs of the firm and high investment costs (Kalaignanam, Shankar & Varadarajan, 2007; Makadok & Walker, 2000; Zahra, 1996), along with the existence of steep learning curves (Malerba, 1992), make a strong case for licensing. Additionally, licensing an innovation is an option when the licensor has superior, tacit knowledge that protects the ability to secure rents, when capabilities required for commercialization are beyond those possessed by the firm, or there is pressure for immediate survival. In the case of the lack of capabilities, if the innovating firm does not license its new technology, competitors may quickly develop their own, possibly better, versions of the technology. By licensing the technology, the innovating firm may ensure that its version of the technology becomes the dominant design in an industry advantage (Hill, 1992; Schilling, 1998; Schilling & Phelps, 2007). Advantages of partnerships include sharing costs and risks of development, combining complementary skills and resources (Ahuja, 2000b; Ahuja & Katila, 2001; Brass, Galaskiewicz & Greve, 2004; Freeman, 1991; Powell, Koput & Smith-Doerr, 1996; Provan, Fish & Sydow, 2007), enabling transfer of knowledge between firms (Cowan & Jonard, 2004; Freeman, 1991; Gulati, Nohria & Zaheer, 2000), and facilitation of creation of shared standards (Brass et al., 2004; Gulati, 1995, 1998; Gulati & Gargiulo, 1999; Powell et al., 1996; Provan et al., 2007). A clear example of these advantages is in the commercialization of Microsoft's Windows software. Developing complementary assets needed for commercialization of the software required sets of capabilities that were distant from what Microsoft possessed, but the partnership with Intel resulted in the emergence of the industry standard Wintel and a success for both firms.

Going back to the transaction-cost economics (Williamson, 1981, 1983, 1991, 1994, 1998), contracts with partners in developing an innovation may lead to a reduction of uncertainty at the cost of opportunism. Such behavior occurs when an innovation, albeit novel, has uncertain market potential, or requires capabilities beyond those of the firm. A governance structure that leads to reduction of uncertainty in this scenario is more important than a partner being opportunistic. Mutual gains from contracts and alliances will be a less risky form of governance than in-house development. Such was the case for Microsoft.

Lastly, when the potential to earn profits is low and the capabilities needed to develop assets required to commercialize the innovation are not available internally or

through partnerships, the most logical option is to sell the innovation to another firm. Given this low-returns scenario, this would be the least risky option. That, of course, assumes that the sale would not result in the buyer becoming a future competitor. Thus,

Proposition 3a: An innovation with low profit potential, combined with the lack of capabilities necessary for developing the assets required for commercialization, will result in selling the innovation.

Proposition 3b: Firms will mitigate the risk of commercialization via alliances or licensing when an innovation has low profit-potential even though the capabilities for commercialization are present, or when the innovation has high profit-potential but the capabilities are not present.

Proposition 3c: An innovation with high profit potential, combined with the capabilities necessary for developing the assets required for commercialization, will result in retained ownership of the innovation and in-house commercialization.

The base line model along with the moderators was depicted in Figure 1.

Moderators

The effect of the moderators on Proposition 3 is depicted in Figure 2 and Figure 3.

Figure 2: *Model of Factors Affecting Governance of Innovation Commercialization*

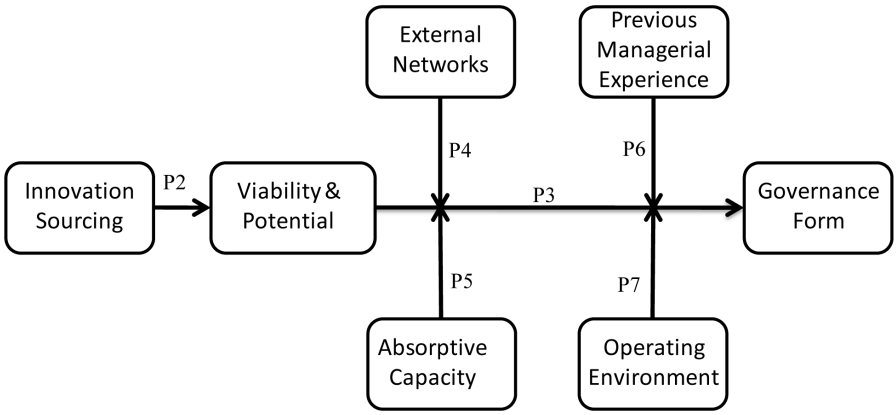
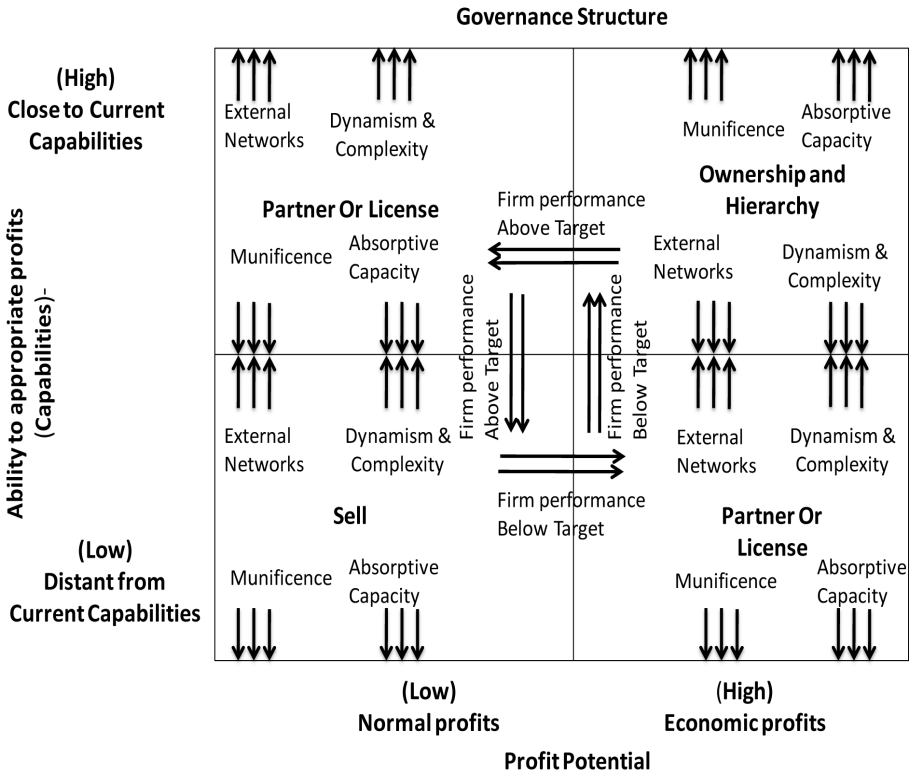


Figure 3: *Effect of moderators on Governance*



Firm-level Moderators

Networks. Social, external, and internal networks are considered three different network types that focus on different levels of analysis, use different theoretical constructs, and explain different outcomes (Van Wijk, 2003). For the purpose of discussion, networks external to the firm and those which extend its boundaries will be the focus. External network research focuses on networks as a governance mode intermediating markets and hierarchies—e.g., joint-ventures and strategic alliances. It highlights the competitive dimension of networks and, therefore, focuses particularly on performance issues (Dyer & Singh, 1998). The terms 'external' or 'interorganizational' network are used interchangeably with strategic alliances, coalitions, and cooperative arrangements (Provan et al., 2007), and have been tied to resource dependence theory (Pfeffer & Salancik, 1978), transaction cost economics (Williamson, 1991), and interorganizational contracts (Ariño & Reuer, 2006). Despite these differences, all definitions of external networks refer to common themes including social interaction, relationships, connectedness, collaboration, collective action, trust, and cooperation (Provan et al., 2007).

Organizations enter alliances with each other to access critical resources,

knowledge, and capabilities, but they rely on information from the network of prior alliances to determine with whom to cooperate (Gulati & Gargiulo, 1999). These new alliances modify the existing network, prompting an endogenous dynamic between organizational action and network structure that drives the emergence of external networks. While networks are formed to access and share resources (Dyer & Singh, 1998; Gnyawali, He & Madhvan, 2006; Gulati, 1998; Gulati & Kletter, 2005; Gulati et al., 2000; Klein, Rai & Straub, 2007b; Pfeffer & Salancik, 1978), they themselves become valuable resources, enabling a firm to access and possibly increase its stock of knowledge and capabilities beyond its boundaries (Barney, 1991; Mata, Fuerst & Barney, 1995; Melville, Kraemer & Gurbaxani, 2004; Porter, 1980; Ray, Muhanna & Barney, 2005). The characteristics of an organization's network of external relations are relevant to a firm's ability to commercialize innovations (Nohria, 1992; Nohria & Eccles, 1992). Networks can be defined as the collective of structures and collaborations between organizations. From an external-network standpoint, this includes social networks, business clusters, partnerships, business ecosystems, and relationships with innovation engines. To better understand the impact of networks on the commercialization process, the concepts of centrality and multiplexity in networks need to be considered.

Centrality determines the relative importance of an entity or a node within a network. While some organizations will struggle to reach the central position on any network to maintain competitive advantage and control key resources and capabilities, others may instead link themselves to the central node (Dyer & Singh, 1998; Gnyawali et al., 2006; Gulati, 1995, 1998; Gulati & Gargiulo, 1999; Gulati & Kletter, 2005; Gulati et al., 2000; Klein, Rai & Straub, 2007a). Being in a central position or having a direct link to the central node within an external network, firms are better able to access resources and capabilities, such as finance, manufacturing facilities, or distribution channels that help in the commercialization of innovations (Gnyawali et al., 2006; Klein et al., 2007a).

Multiplexity deals with the strength of the relationship an organization maintains with network partners, based on the number of types of links (e.g., research ties, joint programs, referrals, and shared personnel) connecting them (Provan et al., 2007). Multiplexity is also referred to as a heterogeneity of networks (Newman, 2001). Multiplex ties are thought to be an indicator of the strength and durability of an organization's links because they enable the connection between an organization and its linkage partner to be sustained even if one type of link dissolves (Provan et al., 2007). Two entities that have collaborated in multiple arrangements such as manufacturing and marketing or the exchange of unique information, are likely to know each other better, on average, than those that have had fewer such collaborations. These interactions add value to the network, enabling the exchange of knowledge and capabilities required to succeed in the commercialization of innovations.

External networks can also include ties with universities, national research laboratories, and other research institutes that conduct basic research and are regarded as engines of innovation (Agarwal, 2006; Chataway & Wield, 2000; Colyvas et al., 2002; Henderson & Cockburn, 1996; Henderson et al., 1998; Henderson & Clark, 1990; Jaffe et al., 1993; Numprasertchai & Igel, 2005). It constitutes a type

of multiplex tie that we mentioned earlier. Knowledge exchange between firms and innovation engines occurs through formal and informal mechanisms such as scientific meetings, licenses, joint ventures, research contracts, consulting, personal networks, research grants, recruitment of students, email, shared databases, workshops, and communities of practice (Cohen, Kamienski & Espino, 1998; Cohen et al., 1998; Cohen & Levinthal, 1990; Cohen, Nelson & Walsh, 2002; Hoegl & Schulze, 2005; Oliver, 2004; Powell, 1998; Rothaermel & Thursby, 2005; Salman & Saives, 2005; Van den Bosch, Volberda & Boer, 1999). Through contracted and funded research, both the innovator and the commercializer benefit and the innovation/commercialization cycle appears to crystallize faster and more effectively (Birkinshaw & Gibson, 2004). Such relationships help shorten the innovation cycle and promote faster commercialization, giving the innovator access to the firm's capabilities and also leading to the firm gaining knowledge about a new technology or innovation.

In our previous section on governance, it was already mentioned that advantages of partnerships include sharing costs and risks of development, combining complementary skills and resources, enabling transfer of knowledge between firms, and the creation of shared standards. Further, choosing between alliances for joint development or licensing depends upon several factors including profit potential and capabilities. The decision to collaborate with networks to bring an innovation to market is therefore multidimensional. The factors include: (a) whether the firm or the collaborator has the required capabilities, (b) the degree to which collaborations would make proprietary technologies vulnerable to expropriation by a potential competitor, (c) the importance a firm plays in controlling the development process for its innovations, and (d) the role of development projects in building the firm's own capabilities or permitting it to access another firm's capabilities (Ahuja, 2000a; Hagedoorn, 1993; Powell et al., 1996).

Centrality and multiplexity in external networks moderate the relationship between viability and governance by extending firm boundaries. Firstly, for innovations with low profit potential, networks facilitate easier disposition of the technology to potential buyers. Knowledge of network partners and their specific needs allows the disposing firm to more quickly find a customer for the technology. Additionally, that knowledge may lead to a better fit between the innovation and the customer's needs, which could, in turn, lead to increased funds from the sale. Networks thus have a positive effect on disposition as a form of governance. Secondly, and as discussed, networks aid in accessing capabilities that are essential for commercialization, such as those in manufacturing, or marketing and distribution. That access can come either in the form of licensing or alliances and as noted earlier, it depends upon the need to lock out competitors or to establish a dominant design. An additional potential benefit though is that by licensing or forming alliances to bring the innovation to market, firms that may have been natural competitors can effectively be removed from the equation.

When a firm has an innovation with high profit potential, plus the necessary capabilities for commercialization of the product, the concern is with protecting proprietary knowhow and controlling the development process to secure any available rents. Those requirements and that outcome are best achieved by keeping all activities in-house rather than working with partners. Networks, however, have a negative

impact on the selection of that form of governance. Firms centrally located in the networks will have access to resources from other firms and will therefore be more likely to develop innovations with partners. Being central in a network will enable the firm to have higher bargaining power which should not be compromised even when a critical capability required for commercialization is developed outside the firm boundary. Hence, centrality resists suppliers from becoming potential competitors so that firms can enjoy sourcing capabilities from other firms. Firms that are not central in the network will also tend to either license or codevelop innovations (with high profit potential) with partners, because being in the network will enable them to access critical resources, capabilities, and knowledge that would otherwise be expensive to develop. Overall, easier access to complementary resources offsets the advantages of in-house commercialization of innovations. Thus,

Proposition 4a: External network relationships have a positive moderating effect on decisions to sell an innovation.

Proposition 4b: External network relationships have a positive moderating effect on decisions to license or develop an innovation with partners.

Proposition 4c: External network relationships have a negative moderating effect on decisions to use in-house commercialization.

Absorptive capacity. According to Cohen and Levinthal (1990) and Jansen, Vanden Bosch and Volberda (2005), absorptive capacity is the limit to the quantity and rate at which a firm can absorb scientific or technological information. Conceptually, absorptive capacity is similar to information-processing capacity but at the firm level rather than at the individual level. Absorptive capacity enables firms to predict the commercial potential of technological advances more accurately (Cohen & Levinthal, 1990). It is inherent within a firm's knowledge capabilities by which it acquires, assimilates, transforms, and exploits knowledge resources to produce capabilities such as innovativeness (Zahra & George, 2002), and a firm's investment in prior experience can increase its rate of future learning by building its absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002).

Zahra and George (2002) deconstructed absorptive capacity into potential and realized absorptive capacities. *Potential absorptive capacity,* which includes knowledge acquisition and assimilation, captures efforts expended in identifying and acquiring new external knowledge and in assimilating knowledge obtained from external sources (Zahra & George, 2002). *Realized absorptive capacity,* which includes knowledge transformation and exploitation, encompasses deriving new insights and consequences from the combination of existing and newly acquired knowledge, and incorporating transformed knowledge into operations (Zahra & George, 2002). Realized absorptive capacity converts knowledge into products, services, and technologies (Jansen et al., 2005). Through the combination of potential and realized absorptive capacity, firms increase the distinctiveness of their innovations (Yli-Renko, Autio & Sapienza, 2001) and are able to develop new innovations that differ substantially from existing

products, services, and processes and, all else being equal, should have the potential for generating higher income. In turn, that means that absorptive capacity should therefore have a positive moderating effect on in-house commercialization and a negative effect on the other forms of governance.

In addition to absorbing and capitalizing on external scientific and technological information, absorptive capacity also means being able to identify and build on internally generated information. In other words, learning from and capitalizing on prior experience, which in turn, shapes the ability to recognize the value of new information and use it effectively. A firm's experimentation with innovations increases its knowledge and experience with the technology, and also its understanding of market potential, which leads to better gauging of the profit potential of innovations. Additionally, it helps in developing new innovations, which can help firms stay ahead of competitors. In resource-based theory terms, previous experience is a valuable and difficult-to-imitate resource that provides firms with an advantage. Firms that don't build on such experience effectively are starting anew with the process of bringing each new innovation to market and thus, they are at the bottom of the learning curve and unable to capitalize on cost-reducing, experience-curve effects. Further, prior experience will lead firms to identify complementary innovations that will add value to the innovation to make it more attractive. Thus, absorptive capacity has a positive moderating effect on the relationship between viability and governance leading to ownership of innovations,

Proposition 5a: Absorptive capacity has a negative moderating effect on decisions to sell an innovation.

Proposition 5b: Absorptive capacity has a negative moderating effect on decisions to license or develop an innovation with partners.

Proposition 5c: Absorptive capacity has a positive moderating effect on decisions to use in-house commercialization.

Micro- and Macro-level Factors

Thus far, our arguments have focused on the role of the firm and firm-level factors in innovation commercialization. As such it is a meso-level model. There are, however, factors at both the micro and macro levels that affect success in commercialization and thus need addressing.

Micro level. At the micro level, the previous experience of managers in bringing an innovation to market will affect their actions with subsequent commercializations. Prospect theory, which explains decision making involving uncertainty in the context of psychology and economics (Kahneman & Tversky, 1979), provides a useful means of assessing the effect of this micro-level variable on the selection of form of governance for commercialization. The theory offers insights into why managers make non-optimizing decisions rather than strictly choosing those that are profit maximizing. The most distinctive implication of the theory is the effect that previous performance has on managerial attitudes towards risk. If previous firm performance is acceptable,

then managers will avoid risk-laden situations, even if the associated returns are high. However, if previous firm performance is below target, they will be more likely to accept more risk for higher returns. That relationship, however, is moderated by the framing that previous experience provides. If managers have been successful with such actions in the past, their assessment of the probability of failure will be artificially low. If they have failed in the past, it will be artificially high. Holding previous firm-performance constant, successful previous experience with a hierarchy solution to commercialization would again push them towards hierarchy. Similarly, if in the past a firm did not have the necessary capabilities to commercialize a product, but managers successfully developed them, they would be more likely to underestimate the risk of doing so again. A poor experience would push them away from hierarchy. The same logic applies to previous experiences with selling an innovation or partnering to bring it to market.

Obviously, Prospect theory is temporal in nature, whether previous performance has met target performance or not, and what managers do today is affected by what has happened in the past. Thus,

Proposition 6a: If firm performance is below target, then the probability of selling is reduced in favor of partnering or hierarchy, and the probability of partnering is reduced in favor of hierarchy.

Proposition 6b: If firm performance is above target, then the probability of hierarchy is reduced in favor of partnering (unless that form of governance has been successful in the past), and the probability of partnering is reduced in favor of selling (unless that form of governance has been successful in the past).

Macro level. For the macro-level, the established environmental constructs of dynamism, munificence, and complexity is drawn on. Environmental dynamism results in uncertainty and unpredictability in the external environment (Child, 1972; Dess & Beard, 1984). Firms faced with more stable environments tend to emphasize static efficiency at the expense of dynamic efficiency, and this process is reversed when firms find themselves in unstable environments (Ghemawat & Costa, 1993). In other words, a firm tends to be inward-looking during stable times and outward-looking during disruptions. In highly dynamic environments, there is rapid and discontinuous change in demand, competitors, technology, and regulations. As a result, information is often inaccurate, unavailable, or obsolete (Eisenhardt & Bourgeois, 1988; Simsek, 2009). Therefore, dynamic environments require that the organization develops adaptive responses quickly and expands the scope of information acquisition and gathering (Sidhu, Volberda & Commandeur, 2004; Simsek, 2009). In doing so, dynamism imposes a challenge to the organization by demanding flexibility and agile actions ranging from information scanning, selection, and processing to interpretation (Miller & Friesen, 1983; Simsek, 2009), and that strains an organization's information-processing capability (Simsek, 2009). Such problems can cripple an organization's ability to correctly assess the profit potential of an innovation. Therefore, environmental dynamism has a negative moderating effect on the relationship between viability and

governance such that there is a reduced tendency to use an in-house approach to commercialization. The corollary to that is that dynamism will positively affect the relationship between viability and governance that leads to selling an innovation and licensing or developing it with partnerships. Even if the firm currently posseses what it considers to be the capabilities required for successful commercialization, a dynamic environment may make them useless or irrelevant in the future. Thus, licensing or development with partners remains the lower-risk option. All else being equal, such as prospect theory considerations, then managers will likely choose to avoid, rather than incur risk.

An environment is said to be munificent to the extent that it supports a firm's continued and sustained growth, and thus refers to the extent to which critical resources exist in the environment (Dess & Beard, 1984). The degree of resource abundance in the firm's environment (i.e., munificence) has a significant impact on the firm's entrepreneurial orientation and subsequent growth (Castrogiovanni, 1991), as well as its ability to overcome capability weaknesses (Sirmon et al., 2010). Thus, in a munificent environment, a firm is more likely to take ownership of a venture (Tyebjee & Bruno, 1984). When the environment is munificent, that is, there are resources for growth, demand is present and the profit potential is high, not being able to own the technology and develop it in-house sacrifices income. When the environment offers opportunities and resources for growth, developing capabilities that may be distant from its current ones, but which are required for commercialization, becomes a more attractive option than in an environment that does not offer the same income opportunities. Thus, munificence has a positive moderating effect on the relationship between viability and governance leading to ownership, whereas the relationship leading to licensing or development with partnership or selling the innovation is affected negatively.

Environmental complexity is defined as the heterogeneity and concentration of environmental elements (Dess & Beard, 1984). A highly-complex environment is characterized by the level of heterogeneity of firms within the industry, a diverse range and high number of suppliers and customers, and a wide range of products being offered (Dess & Beard, 1984). A complex environment will be perceived as requiring more information processing than a simple environment and thus be less predictable (Dess & Beard, 1984; Simsek, 2009). Complex environments do not diminish an organization's ability to act, but make it difficult to identify what is most appropriate (Boisot & Child, 1999). Under this scenario, reduction of uncertainty becomes an important criterion, and that can be achieved either by licensing the innovation or developing it with partners. Similarly, the uncertainty created by complexity also will likely result in more selling of innovations. Thus, complexity has a positive moderating effect on the relationships between viability and governance leading to selling the innovation, licensing the innovation or developing with partners, and a negative moderating effect on in-house commercialization. Therefore,

Proposition 7a. Environmental dynamism has a negative moderating effect on the relationship between viability and governance leading to hierarchy, but a positive effect on partnering or selling the innovation.

Proposition 7b. Environmental munificence has a positive moderating effect on the relationship between viability and governance leading to hierarchy, but a negative effect on partnering or selling the innovation.

Proposition 7c. Environmental complexity has a negative moderating effect on the relationship between viability and governance leading to hierarchy, but a positive effect on partnering or selling the innovation.

Discussion

Commercialization of innovation is a critical entrepreneurial activity that leads to economic growth, but is not yet fully understood. A model has been constructed that explains how firms go from idea generation to innovation commercialization. When an idea emerges, then its viability has to be assessed before the process moves on to commercialization. This baseline framework constitutes a mid-level process model. Underpinning the core of the model is the argument that success in commercialization is derived from selecting the governance form that allows the firm to secure returns from an innovation while mitigating unnecessary risk. That is achieved by retaining ownership of the technology, licensing it to or developing it with partners, or selling it. Which of the three forms of governance should be selected is determined by the profit potential of the innovation and the current capabilities of the firm. Profit potential is part of the determination of the viability of an innovation and rests on the assumption that the technological and legal mechanisms that govern innovators' ability to earn rents from innovation are in place (Teece, 1986). An innovation is sold before developing it into a finished good when the profit potential from the innovation is low and ownership of or access to capabilities that are required for commercialization are distant. If one of the two main conditions of profit potential or capabilities is in place, the innovation is either licensed or developed with partners. If, however, the profit potential is high and the firm has the capabilities required to develop the innovation and take it to market, the firm will retain ownership of the innovation and governance will be hierarchical.

Four moderators were identified that affect the strength of the relationship between viability and governance. First of those moderators was external networks, which had a negative effect on the likelihood of a firm commercializing the innovation in-house, and a positive effect on selling the innovation or licensing or developing with partners. Absorptive capacity, our second moderator, had a positive effect on the relationship between viability and governance leading to in-house commercialization, and a negative effect on selling the innovation or licensing or developing with partners. At this point, the meso-level analysis was deviated from and included both micro and macro factors. The previous experience of managers in bringing innovations to market was our third moderator—a micro factor. Prospect theory was used to argue that if firm performance is above target, the probability of hierarchy is reduced in favor of partnering or selling, particularly if those forms of governance have been used successfully in the past. If firm performance is below target, then the probability of selling was reduced in favor of partnering or hierarchy, and the probability of partnering was reduced in favor of

hierarchy. The final moderators were at the macro level: environmental dynamism, munificence, and complexity. They have mixed effects on the relationship between viability and governance. Dynamism and complexity had a negative effect on the relationship between viability and governance leading to hierarchy and a positive effect on the on selling the innovation or licensing or developing with partners. Munificence, however, had a positive effect on the likelihood of a firm using hierarchy, and a negative effect on the use of licensing or developing with partners.

This work has made contributions to both theory and practice. For research, the framework recognized that successful commercialization is a process that has distinct stages and is as dependent on moderators to the process as it is on the direct effects. The paper offered insights into idea generation—interactions between source and type—that need exploring in more detail to determine under what conditions the output from those interactions is maximized, both in terms of quantity and quality. It also introduced the concept of viability assessment into the process of commercialization—something that is most notable by its absence from the theoretical literature on innovation management. A direct link between governance and success was also made, recognizing that not all innovations have to be developed in-house or with partners—they also can be sold, an outcome that is still commercialization. Addressing these questions should further our understanding in terms of what forms of governance should maximize returns from innovation. This work recognized that successful commercialization is a complex, multi-level process that requires input from extant theories as diverse as those explaining governance, networks, absorptive capacity, managerial behavior, and environmental factors. It opens up the potential for extending empirical research on commercialization. Additionally, the assumptions on which the model is based need to be empirically tested for validity. Before these or any other lessons can be acted upon with confidence, much research remains to be done. Surveys or secondary data sets can be used to conduct positivist research in order to test the propositions, while detailed case studies of firms in specific industries under given circumstances may aid in attaining an interpretivist understanding of commercialization of innovation that is deeper, richer, and more detailed.

In terms of practice, the baseline model revealed an interaction between internal and external sources of ideas for innovation, and whether or not they were deliberate or emergent. To be effective, those interactions need managing. Second, a careful assessment of the profit potential, vis-à-vis the firm's capabilities, helped force a separation between commitment to the newly developed technology and the ability to make money from it. Third, the model highlights the need for a firm to consider its network of partners and their capabilities before plunging into a decision. This permits risk reduction, it prevents a firm from disposing of a technology that could be developed with partners, it allows the firm to find better capabilities than those it possesses, and it allows the firm to hand-off development and commercialization, which then frees up time and resources for bringing other innovations to market. Fourth, it showed that firms need to question the effects of previous experiences on commercialization of innovations. For instance, if managers have been successful with such actions in the past, their assessment of the probability of failure will be artificially low. Lastly, an understanding of the macro-level environmental factors of dynamism,

munificence, and complexity is crucial in determining whether an innovation is best kept in-house, developed with partners, or simply disposed of.

All projects have certain inherent limitations. In this work, it was implicitly held constant the impact of networks within the firm as a potential moderator between viability and governance. Further, the paper did not discuss how the variables in the baseline model and the four moderators interact with each other. In determining the effects of each moderator, we implicitly held the other constructs constant. Future research extensions could be made on understanding the impact of these moderators, and internal networks, as a gestalt. Within that gestalt there also will be a feedback loop from commercialization to idea generation within innovation sourcing, an issue that was intentionally left beyond the scope of our discussions.

Some firms are good at innovation, but the fact remains that firms live and die by their ability to successfully bring innovations to market. This work has provided a theoretical model to address the question of what drives success in that process. While the thinking in this work is of relevance to practice, we have generated a model that should act as a catalyst for scholars to extend existing research on the commercialization process, and thus create an even deeper understanding of this crucial business activity.

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Safety and Organizational Design Factors: Decentralization and Alignment

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This study examines the relationship between two key organization design factors—decentralization and alignment—and organizational-level safety outcomes. Safety-related practices embedded in organizational design at 54 United States-based organizations through a survey of top-level managers and used injury reports provided to the Occupational Safety and Health Administration (OSHA) to measure each organization's safety record are assessed. Results extend the organizational design and occupational safety literature by providing evidence that decentralization and alignment help reduce overall organizational injuries, and lending additional support for increased worker control of safety practices, along with a need for congruency across the broader company policies and practices.

Safety remains one of the most important issues in the workplace for many reasons. First, the human imperative exists, stemming from millions of disabling injuries and deaths that occur each year at work. Second, the financial cost to organizations and individuals resulting from safety failures is significant, including millions of days lost from work, costing employers and employees billions of dollars each year (National Safety Council, 2008). Third, safety requirements and enforcement routines enacted by safety regulators represent a significant policy obligation for organizations. Further, the efficacy of government policy is often contingent on the actions of organizations to secure worker safety. Although workplace accidents occur all too often, there is growing evidence that managerial practices can have a significant effect on safety (Zohar & Luria, 2004; Zohar, 2002).

Continuing the search for practices that will have the greatest impact on safety outcomes is critical to improving the effectiveness of policy and to protecting people

in the workplace. Recent industrial and mining accidents such as the Deepwater Horizon explosion and oil spill in the Gulf of Mexico have put the importance of safety for organizations and the need for effective practices in sharp relief. In post-incident analyses, organizational design issues have often been found to be especially important as causal to the accidents. The report of the National Commission on the BP Deepwater Horizon (Chief Counsel's Report, 2011), for example, showed that reorganization prior to the spill changed well management to a functional structure from a project-based model in which responsibility for individual wells was localized. In the commission's report, confusion over responsibility for safety and slowed decision making were argued to be at the heart of many of the failures leading to the disaster. In another example, NASA has experienced a number of high-profile safety failures in its history. In each of the space shuttle explosions in which all crew members were killed, analysts identified structural issues as key. Although there were immediate, technical causes to these accidents (the O-ring on the Challenger and the heat tiles on the Columbia) broader structural factors in the organization proved to be the enabling—and sometimes causal—factors that led to disaster (Columbia Accident Investigation Report, 2003; Vaughan, 1997).

Even as the awareness of the role of structure in the lead-up to accidents has increased, relatively little research examining the efficacy of various structural interventions is available for practitioners. Although a number of case studies have examined the structural issues associated with major safety failures, more multi-organization research that examines the relationship between design factors and safety outcomes is needed in order for managers and policy makers to make evidence-based design decisions. The purpose of this study is to extend the current safety literature by examining how the design of organization-level safety practices impacts organization-level safety outcomes.

Organizational design involves a series of decisions about structures that define accountability and responsibility and enable execution of an organization's goals (Miller & Friesen, 1984). We will examine two design factors and their relationship to safety performance goals. First, decentralization should affect safety by moving responsibility for decision-making and implementation to operational levels of the organization. This brings decisions about safety to the level where knowledge of safety problems and awareness of relevant solutions actually reside and where employee behaviors occur. Decentralization of safety decision making is consistent with calls to increase worker control over work processes, particularly with regard to work environment reforms (Deutsch, 1981).

Decentralization with regard to safety is not uncontroversial, however. Centralization of safety accountability in a single department offers the advantages of standardization of safety routines throughout an organization as well as more intensive specialization in safety. Nevertheless, evidence from case research on accidents seems to lend support to the notion that one of the most significant problems in organizations has been the movement of critical information upward in organizations (Vaughan, 1997; Weick, 1990). When critical safety problems occur, communication flow is interrupted and "structural secrecy" impedes the movement of information that would inform decisions (Vaughan, 1997). Information accuracy also is affected

by "hierarchical distortion" in which such macrostructures as centralization affect communication processes. The weight of evidence from this case research suggests that decentralization offers benefits with regard to communication and responsiveness to safety issues.

Decentralization, however, cannot be effective unless organizational processes related to performance evaluation and rewards reinforce safety as a critical imperative. Often pressures to meet deadlines or meet operating cost targets (and performance evaluations and rewards linked to their achievement) can push safety concerns to the background. These effects can be overt or subtle, as the report of National Commission on the Deepwater Horizon Oil Spill (Chief Counsel's Report, 2011, p. 247) concluded:

> "Cost accounting is a necessary and reasonable part of running a business. Nonetheless, given the many decisions that increased risk but saved time and money, it is a reasonable inference that cost and time overruns had an effect, conscious or unconscious, on decision making."

Thus, the second design factor is the alignment of important practices, particularly those associated with the systems of evaluation and rewards. Decentralizing decision making on safety when operational pressures on which employees are evaluated and rewarded are also present can result in decreased attention to safety. In the following sections, will be a brief review on the safety literature, and then introduce the literature on organizational design and the hypotheses about their relationship to safety performance. Following the description of methods and results, the implications of the study to research and practice, the study's limitations, and directions for future research will be discussed.

Safety Research

Safety outcomes have been studied at multiple levels of analysis and from multiple perspectives. The earliest safety studies took an ergonomic approach, focusing on how organizations should arrange the physical working environment to minimize injury. This research, particularly in the field of industrial engineering and operations management, remains a significant focus of safety research (e.g., Colombo & Cugini, 2005; Paquet, Mathiassen & Dempsey, 2006; Li, Yu & Han, 2007). Another stream of research, which has yielded little in the way of consistent results, examines individual differences that might identify those who would be "accident prone" (Hale & Hale, 1972). More recently, Hale and Hayden (1998) suggested a third phase of safety research has begun, one that seeks to identify factors from organization theory that may inform safety theory and practice.

The third phase of safety research has been dominated by research and theory focusing on the idea that a "safety climate" influences safety outcomes (Hofmann & Stetzer, 1996; Zohar, 1980). Safety climate has been described as a combination of employee perceptions of management's commitment to safety, the importance of safety to coworkers, self-beliefs about safety, and general perceptions of worker involvement in safety-related activities (Dedobbeleer & Beland, 1991). Although measures associated

with safety climate vary considerably across studies in terms of scale length and content, they share the focus on employee perceptions of organizational policies and practices. This is consistent with the general assumptions behind the idea of climate—that employee perception is assumed to be the consequence of the policies, procedures, and rewards within an organization. Employees apprehend these organizational practices and use them to help make sense of their work world (Schneider, 1975; Schneider & Reichers, 1983).

Although research has shown a relationship between safety climate and safety outcomes, employee perceptions can be based on a range of practices as well as overall attitudes toward the organization (Schneider, 1975), and it can be difficult to tease out which specific practices affect climate. Climate has been described as a "Gestalt" (Schneider, 1975) or a "feeling in the air" about a company (Schneider, Gunnarson & Niles-Jully, 1994). It is critical, therefore that research in the field of climate is seeking to unpack practices subsumed within various characterizations of climate (c.f. Schneider and colleagues' work on service climate; Schneider et al., 1994; Schneider et al., 2005). Research on safety climate has also moved in this direction, examining leadership and its effects on safety climate (Zohar, 2002) and safety outcomes (Barling, Loughlin & Kelloway, 2002). This study extends this research by specifically examining organizational design factors and their impact on safety performance.

Organizational Design Literature

A wide range of literatures have examined the effects of organizational design on organizational outcomes, including such disparate topics as innovation (Damanpour, 1991), effective strategy implementation (Love, Priem & Lumpkin, 2002), and procedural justice (Schminke, Ambrose & Cropanzano, 2000). The field of human resources (HR) and high performance work systems (HPWS) employ many of the classic design elements in determining which policies, procedures, and practices will have the greatest effect on employee and firm performance. Research in HPWS found considerable support for the impact of these design-related factors on important organizational outcomes, including turnover (Huselid, 1995; McEvoy & Cascio, 1985), productivity (Katz, Kochan & Keefe, 1987), sales, and return on average assets (Huselid, 1995). These studies attempt to capture organization-level design factors in order to uncover connections to organization-level results, with a consensus that certain "good" practices led to positive organizational outcomes (Delaney & Huselid, 1996; Becker & Gerhart, 1996). Although most of this literature does not focus on safety, components of organizational work systems such as participative decision-making and information sharing have been linked to overall improved organizational performance (Huselid, 1995; Pfeffer, 1998).

These literatures differ from much of the prior research on safety because they have organization-level performance outcomes as their unit of analysis, rather than the group or sub-unit level outcomes. Although leading scholars in the safety climate research stream (Zohar 2000, 2004) have called for studies to examine climate at the organization level as well as the group level, much of the climate research remains focused on the group level (Hofmann & Stetzer, 1996; Zohar, 2002), making potential

organization-level and policy-level interventions difficult to specify. In this study we follow the model used most often in organizational design and HPWS literature and focus on organization-level independent variables and outcomes.

Classic work in organizational design has sought to identify the major structural factors that describe organizations and the appropriate arrangements of structure that maximize various types of performance (Pugh et al., 1969). Several organizational design constructs and their measures have been developed including: specialization, functional differentiation, professionalism, formalization, authority, administrative intensity, centralization, internal communication, vertical differentiation, and alignment of policies and procedures (Galbraith, 2005; Price & Mueller, 1986b). The safety climate literature provides a useful starting point for developing a theoretical rationale for focusing on a more limited subset of structural factors. Since many of the factors within the safety climate literature focus on employee perceptions of how supportive day-to-day practices are of safety (DeJoy, 1985; Zohar, 1980), it was useful to focus on those factors that might be most salient, or meaningful (see Schneider, 1975) to employees. For this reason, we narrowed our focus to two specific organizational design factors: decentralization and alignment.

Henry Mintzberg (1993, p. 2) argued that "every organized activity….gives rise to two fundamental and opposing requirements: the division of labor into tasks, and the coordination of these tasks to accomplish the activity. The structure of the organization can be defined simply as the ways in which labor is divided into distinct tasks and coordination is achieved among these tasks." This simple statement accurately describes the issues associated with organizational design, but masks considerable complexity. Organizations are a nexus of multiple, sometimes conflicting, tasks and functions (Gresov & Drazin, 1997), and designers must determine what structure will best secure the performance of each of these functions separately; how coordination across functions will occur; and how tradeoff decisions will be made when conflicts occur between tasks (Lawrence & Lorsch, 1969). Safety is one of the many functions that designers must accommodate within the structure. Is the safety function best centralized at the top levels of the organization, or decentralized to the operations level? If decentralized, how will coordination with other key functions such as performance appraisal and compensation occur when those processes are also used to support other functions associated with productivity? These are questions we examine using the organizational design factors of decentralization and alignment of organizational practices, both of which are hypothesized below to be associated with effective safety outcomes.

Decentralization

Organizational design options that enable responsiveness to contingencies and influence both perceptions and behaviors of employees have long focused on the issue of centralized vs. decentralized decision-making (Child, 1973; Damonpour, 1991). Decentralization is defined as the extent to which decision making and authority are distributed throughout the organization and employees are able to make independent decisions about their work (Aiken & Hage, 1971; Corwin, 1975). Decentralization has been a focus of attention in organizational design because of its practical utility in achieving organizational goals in the face of complexity and change in the environment

and because of its psychological effect on employees.

Although much of the focus on decentralization has been on issues of responsiveness to external environmental pressures (Lawrence & Lorsch, 1969) there are several other factors within the organization that can be affected by decentralization. Decentralization recognizes that the exigencies of practice may be quite different in various units of the organization, as each experiences different types of performance pressures, resulting in different time horizons, different goals, and different levels of informality (Galbraith, 2002; Lawrence & Lorsh, 1969). A single, centralized authority is unlikely to have the knowledge, flexibility or expert authority to make decisions in these very different environments (Lawrence & Lorsch, 1969). Further, from the organizational behavior literature we understand that decentralization can increase feelings of autonomy in the workplace (Iverson & Roy, 1994; Price & Mueller, 1986a), thus improving overall work behaviors. An example of this was found by Dwyer and Fox (2006) when they noted that the more control employees viewed themselves as having over their work, the more likely they were to spend additional time helping customers and achieving customer satisfaction (rather than rushing to meet number of customers-served expectations).

Each of these outcomes resulting from decentralization (acknowledgement of differences between units across the organization and increased feelings of autonomy) may positively impact safety outcomes. Increased knowledge of unit-specific differences, could affect organization-level outcomes as safety processes at lower organization levels reflect the immediate environment of a work group and allow responsiveness to work-centered contingencies. The second – increased feelings of autonomy – may impact safety through an improved individual responsiveness due to an increased sense of control over one's own work. In a study of miners, for example, Fitzpatrick (1980) found that workers engaged in social interaction and created a subculture that helped the miners cope with the dangers they faced. Similarly, steel workers collectively constructed processes that allowed them to maintain a sense of control over the dangers in their work (Haas, 1977). Thus, decentralization would seem to be an important design mechanism that may support the function of safety by enabling worker control.

Decentralization of safety is a controversial strategy. Many organizations place the responsibility for safety within the HR function, some place it within engineering departments, and still others have a separate safety department, often associated with production. The determination of the relative effectiveness of the decentralization decision is, as a result, an important practical question as well as a theoretical one. Centralization can signal importance and in the case of implementation of standardized practices, can be an efficient means of diffusion (Damanpour, 1991). Yet, the perception of how likely a crisis is to occur in an organization is perceived differently depending on the hierarchical level of the individual in the organization (Larson & Fowler, 2009). Specifically, the likelihood of an accidental crisis occurring is viewed as much higher at the lowest level (entry-level) of managers in organizations due to their day-to-day exposure to the possibility, indicating an importance of decentralizing due to more direct exposure and familiarity with safety situations. In addition to the importance of familiarity in responding to safety situations, the importance of worker control

with regard to safety (Deutsch, 1981) would also seem to favor decentralization. The American Society of Safety Engineers seems to support decentralization as well, asserting in their guidelines that safety is "learned from others," and everyday experiences either reinforce or weaken the strength of safety (Cooper, 2001). This implies that if organizations want to reinforce safety, they should decentralize the enforcement of safety practices to all employees. Organizations convey the importance of safety through continual reinforcement at the operational level (Hofmann, Morgeson & Gerras, 2003), and immediate reinforcement is more likely to be possible when organizations deploy the responsibility for safety practices to lower levels of the organization.

Thus, the design decision to decentralize safety should be associated with a reduced number of injuries for an organization. Specifically, decentralization is defined as the deployment of responsibility and authority to lower levels of the organization so that the safety function is enacted closest to its operational base. It is at this level that employees are affected by unsafe situations, and at this level that employees need to be able to immediately react.

Hypothesis 1: Decentralization of safety responsibility will lead to lower numbers of injuries.

Decentralization deals with the first important requirement of organizational design, the best structure to support the functions of the organization. The next hypothesis examines the other important aspect of design; that of coordination across functions.

Alignment of Practices

Lawrence and Lorsch emphasize the importance of integration, defined as collaboration across functions in order for "unity of effort" to be achieved (1969, p.11). As a nexus of multiple tasks and goals, organizations, especially decentralized organizations, run the risk of sub-optimizing performance on some tasks when there are multiple goals (Gresov & Drazin, 1997). Thus, for the function of safety to be sustained within an organization, the organization's design needs to include mechanisms of coordination among tasks and goals so that sub-optimization of performance on safety does not occur.

One way to achieve coordination is by creating multiple, reinforcing practices within an organization. This coordination is often quite difficult when tasks and goals vary widely, but a range of activities and structures can assure a level of internal consistency of practices within a work group, while assuring that these practices are at least neutral with regard to other tasks and functions (Grazin & Dresov, 1997). These concepts indicate that safety policies, procedures, and reward systems must be both internally consistent, as well as integrated with the other organizational or functional imperatives.

Probably the most significant research on the importance of consistency or alignment of practices can be found in the literature on high performance work systems (Becker & Gerhardt, 1996; Huselid, 1995; Pfeffer, 1998). In order for congruence or

alignment between the practices to exist, each of the practices must work toward the same end simultaneously, and each practice must provide reinforcement for the others, as well as coherence to the practices. The consistency of practices can be expected to lead to more positive organizational outcomes (Beer et al., 1985) as clarity of purpose is continuously reinforced across activities. This indicates that safety practices must be aligned internally, as well as with practices in other functional areas.

Empirical studies in HR strategy support the positive effect of the alignment of practices (Arthur, 1994; MacDuffie, 1995; Delaney & Huselid, 1996). MacDuffie (1995) argues that not only does a group of coherent practices provide several ways for workers to acquire skills, but they also more strongly shape the pattern of interactions among employees and managers within an organization. Dwyer and Fox (2006) address the alignment issue as well, noting that time spent on customer satisfaction is typically reduced in call centers as they are rewarded for volume of calls, not for solving issues. The need for internally consistent practices would also be seen as important in impacting a range of other outcomes, including safety. The idea that internal consistency re-emphasizes organizational values is addressed most directly in the training literature. Heinrich (1950) indicated that injury prevention campaigns often fail because organizations continue to emphasize other types of organizational goals besides safety. The transfer of training literature (e.g. Baldwin & Ford, 1988) suggests that if organizational practices are contradictory (e.g., employees are trained on safety, but evaluations emphasize something else such as productivity), then employees are less likely to transfer what they have learned to their job. Lehto and Salvendy (1995) describe four practices—selection, training, job design, and supervision, as working synergistically to maximize safe procedures in an organization.

The safety climate literature also reflects the importance of alignment, since climate scales ask employees whether or not safety is prioritized higher than production and meeting deadlines (Zohar, 1980; Hofmann & Stetzer, 1996). In general, for employees to grasp the importance of safety, they need to see the presence of company-wide support and formal reinforcement that affects everyday practice. This is supported by climate research that describes climate as something developed on a "day-to-day basis" by organizational "practices, procedures, and rewards" (Schneider et al., 1994, p. 17). Thus, the formal coordination mechanism of alignment will help the various tasks and functions work together toward common goals.

Hypothesis 2: Organization-level alignment of practices supporting safety will lead to lower numbers of injuries.

Method

Survey Distribution/Sample

Sampling procedure. To obtain a sample, advertisements were placed at associations of business and industry and safety councils throughout a state in the Midwest United States. Interested members were asked to contact the researchers directly for additional information. This voluntary method was used because of the sensitivity of the information being requested. Although a self-selection bias was of concern, no

major differences existed between the average number of injuries in the responding organizations and overall population averages (obtained from Occupational Safety and Health Association [OSHA] statistics). Further, this method overcomes the biases in previous research that has tended to focus on individual injury self-reports or perceptions of safety risk (Huang et al., 2004). In exchange for their participation in the study, each organization received a benchmarking report of safety practices across participating organizations, as well as an executive summary of the research findings.

Respondents. Of the 112 organizations that originally responded to the advertisements, 54 organizations completed the survey, with 48 of these organizations providing complete, usable data (including OSHA logs of reportable injuries and/or safety records). Most of the organizations that chose not to participate (or that did not provide complete data) opted out because of time constraints and organizational policies restricting the amount of injury information they could provide. Instructions asked organizations to have their top safety officer, CEO, HR Manager, or whoever would be most knowledgeable of the organization's safety practices, to complete the survey, along with two other top managers with similar familiarity of safety practices (if possible). Using senior executives as informants concerning issues of strategy and organizational design, along with organization-level outcomes is common practice in a range of literatures (e.g., Aiken & Hage, 1971; Huselid, 1995; Becker & Gerhardt, 1996). Of the organizations responding to the survey over half (51.9%) had multiple respondents return the survey. Typically, the organizations with multiple respondents were larger organizations where multiple upper level managers responded (i.e. CEO and safety officer, HR Manager, and unit managers). The majority of the responding organizations were from the manufacturing (61.1%), services (16.7%), and transportation and public utilities (11.1%) industries. Agriculture, mining, finance, wholesale and retail trade, and construction each had two or less organizations respond. (Organizations were classified into eight broad categories as identified in OSHA's yearly reports.)

Measures

Independent variables. The survey focused on decentralization of safety and alignment of the safety practices within the organization. The survey asked that respondents answer Likert-type items based on a 1-5 scale (not at all = 1, great extent = 5). Cronbach's alpha was estimated for each scale to determine the internal consistency of the scales. These reliability coefficients were used to correct for measurement error in the observed correlations. The resulting disattenuated correlations were then used in the regression models to estimate the relationships between independent variables and organizational safety (Schmidt & Hunter, 1996).

Decentralization. The five-item scale asked respondents the extent to which the responsibility of safety is decentralized throughout the organization; each department is responsible for their own safety procedures; safety is viewed as everyone's concern (not just the safety department's concern) within the organization; decisions on safety policies/procedures are determined with input from all departments; and various departments participate in safety enforcement across the organization. These five

items were combined for the decentralization scale. Cronbach's alpha for this scale was estimated to be .81, indicating the scale to be reliable.

Alignment. The six-item scale asked respondents the extent to which the safety practices in place at the organization were supportive of each other; multiple safety practices were used to enforce safety; various safety practices within the organization contradicted each other (reverse coded); HR practices (selection, training, evaluations, compensation) were all used to reinforce organizational safety outcomes; safety practices send mixed messages to employees (reverse coded), management emphasizes other outcomes (i.e. placing productivity above safety) causing the importance of safety to be decreased (reverse coded). These six items were combined for the alignment scale. Cronbach's alpha for this scale was estimated to be .76, indicating the scale to be fairly reliable.

Dependent variables. Because the present study examines organization-level practices, the dependent variable of interest is overall organizational safety outcomes. Since the study examines measures across several organizations, it uses recorded safety measures (rather than observed) due to practicality. Furthermore, because the study includes multiple organizations, it is necessary to obtain recorded injuries reported in a consistent, standardized form. Thus, as the organizations surveyed were US-based, the organizational safety measures were obtained from OSHA 300 logs since these are required injury reports of all US companies. The safety officers were asked to provide copies of the actual logs they had used to report their injuries to OSHA (or to complete an injury reporting sheet if the logs were unavailable) for their organization over the past five years. Table 1 shows the injuries in each OSHA category, by year, for the organizations in the study as well as total injuries for each category and the percentage of total injuries that each category represents. Sprains and strains were the most common type of injury reported.

Table 1: *Summary of Injuries for Each OSHA Category (All Companies Combined)*

Type of Injury	*(1) Fracture*	*(2) Eye*	*(3) Contusion*	*(4) Diseases*	*(5) Toxics*	*(6) Cuts*	*(7) Needles*	*(8) Abrasions*	*(9) Sprains/ Strains*	*(10) Bites*	*(11) Skin*	*(12) Cumulative Trauma*	*(13) Mental Stress*	*(14) Burns*	*(15) Other*
Year 1	301	74	157	3	7	201	68	6	536	2	51	249	3	37	13
Year 2	375	148	212	7	17	229	301	96	848	6	24	309	3	51	19
Year 3	353	131	271	9	5	251	232	73	773	5	25	349	0	73	26
Year 4	320	166	214	3	6	181	119	130	609	4	32	378	2	38	32
Year 5	258	176	219	16	54	260	165	143	694	9	31	257	2	38	25
Total Injuries	1140	517	718	635	82	722	912	247	2116	49	364	991	227	142	111
Percent of Total Injuries	12.7	5.8	8.0	7.1	0.9	8.0	10.2	2.8	23.6	.5	4.1	11	2.5	1.6	1.2

In addition, because it is important to capture as many dimensions of safety as possible in order to determine the overall safety of an organization, this study weighted injuries from the OSHA 300 logs according to seriousness. Organizational safety outcomes were measured as the average number of injuries, weighted for seriousness (based on type of injury and type of medical treatment required) (Vreedenburgh, 1998), over five years. Incident types on OSHA logs are broken down into fractures, eye injuries, contusions, infectious diseases, lacerations, needle punctures, abrasions, sprains/strains/fractures, bites, occupational skin disease, disorders, mental stress, thermal burns, and other. These types of injuries as well as what type of medical treatment was required (medical treatment only, or lost days from work) were used to rate the injuries incurred for seriousness.

OSHA logs for the past five years were obtained from the organizations in order to have a more consistent report of employee injuries, allowing for the control of random fluctuations in reported injuries. To do this, the correlation of injuries across five years was determined and the average calculated. The resultant mean correlation (.78) was the reliability of injuries reported for one year. The reliability of the average injuries across five years was then determined by using the Spearman-Brown prophecy formula to adjust the one-year reliability. This procedure yielded the estimated reliability of .95 which was then used to correct the correlations between the dependent variables and independent variables for measurement error. This correction helps account for random fluctuation of responses over time (Schmidt & Hunter, 1996).

Control variables. In order to determine whether it is the hypothesized design practices that are influencing organizational safety additional factors needed to be considered and used as control variables. When examining the human resources literature, the most common variables controlled for were type of industry (Bae & Lawler, 2000; Huselid, 1995) and firm size (Huselid, 1995; Huselid, Jackson & Schuler, 1997; Jackson, Schuler & Rivero, 1989; Delaney & Huselid, 1996). One study that looked specifically at organizational characteristics found that industry actually influenced the type of HR practices put in place (Jackson et al., 1989). The National Safety Council (2008) also makes distinctions across industries in its yearly reports, and has found a definite distinction in the number of injuries by industry. There also may be an indirect link with firm size and injuries, because larger firms have been found to have additional practices such as drug testing (Borg, 2000), developmental initiatives (Douglas & McCauley, 1999), and training (Colarelli & Montei, 1996) which may influence an organization's safety outcomes. Thus, this study controlled for both industry and organizational size.

Size of the organization was measured with a single, open-ended item asking "Approximately how many people are in your organization?" (Min = 4, Max = 6,000, Mean = 489). Type of industry was measured with a single open-ended item asking "Type of industry." The responses were used to classify the organizations using OSHA's classification system: agriculture, forestry and fishing, mining, construction, manufacturing, transportation and public utilities, wholesale and retail trade, finance, insurance, real estate, and services. These eight industries were then broken down into two classifications – high risk and low risk – based on the incidence rates per industry provided by OSHA records.

Analyses

Examining informant agreement. Because there were multiple respondents from organizations on the survey, the intraclass correlations (ICC) of the responses were determined (Bliese, 2000). The mean ICC(2) was found to be .83 (Minimum = .64, Maximum = .96). Because the ICCs were fairly high, multiple responses from within organizations were averaged, and the means were used for the rest of the analyses.

Hypothesis testing. The proposed relationships were tested by regressing organizational safety on the predictor variables (decentralization and alignment) and control variables (industry type and organizational size). Support for the hypotheses was found if the beta weight was negative and the confidence interval around the beta weight did not include zero.

Results

Findings

Correlations and descriptives. Descriptive statistics, reliability estimates, and correlations for all measures are reported in Table 2. Because the sample size was small, a 90% confidence interval was used to examine correlations and test hypotheses. When examining the corrected correlations between the perceived organizational safety practices and numbers of injuries, decentralization (r = -.37) had a negative value and a confidence interval not including zero (CI = -.60, -.15). This indicated that decentralization was associated with fewer injuries. Alignment (r = -.18) is also negatively correlated with injuries, indicating that they may be associated with fewer numbers of injuries; however, their confidence interval included zero.

Table 2: *Means, Standard Deviations, and Correlations between Organization Design Variables, Control Variables, and Safety Outcomes*

Variable	Mean	N	SD	1	2	3	4	5
1. Decentralization	3.51	54	.81	(.81)	.73*	-.02	.16	-.37*
2. Alignment	3.52	53	.65	.66*	(.79)	.12	.13	-.18
3. Industry (by high or low risk)	.80	54	.41	-.02	.11	(---)	-.18	-.32
4. Organizational Size	530.43	53	1044	.12	.15	-.18	(---)	-.05
5. Injuries per 100 employees	26.86	48	24.08	-.21	-.33*	-.31*	-.05	(.95)

**Indicates correlations with 90% confidence intervals which do not include zero*
Upper diagonal correlations are corrected for measurement error
Diagonal cells are Cronbach's alpha

Hypotheses. The first proposed hypothesis was tested by regressing injuries on the decentralization predictor variable and control variables (industry type and organizational size). The relationship of decentralization with injuries (r = -.37) was negative, indicating that decentralization of safety practices was associated with fewer injuries. Further, the confidence intervals around this beta-weight did not include zero (CI = -.59, -.15), providing support for the hypothesis that decentralization of safety practices has a relationship with organization-level safety outcomes (see Table 3).

Table 3: *Regression of Injuries on Decentralization*

Injuries (per 100 employees)						
Variable	β	R^2 (Shrunken R^2)	R (Shrunken R)	ΔR^2	90% CI	
					L	H
Step 1						
Industry Type	.36	.11	.33	.11	.13	.59
		(.07)	(.26)			
Organizational Size	.08				-.16	.32
Step 2						
Decentralization	-.37	.24	.49	.13	-.59	-.15
		(.19)	(.43)			

The second proposed hypothesis was tested by regressing injuries on the alignment predictor variable and control variables (industry type and organizational size). The relationship of alignment with injuries (β = -.29) was negative and the confidence intervals did not include zero (CI = -.52, -.05). This provided support for the hypothesis that alignment of safety practices is related to organization-level safety outcomes (see Table 4).

Table 4: *Regression of Injuries on Alignment*

Injuries (per 100 employees)						
Variable	β	R^2 (Shrunken R^2)	R (Shrunken R)	ΔR^2	90% CI	
					L	H
Step 1						
Industry Type	.40	.11	.33	.11	.16	.64
		(.07)	(.26)			
Organizational Size	.08				-.16	.32
Step 2						
Alignment	-.29	.19	.44	.08	-.52	-.05
		(.13)	(.36)			

Discussion

This study lends support for the prospect of using organizational design as a means to manage safety practices in an organization and to affect safety performance. We identified two organizational design constructs – decentralization and alignment – that were associated with reduced reported injuries. The indication that decentralization of safety practices may reduce injuries demonstrates the potential importance of continual, day-to-day reinforcement of safety (Hofmann et al., 2003) through distribution of safety authority and responsibility to all employees. By locating the decisions about safety at the place where the greatest understanding of processes exists, and enabling greater worker control, safety outcomes improve. The result that the alignment of practices may be associated with fewer injuries for the organization supports the argument that practices should be consistent within an organization (MacDuffie, 1995; Delaney & Huselid, 1996).

The finding that both decentralization and alignment may have a relationship with reduced injuries, suggests that safety is considerably more than the implementation of particular, isolated safety practices or rules. Rather, the results suggest safety should be explicitly included in organizations' fundamental design decisions. When determining structures that may best implement overall strategy, safety must enter into the design calculus. Safety performance depends on worker control and coherence of practices.
Perhaps the most important implication of this study is that focusing on organizational factors rather than individual factors will go a long way toward improving safety and improving an organization's capacity to problem solve. There is a strong tendency in the United States to seek individual accountability when safety issues arise. In many cases, post-accident reviews focus on proximal causes—on individuals and individual actions. In her exhaustive analysis of the Challenger launch decision, sociologist Diane Vaughan (1997, p. 392) argued that the tendency to look at immediate cause, rather

than the organizational context in which the immediate cause became possible stems from the desire for quick action, playing the "politics of blame":

> "Responsible individuals can be fired, transferred, or retired. New rules that regulate decision making can be instituted. Having made these changes, the slate is clean. Organizations can go on… The myth of managerial wrongdoing made the strategy for control straightforward: fix the technology and change the managerial cast of characters, implement decision controls, and proceed with shuttle launches."

In other words, safety approaches that do not look at the design of the organization run the risk of appearing to respond to calls for accountability, but in the end, safety problems were not addressed. Thus, in spite of actions to hold individuals accountable and implement new decision controls after Challenger, the review of the Columbia accident more than a decade later showed that NASA's "fix" after the Challenger did nothing to change the safety environment. In fact, most of the antecedents to Columbia's failure were the same as those that led to the Challenger disaster (Columbia Accident Investigation Board, 2003).

The results lend further empirical support to the conclusions of prior case studies and to reports on major safety failures. Although there are arguments for centralization—accountability can be pinpointed, specialization is possible, and standardized practices can be diffused—this research would seem to suggest that the counterarguments associated with decentralization are instead supported. Local information, knowledge, and responsiveness, as well as more accurate and frequent communication about safety are associated with better safety outcomes. Alignment of a range of practices around safety is also critical. Given that prior research has shown that declining and misallocated resources lead to "drift" toward the possibility of more serious accidents as attention turns from safety to cost (Marcus & Nichols, 1999), the findings indicate that one way to avoid drift is to maintain alignment of rewards and performance management systems around safety. Both decentralization and alignment may offset tendencies at higher levels of the organization to make decisions that sub-optimize safety goals.

Limitations

There are a number of limitations to this study. One of the most notable is the sample size. This study took a complex format asking organizations not only to complete a survey, but also to provide multiple respondents, as well as provide sensitive safety information over multiple years. Thus, though the sample size was small, when looking at the required time and willingness to disclose safety information for participating organizations, the response rate and amount of in-depth information provided by each organization was actually quite good. Given that many safety studies look at practices within a single organization, this sample represents a significant departure from the norm, and gives us much needed cross-organizational information. However, because of the small sample size, there could be a problem of capitalization on chance, and results are likely not completely representative of the population value.

Further, because of reduced power due to the smaller sample-size, it may be difficult to detect a relationship when there is one. There were also limitations with the measures of this study. Measures were all collected from upper management, which may have caused some information on what actually occurred (versus what policies say should have occurred) to be lost. Further, full correction for transient error was not possible in the measures of the independent variable (only random response error and specific factor error were accounted for by alpha coefficient) (Schmidt, Le & Illies, 2003). Therefore, the correlation and regression estimates are most likely conservative, reducing the probability of detecting an impact of design factors.

The dependent variable measures were also a limitation. In order to get the most consistent information across companies possible, OSHA log information was used. However, this information provides only injuries serious enough to report, resulting in a low base rate of the injury criterion. Consequently, the magnitudes of estimated correlations between this criterion and the independent variables were potentially affected (reduced). Yet despite the small sample size and conservative estimates, this study still supports the relationship between structural decentralization and alignment and organizational safety.

Future Research

This study represents a first step toward expanding current research in safety from employee perceptions of safety climate to identifying potential design factors that may affect safety outcomes. Multiple overlaps were identified in the theoretical portions of this paper between the safety climate, the HR literature, HPWS and the organizational design literature. Because of the complementary findings that each area of research contributes, it is important that additional consideration and theoretical development between them continues.

Decentralization should be explored further to see if there is an appropriate degree of decentralization necessary in developing practices and responsibility. Whether the type of job, management, industry, or size of organization makes a difference on the impact of decentralization is also important. Research should also examine the possibility that some aspects of safety might be best centralized (dissemination of safety information and practices or training), but others, such as response to safety incidents, should be decentralized. Perhaps most important is a replication study with a larger sample and a research design that limits the sample to just one or two particular industries so that potential noise from cross-industry differences can be controlled. A larger sample also would enable examination of interactions between independent variables. For example, alignment may actually increase the importance of decentralization. Although decentralization is associated with safety on its own, it may have a greater impact on safety when alignment of practices is present. The study could not test that possibility with a sample this small, but it certainly merits attention in future studies. A replication study in organizations in other countries would also be of interest to see if the same design factors hold importance across cultures.

Conclusion

This study extended the safety research by providing evidence for a relationship between organizational design factors and safety outcomes. Specifically, two organizational design constructs, decentralization and alignment, were identified as related to reduced injuries. These findings opened the door to new avenues of research in organizational design and suggested new connections between practices, perceptions of practices, and results. The results also supported the possibility that advances in work environment reform (Deutsch, 1981), particularly with regard to increased worker control over safety practices, may improve workplace safety.

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Student Perceptions of Their Writing Skills: Myth and Reality

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There are many reasons why college-level students often do not possess college-level writing skills. This study investigates two of them: (1) students do not believe that good writing skills will be important to them in their careers, and (2) students perceive that they are already good writers (when in fact they are not). To test these hypotheses, demographic information is collected, self-ratings of writing ability, and three independent writing-skill assessments of 140 students. Ample evidence is found to reject the first hypothesis, and even more evidence to support the second one.

It was difficult to determine who was more surprised at the termination meeting—the employee or the boss. The new hire had a strong technical resume, enthusiastic references, and (theoretically) the skills needed to translate IT directions into the simple English prose required by the firm's customers. Yet the services director repeatedly found himself editing this individual's work, deleting whole paragraphs that said little, and wondering how a customer would react to the writer's confusing language. With corporate morale on the line and after sufficient warning, he felt he had no choice but to let the employee go (Gerencher, 1999).

It is difficult to find an employer that does not rate "good writing skills" as essential for both existing employees and new hires (Bacon & Anderson, 2004; Wallace, 2004; Kelly & Gaedeke, 1990, McDaniel & White, 1993; 2004; Dillon, 2004; Jusino, 2005; Rowh, 2006). Similarly, it is difficult to find an accredited business program that does not recognize this need, and therefore does not require students to take one or more business communications classes (Riordan, Riordan & Sullivan, 2000). Finally, revisions to such certification examinations as the Uniform CPA exam or the addition

of a formal, "analytical writing assessment" component to the Student Aptitude Test (SAT) and Graduate Management Admissions Test (GMAT) now formally recognize the importance of such skills (Noll & Stowers, 1998).

If both employers and educators recognize the importance of good writing skills, why do they continue to bemoan the lack of such skills? In a survey of 120 U.S. corporations, for example, the National Commission on Writing (a panel of the College Board) found that about a third of all employees wrote poorly (Dillon, 2004). This commission also estimated that businesses were spending over $3 billion annually on remedial writer training. Similarly, in a study on the performance of business communication interns on the job, supervisors rated intern performance related to writing skills the lowest among 11 performance areas (Sapp & Zhang, 2009)

How did it come to this predicament? The next section of this paper provides several reasons why many university students demonstrate poor writing skills. It also presents the hypothesis that students do not recognize their own writing deficiencies. To test it, a survey was devised and collected a set of sample data from the students enrolled in several classes at the university. The third section of this paper reports the results of this investigation. The last section of the paper provides a brief summary of the work and conclusions.

Why Can't Johnny Write?

Experts studying "the writing problem" in corporate America have proposed a variety of explanations as to why many Americans cannot write cogent prose. Some authorities blame the K-12 school systems, where "social promotion considerations" often outweigh academic deficiencies in passing students through the system (Mohl & Slifer, 2005; Parker, 2001). Others blame illiterate or uncaring parents, peer pressure to speak vernacular English, or a host of environmental factors. Time pressure can add to these problems, allegedly forcing communicators to sacrifice "quality" in the interests of "expediency."

What about the students enrolled in accredited colleges and universities? Surely here we should find an oasis of good writing skills. But that is not the case. Ashbrand (1986) noted, for example, that "poor writing" has been a weakness of graduating seniors for nearly 50 years—a sentiment echoed by Joseph (1989) and Bradney and Courbat (1998). More recently, Mark Bauerlain's book *The Dumbest Generation* (Penguin, 2008) provided further evidence of the writing deficiencies of college-level students.

Sadly, it appears that little has improved. A study by Tanner and Totaro (1998) for example, found that over 275 accounting educators in 43 states (and the District of Columbia) continue to be dissatisfied with the writing and verbal communications skills of the students in their schools—a satisfaction level that showed no improvement from a study conducted 10 years earlier. Jameson (2007) found that writing scores have remained stable over the last 30 years, but a greater proportion of students are entering higher education, resulting in a greater proportion of poor writers in college. It is easy to find potential explanations for this lamentable condition. One often cited reason is a lack of high-school training. Describing the students in her freshman

writing classes at the University of Maryland, for example, Jablon (2004) laments that many of her students "barely write on a high school level" and that she consequently spends much of her time teaching such remedial skills as basic grammar and English syntax, vocabulary "that students should already know," and verb conjugation. Underachieving college freshman, including those with high abilities, have reported that their high school experiences left them unprepared for college (Balduf, 2009).
Another possible explanation for the poor writing skills of university students is that it mirrors the decline of literary reading in the nation. In a comprehensive survey of 17,000 American readers, the National Endowment for the Arts found that, during the period 1982-2002: (1) less than half the adult U.S. population reads literature, (2) literary reading of young adults ages 18-34 has declined 18% (from 57% to 48%), and (3) literary reading of individuals with "some college" education has declined even more—a 20% drop (from approximately 73% to 53%). Those authors also note that "a cultural legacy is disappearing, especially among young people" and repeat the warning the foundation issued 20 years ago that "a rising tide of mediocrity [has] overtaken the school system and threatens a generation of students" (Bradshaw & Nichols, 2004).

The inferior writing skills of university students can also be blamed on the common use of email and text messaging, in which "expediency" and "brevity" often take precedence over cogent, grammatically-accurate prose. Although it is possible to dismiss such writing as endemic to the subculture of emails or web logs, most faculty members can provide similar, if less extreme, examples of such communications from their students. The fear is that many students fail to distinguish between those situations in which good writing does not matter, and those venues in which it is very important.

Another explanation for the poor writing skills of some students can be traced to loopholes in university admissions policies, which often permit such individuals to enroll in advanced courses despite clear inabilities to write well. Although the entrance requirements at most such schools require minimal scores on the verbal portion of the ACT or SAT exams, many students can avoid these requirements by matriculating as junior-college transfers.

Yet another explanation for the poor writing skills of university students is that universities do little to enhance them. In an in-depth study of undergraduate student writing portfolios, Levelle (2003) found no significant improvements in writing quality between the subjects' freshman and senior year (several factors limit the results of this finding, including the study's small sample size (30 students), the relatively high scores of all the writing portfolios examined, the fact that the sample was drawn from a single university, and the fact that all the student participants were volunteers). This finding is further supported by Rachal, Daigle and Rachal (2007) who report that over half the college students in a 485-sample study had difficulty writing introductions and conclusions in their papers. The idea that "writing skill is an art and cannot be taught" bolsters this argument, as does the fact that few business schools require students to take more than one or two English or communications classes. But even here, it is important to note that most universities require students to merely pass these classes, not demonstrate that they have mastered the skills taught in them.

Large university class sizes may also help explain why today's students are often poor writers. High student volume can cause faculty members to ignore writing errors in papers or examinations, or lead them to use computer-graded examinations that contain no writing components at all (Bacon & Anderson, 2004). Furthermore, while faculty do make written assignments in non-communications courses, the authors found that students often object to grading rubrics that include assessments of the grammatical accuracy or cogency of their works. Then too, the promotion and merit criteria at many universities emphasize research and publishing, placing little rewards or even recognition for assigning or grading written student work in non-English classes. Finally, where instructors do assign written work requiring cogent prose, the assignments are often graded by graduate students who do not, or cannot, evaluate the writing skills demonstrated in the samples.

Student misconceptions about the importance of writing may also help explain why more of them cannot write well. Wallace (2004) noted, for example, that the many errors in student résumés and cover letters reflect the attitude that "good writing skills" are not important in those jobs not directly requiring them. He also mentions the common misguided expectation that new hires will have a good secretary to "fix" their mistakes. A study of 1,100 students by Hassel and Lourey (2005) supports the likelihood that students do not value good writing skills. Those authors suggest that apathy, grade inflation, and absenteeism all appear to contribute to a growing loss of student accountability and perhaps writing skills are among the casualties.

Crainer and Dearlove (2004) note that self-awareness can make a significant difference in the quality of written output. This suggests yet one more possible explanation for the lack of good writing skills among business students—the misconception that they are already good writers. Certainly there are good reasons for this. Most high schools require students to pass one or more English classes in order to graduate, most universities now require minimal scores on the verbal portions of SAT or ACT examinations to matriculate, and most undergraduate programs require writing samples on their admissions applications. If a student has received good grades in high school, met the minimum requirements on SAT or ACT tests, and been accepted in college, how can his or her writing skills be deficient?

A New Study

The literature on college writing skills suggests a number of interesting, testable hypotheses. The authors were particularly interested in two of them. The first hypothesis is that students do not believe "good writing abilities" will be important for their future careers. The second hypothesis is that students believe that they are already good writers, when in fact they are not. While the first hypothesis can be measured directly in a survey, the second requires more data. In particular, we wanted to compare student perceptions of their writing abilities with one or more objective measures of these skills. The null hypothesis is that student perceptions of their writing abilities are high, reflecting their natural writing abilities.

To test these hypotheses, a survey was used to gather information from the students in five separate, junior-level classes at a 15,000-student western university. A total of

140 students completed it: Twenty-nine students in a junior-level information systems class and 111 students in four sections of a junior-level business communications course.

Results: Demographics

Part I of the survey gathered demographic information about each student, including his or her age, gender, native language, major, and class rank. The student respondents were identified only by the last four digits of their student numbers. This allowed us to match individual perceptions with performance results. Table 1 summarizes this demographic information, which was obtained from the answers to questions 1 to 3 of the survey instrument. The average age of the respondents was 23.5. The oldest was 59 and the youngest was 18. In this sample, 69 were male and 70 were female. Most of the respondents (119 students) reported that English was their native language. However, 3 reported Spanish as their native language, 3 reported Japanese, and 4 reported Chinese. Ten respondents indicated some other language as their native language. Most of the respondents (119) were business majors, but a surprising number (21) were non-business majors. Finally, most of the respondents (92) were juniors, but 25 of them were seniors, 15 were sophomores, and 1 was a graduate student.

Table 1: *A Summary of Demographic Information of Survey Participants (Totals for some rows may not add to 140 because of non-responses)*

Question					
1A—Age	**Average**	**Oldest**	**Youngest**		
	23.5	59	18		
1B—Gender	**Male**	**Female**			
	69	70			
1C—Native Language	**English**	**Spanish**	**Japanese**	**Chinese**	**Other**
	119	3	3	4	10
2—Major	**Business**	**Non-Business**			
	119	21			
3—Class Rank	**Freshman**	**Sophomore**	**Junior**	**Senior**	**Graduate Student**
	0	15	92	25	1

Results: Students Believe That Good Writing Skills are Important to Their Careers

Questions 9 and 11 (Table 2) asked students how important they thought their writing abilities would be in the future. These questions test the hypothesis that another reason students might not write well is because they do not think "writing abilities" are important. The survey responses refute this hypothesis: students do recognize the importance of writing well. As evidence, in Question 9, 105 students thought that writing ability was likely to be "very important" to their careers, 35 thought it was going to be "somewhat important," and no one thought it was going to be "unimportant."

Similarly, 136 students answered "yes" to Question 11, indicating that their writing abilities were likely to affect the way others perceived their intelligence, knowledge, or other capabilities, while only 4 students answered "no" (that it would not). If students are poor writers, it is not because they think "good writing skills" will be unimportant to their future careers or to the way others perceive them.

Table 2: *Distribution of response to Questions 9 and 11 (Perceived importance of Writing)*

	Very Important	**Somewhat Important**	**Not Important**
9. Importance of Writing to Career	105	35	0
	Yes	**No**	
11. Writing affects how others will perceive your other capabilities?	136	4	

Results: Students Believe That They Are Good Writers

Question 5 asked each respondent to rate his or her writing ability using the categories "Excellent," "Competent," "Average" or "Poor." Table 3 provides a frequency distribution of answers to this question.

Table 3: *Distribution of Self-Rating of Writing Ability*

	Excellent	**Competent**	**Average**	**Poor**	**Total**
Writing Ability Self-Rating	15	79	41	5	140

The data in Table 3 provides some support for the hypothesis that most students believe they already possess adequate writing skills. In our survey, 15 students rated themselves as "excellent" writers, 79 students thought they were "competent" writers, 41 students rated themselves as "average" writers, and only 5 students—less than 4% of our sample—rated themselves as "poor" writers. Clearly, few of the students in our sample agreed with the general view that students lack good writing skills—at least when rating themselves.

Our survey asked several additional questions about student backgrounds, writing experiences, and perceptions of the importance of writing abilities in the future. Table 4 summarizes our findings. Question 7, for example, asked respondents if they thought that their high school classes "had prepared them to write well." This question relates to the claim that most students enter college thinking that they already possess adequate writing skills. The data suggest that a majority (82 students) think they do. However, 56 students answered "no" to this question.

Table 4: *Distribution of answers to questions 7, 8, and 10 of the survey (Totals for each row may not add to 140 because of non-responses)*

	Yes	No
7. Did high school prepare you for college writing?	82	56
8. Have past college courses improved your writing?	119	21
10. Has your writing been criticized by someone besides a teacher?	77	63

Question 8 of the survey asked respondents whether any college classes had helped them improve their writing abilities. A large majority of the respondents (119) answered "yes" to this question, while 21 said "no." At face value, a clear majority of the students in this survey thought that their college classes were helping them. Although we would like to think that a student's college experience, where writing skills are stressed across the curriculum, was a positive force in developing writing skills, it is difficult to place too much confidence in this result. Most of the respondents were enrolled in a business writing class at the time they answered this question.

Question 10 of the survey asked whether anyone other than a teacher had ever criticized the respondent's writing abilities. Our intent here was to examine to what extent students had received independent, critical feedback about their writing. Again, this question speaks to the issue of perceived writing ability because an absence of negative feedback is easily interpreted as positive feedback. A total of 77 students said "yes" (they had received criticism from others) and usually mentioned a family member, friend, or spouse as the individual providing the feedback. But a surprising number of students—63 of them—answered "no" to this question. This means that nearly 45% of students had never received negative feedback about their writing abilities from external sources other than teachers.

The vast majority of the respondents in our survey viewed themselves as decent writers—meaning that they possessed at least average writing capabilities—and most thought that they were better than average (i.e., classified themselves as "competent" or "excellent" writers). This study used three separate assessments to evaluate student abilities. First, we asked students to complete Part II of the survey instrument—a mini-test of the grammar and punctuation rules required in good writing. Second, we asked students to complete Part III of the survey instrument—a vocabulary test. Third, we gave each student a writing assignment. The following paragraphs discuss each of these measures in greater detail.

Results: A Grammar Test

The (15) questions in Part II of the survey instrument tested each respondent's writing and grammar skills. Most of these questions were taken from (Collinson et al., 1992) and tested three levels of writing mastery. First, students were asked to determine whether or not a given sentence contained an error. This allowed students to identify incorrect sentences as "bad" ones, even if they did not know what the errors were. Students could also indicate that the sentence was "correct" or that they "didn't know" whether or not the sentence contained an error. Second, students were asked to circle the error in each "bad sentence." This enabled us to distinguish between

those students who actually knew the location of a given error, and those who did not. Finally, students were asked to correct each mistake they identified. This third requirement enabled us to determine whether or not students knew what was required to fix each sentence.

Each tested a simple grammar rule. For example, Sentence 1 ("There were less visitors than usual.") tested whether students knew when to use "less" and when to use "fewer." Similarly, Sentence 2 ("The vehicle has it's own reserve power supply.") tested whether students knew when to use "its" and when to use "it's." Our favorite sentence was Sentence 9 ("If the baby doesn't thrive on whole milk, boil it."). Other sentences tested the respondent's understanding of the differences between "their" and "there," "between" and "among," and "affect" and "effect." The authors of the questions used in our study suggest that these are high-school-level grammar skills that college-level students should know.

Table 5 provides summary statistics for the first level of these grammar tests—a student's ability to identify whether or not a given sentence contained an error. For this test, the minimum score was "2" and the maximum score was "15" (a perfect score). The average score was 10.25—i.e., a score of about "two-thirds" or 67% correct. This result suggests that, if students are good writers, they achieve such a rating in spite of their knowledge of grammar rules, not because they know how to use such rules.

Table 5: *Sample statistics for the grammar portion (Part II) of the survey.*

	Min	Max	Range	Mean	Median	Mode	Standard Deviation
Grammar: Number Correct out of 15	2	15	13	10.25	10	9	2.10

An interesting question to ask is how well the student self-ratings of their writing abilities mirrored the scores on their grammar tests. If students have a realistic idea of their writing abilities, these two items should be related—e.g., those students rating themselves "Excellent" should do well on this test, while those students rating themselves in categories less than Excellent should do incrementally poorer on the test.

Table 6 shows the distribution of student self-ratings of their writing abilities ("Excellent," "Competent," and so forth) classified by three levels of performance on the grammar test: "low" (8 or less questions answered correctly), "average" (9, 10, or 11 questions answered correctly), and "high" (more than 11 questions answered correctly)—ratings obtained from the professional instructor teaching this study's writing courses.

Assuming a null hypothesis that a relationship exists between self-ratings and this objective measure of writing ability, we performed a chi square test on these data. This analysis tests the closeness of matchups—i.e., whether the self-rated "excellent writers" performed excellently on this assessment, the "average writers" did average

work, and so forth. Although in general "quality writing" counts, in this test, it did not matter what the absolute scores were on this assessment, as long as the top scores were rated as "excellent," the middle scores as "average," and the lowest scores as "low." For the data at hand, we computed a test statistic of χ^2 = ".016" (with 6 degrees of freedom)—a statistical value low enough to reject this hypothesis at any reasonable alpha level. Stated simply, no statistical evidence to support the claim for a relationship between the student ratings of their writing abilities and the scores on their grammar tests was found.

Table 6: *Distribution of grammar quiz scores (Part II of survey) and self-ratings of writing ability*

	Low (2 to 8)	Average (9 to 11)	High (12 to 15)
Excellent	2	6	7
Competent	12	41	26
Average	8	28	5
Poor	3	2	0

Results: A Vocabulary Test

Many experts argue that "vocabulary" is an integral part of good writing skills (Wallace, 2004; Rowh, 2006). For example, the more extensive an individual's vocabulary, the more tools a person has for writing cogent prose and the more explicit and forceful such writing is likely to be. Accordingly, Part III of the survey instrument used 15 multiple-choice questions to test a student's vocabulary. The words used here were drawn from the "Word Power" section of recent issues of the Reader's Digest. Examples were "concave," "absorption," and "inoculate." Four of the words in this test were 2 syllables, five of these words were 3 syllables, and six of these words were 4 syllables. None of the words contained more than 4 syllables and, in our opinion, all were words that an instructor might reasonably expect college-level business majors to know.

Table 7 reports the results of this portion of the survey. Again, the low score was "2"—an abysmal score by any standard, but made particularly disappointing because the result cames from a multiple-choice test. The maximum score was "13" (out of 15), and the mean score was "7.2"—an average mark of about 50 percent.

Table 7: *Sample statistics for Vocabulary, Part III, of the survey*

	Min	Max	Range	Mean	Median	Mode	Standard Deviation
Vocabulary: Number Correct out of 15	2	13	11	7.22	7.5	8	2.35

Table 8 shows the distribution of student self-ratings of their writing abilities (Excellent, Competent, and so forth) against three levels of performance on the vocabulary test: low (6 or less questions answered correctly), average (7 or 8 questions

answered correctly), and high (9 or more questions answered correctly). These ranges were adapted from the Word Power feature of Reader's Digest.

A chi square test of independence on this data resulted in a test statistic of 0.0001 (with 6 degrees of freedom)—a statistical value enabling us to reject the null hypothesis (that the ratings and test scores were related) at any reasonable alpha level. Thus, here too we find statistical evidence suggesting that there is no relationship between the student self-ratings of their writing abilities and the scores on an independent test of such abilities. This finding again supports the claim that most students are unaware of the deficiencies in their writing skills—in this case, vocabulary skills.

Table 8: *Distribution of vocabulary scores (Part III of survey) and self-ratings of writing ability*

	Low (2 to 6)	Average (7 to 8)	High (9 or more)
Excellent	5	3	7
Competent	19	30	30
Average	26	9	6
Poor	5	0	0

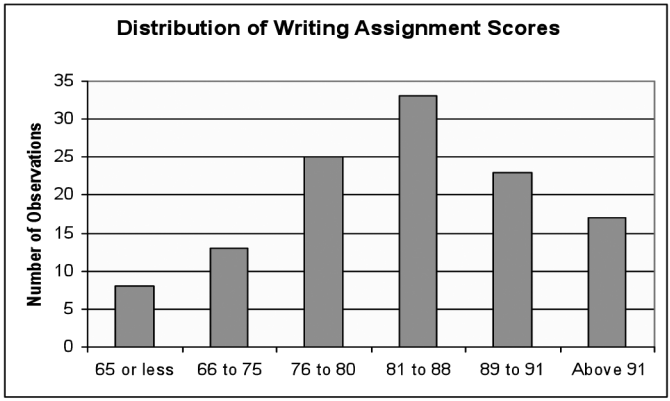
Results: A Writing Assignment

It can be argued that grammar and vocabulary tests are, at best, surrogate measures for writing ability—and perhaps weak ones at that. A more direct measure of writing skill is a grade on a writing assignment. Accordingly, we also gathered evaluation data for the scores for each of the five experimental classes.

A total of 119 students completed this assignment. The students in the IS class were required to write a short paper of less than 5 pages on a topic of personal interest. The students in the business communications classes had two, one-page writing assignments taken from Ober (2003). In both classes, each paper was graded using a standard evaluation sheet. Appendix A provides of a description of the assignment for the IS class and a copy of the evaluation form.

For these writing assignments, the maximum score was "30 points" (in the four business communications classes) or "27 points" (including a 2-point bonus in the IS class). As an adjustment, we converted all grades to percentages, using the grade on the five-page paper for the IS students and the average of the two grades on the 2 one-page papers for the business communications students. For these assignments, the average student score was 82%, the maximum score was 97%, the minimum score was 59%, and the standard deviation for these grades was 8.4%. Figure 1 provides a distribution of the scores.

Figure 1: *Distribution of scores on a writing assignment*



To test the hypothesis that a relationship exists between the grades that students received on this assignment and their perceptions of their writing abilities, the test first divided these sets of scores into the categories of "low," "average," and "high" levels of achievement. To get an approximately-equal number of scores for each level, it used boundary values of 80% and 88%. Thus, we classified students with scores of 80% or less as "low," those students with scores above 80% but less than or equal to 88% as "average," and those students with scores greater than 88% as "high." Then, for each category, it determined the number of students who had classified themselves as "Excellent," "Competent," "Average," or "Poor" writers.

Table 9 provides the results of our classification efforts. If a relationship between "writing ability" and "score on a writing assignment" exists, one would expect "excellent" writers to achieve mostly high scores on their assignments and "poor" writers to achieve mostly low scores. After combining the last two rows of Table 9 (to adjust for the small number of observations in the last row), the test computed a chi square test statistic of $\chi^2 = 0.083$ (with 4 degrees of freedom). This statistical value suggests that there is only an 8% chance that of a relationship between "writing ability" and "self-rating." This finding again supports the claim that most students are unaware of the deficiencies in their writing skills.

Table 9: *Distribution of writing assignment scores and self-ratings of writing ability*

	Low (Below 80.1%)	Average (80.1 to 88.0%)	High (Above 88.0%)
Excellent	2	4	6
Competent	21	25	22
Average	19	10	5
Poor	0	4	1
Totals:	42	43	34

Discussion

This study has focused on two possible explanations of why students are often poor writers. One reason is that they do not think "writing abilities" are important. But the evidence from two questions on our survey overwhelmingly refutes this claim. The data make clear that most students believe their ability to write well will also be important in their future careers, and that poor writing abilities negatively impact the ways others perceive such other characteristics as their intelligence or knowledge.

The other explanation examined here is that students already perceive themselves as decent writers. The survey confirmed this: 135 students (96%) rated themselves as "average" or above, while only 5 students (4%) rated themselves as "poor" writers. But if the students were good writers, they did not prove it on the assessments we used to measure their abilities. The average score on a grammar test was approximately 66%, and the average score on a vocabulary test was even lower at 50%. These were particularly disappointing scores given the high-school level of the questions. The students' best performance was on a simple writing assignment—an average of 82%. A caveat here is that this latter item was a take-home assignment, and there were no controls over outside help. Given their poor performance on the objective tests, it is also easy to wonder if the grading on these assignments was too easy—a potential confounding effect in our study.

Independent of the absolute level of the participants' performance, it is interesting to examine how closely our students' self-ratings tracked their actual writing abilities. Using our three performance measures and standard statistical procedures, we found no relationships. This means that, not only did students perform poorly on most of our assessments, they also seemed to have no realistic idea of their writing abilities as measured by such assessments.

Caveats

A number of considerations limit the findings of this paper. One is the fact that the study was conducted at only one school and with the students in only five (business) classes. Although the findings (e.g., that students have poor grammar and vocabulary skills) parallel earlier studies, we cannot claim that our survey participants or their skills necessarily reflect those of students elsewhere. On the other hand, this was a state school that enforces minimum enrollment requirements, including minimum GPA requirements from high schools. Further, in order to become a business major, a student must first take and pass nine pre-business core courses with a minimum GPA of 2.75. At least within the confines of these requirements, there is little reason for us to believe that the students participating in this experiment are not representative of their peers in other colleges across the country.

Another consideration involves the difficulty in accurately measuring a student's writing ability. Grammar and vocabulary tests are, at best, surrogates for such skills, and perhaps poor ones if the students taking them have no vested interest in the outcome. This might have been a problem here, although there is no evidence for it. To the contrary, for example, the writing samples used in this study were an integral part of the student coursework, and students were therefore motivated to do well.

Did the students do their own work? Again, there is no evidence to suggest that they didn't, and the wide range of scores on the writing assignment suggests that they did (Figure 1). Nonetheless, because this was an out-of-class assignment, there is the possibility that some of the papers were ghost written by others.

It is also possible to argue that the measures of student writing abilities were themselves unreliable, inconsistent, or in some other ways, flawed. This is a possibility, which is one reason three independent assessments were used, rather than just one, to measure them. The grammar and vocabulary tests in this study used carefully chosen questions drawn from independent, expert sources, and that the writing assignment was consistently graded by full-time, professional teachers also.

A related matter is the concern that the writing assignments did not measure "writing ability," even if they were graded professionally. Here, the assignment is best viewed as a writing sample that may not fully represent the abilities of the writers responding to it. It is also possible that the students might have performed better on their writing assignments if more of their final course grades had depended on the outcome, or (say) a hiring decision rested on the quality of their work.

A Suggested Solution

If students are generally unaware of their own writing deficiencies, a natural question to ask is "what to do about it?" Giving (and grading) more writing assignments in traditional business classes is one obvious choice. But the instructors at many schools receive little reward for such assignments and are therefore understandably reluctant to perform the extra work required by such a solution. The fact that nearly half the students in the survey had never received critical appraisals of their writing abilities outside the classroom suggests an alternate solution: peer reviews, in which students provide useful feedback to one another. Such an approach is consistent with the growing use of collaborative learning techniques in the college classroom, and appears to be a fruitful avenue for further research (Tran, Raikundalia & Yang, 2006).

A one-page grading form similar to the one used to assist students in this peer-evaluation endeavor may be useful also. As noted earlier, such an assessment mechanism helps ensure consistency if students grade multiple papers, and also may help a student overcome his or her reluctance to criticize a colleague's work verbally.

Summary and Conclusions

There are many reasons why college-level students often do not possess college-level writing skills. This study investigated two of them: (1) students do not believe that good writing skills will be important to them in their careers, and (2) students perceive that they are already good writers (when in fact they are not). To test these hypotheses, we collected demographic information, self-ratings of writing ability, and three independent writing-skill assessments of 140 students enrolled in various classes at the authors' university.

The evidence from the sample data refutes the argument that students do not believe writing skills are important. All (100%) of the survey participants thought that "writing ability" was likely to be "very important" or "somewhat important" to

their future careers, and 96% of these individuals indicated that their writing abilities were likely to affect the way others perceived their intelligence, knowledge, or other capabilities. Thus, if students are poor writers, it is not because they think "good writing skills" will be unimportant to their careers or to the way others perceive them.

A second objective of this study was to determine how students perceived their own writing abilities. A survey question provided a partial answer to this question. On it, the majority (135 students or 96% of the respondents) rated themselves as "average" or above, while only a tiny minority (5 students or 4% of the respondents) rated themselves as "poor." To determine the extent to which these ratings were accurate, three objective measures of these students' writing abilities—a score on a grammar test, a score on a vocabulary test, and a score on an actual writing assignment were obtained. The average scores on the first two assessments—66% for the grammar test and 50% for the vocabulary test—were disappointing both for their low values and the low skill levels required to answer the underlying test questions. Students did better on their writing assignments, achieving an average score of 82%.

Finally, the study searched for a relationship between the students' ratings of their writing abilities and their performance on these independent measures of these abilities. The statistical analyses found little or no relationship between the students' self-ratings and any of these measures. The simple conclusion is that students are unaware of their own writing deficiencies, and that their perceptions of their writing abilities were inflated.

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R&D Effort, Effectiveness, and Firm Performance in the Pharmaceutical Sector

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Research exploring the impact of R&D on firm outcomes yields mixed results. The paper draws on an integration of the resource-based view, the capabilities perspective, and accumulation theory to highlight the effectiveness of R&D effort in yielding recognized innovative output as a fundamental, yet underemphasized factor in the role of R&D as a contributor to firm performance. Specifically, innovative output is examined as an intervening factor in the relationship between R&D effort and firm performance. Empirical tests on a sample of 303 firms in the pharmaceutical industry reveal that R&D effort yields increasing returns to R&D effectiveness, which suggests that firms can enhance the value of research activities through increased activity. However, the discovery of innovative output as an important mediating factor between R&D effort and firm performance suggests that the benefit of increased R&D may be limited if this effort is not effective in yielding recognized innovative output. These findings are critical since managers in research-intensive industries often base resource allocation decisions on the assumed influence of R&D effort on firm performance.

Research and development (R&D) represents a critical business function for many high- technology firms. Even during economic downturns, many technology firms (e.g. Sun Microsystems, Microsoft, Computer Associates, etc.) continue to invest heavily in research efforts based on the assumption that innovation represents an important factor that influences firm outcomes (Hunter, 2003; Silverman, 2002; Whiting & Ricadela, 2002). However, academic research addressing the organizational impact of R&D only lends partial support for the assumed relationship between R&D and firm outcomes. This research consistently supports a positive relationship between R&D and innovative

output (e.g. Bierly & Chakrabarti, 1996; Graves & Langowitz, 1993; Griliches, 1990; Henderson & Cockburn, 1996). However, conflicting findings have emerged regarding whether R&D yields increasing (Henderson & Cockburn, 1996) or decreasing returns to scale (Graves & Langowitz, 1993). Furthermore, most studies investigating the relationship between R&D efforts and firm performance find mixed results (Lin et al., 2006; Schoenecker & Swanson, 2002), with Hsieh et al. (2003) representing the only exception. While contributing to the understanding of the organizational role of R&D efforts, this paper will reflect the belief that an integration of these two streams of research provides an opportunity to achieve a more fine-grained understanding of the role of R&D effort and to begin to explain the mixed findings present in the literature. Specifically, an integrated consideration of this work motivates the exploration of the effectiveness of R&D effort to yield recognized innovative output as a salient, yet underemphasized, intervening factor in the relationship between R&D and overall firm performance.

To investigate this relationship, this paper draws on the capabilities perspective (Richardson, 1972; Teece, Pisano & Shuen, 1997; Helfat et al., 2007) and the resource-based view (Penrose, 1959; Barney, 1991) as the theoretical foundation. The resource-based view and the capabilities perspective support a focus on R&D effort as an organizational process and a potential contributor to firm performance and competitive advantage. Second, a return to the roots of resource-based thinking and the capabilities perspective highlights the importance of "skillful manipulation," which drew attention to the competence of an organizational process to achieve a given objective. Hence, the term *effectiveness* will be used to denote the ability or competence of R&D effort in achieving the creation of recognized innovative output, and we focus on the effectiveness of R&D effort as an intervening factor that influences the relationship between R&D effort and firm performance will be examined.

By analyzing the relationship among R&D effort, the effectiveness of R&D effort, and firm performance, a number of important contributions will hopefully be made. This work could provide useful insights for both academics and practitioners by providing a more fine-grained understanding of the factors influencing the relationship between R&D effort and firm performance. Secondly, by highlighting R&D effectiveness as another potential isolating mechanism that enables R&D to represent a source of competitive advantage, a greater understanding of R&D may be achieved, and thirdly, by highlighting the importance of process effectiveness as a relevant and intervening factor and offering a greater understanding of the relationship between organizational processes and overall firm performance.

The progression of the discussion proceeds as follows: First, the theoretical foundation that supports our focus on R&D effort as a contributor to competitive advantage, as well as the focus on the effectiveness of R&D in generating recognized innovative output as a key intervening factor will be discussed. Following the theoretical discussion, the hypotheses will be developed, which address the relationships among R&D, innovative output, and firm performance from a resource-based rationale. After the hypothesis development, the empirical methods and results will be presented, followed by a discussion of the results and their implications, and concluding with limitations and avenues for future research.

Theoretical Background

Drawing from a theoretical foundation of the resource-based view (Penrose, 1959; Barney, 1991) and the capabilities perspective (Richardson, 1972; Teece et al., 1997; Helfat et al., 2007), this paper assumes a process-oriented perspective on R&D effort as a potential contributor to competitive advantage. A process-oriented perspective dates back to the seminal work of Penrose (1959) who suggested that the key to firm growth was the skillful manipulation of resources, as opposed to the mere possession of resources. Building on the work on Penrose, Richardson (1972) concentrated on the process-oriented vein of the budding resource-based view and adopted a focus on the distribution and coordination of activities in firms. However, since the work of Richardson (1972), a process orientation emerged within resource-based thinking in the literatures on organizational capabilities (e.g. Teece et al., 1997; Helfat et al., 2007) and the knowledge-based perspective (e.g. Kogut & Zander, 1996; Leonard-Barton, 1992; Loasby, 1999). The process orientation of this work supports the investigation of R&D effort as a potential contributor to firm outcomes.

Also embedded within resource-based thinking is the notion that not all resources are equally endowed in their ability to support a competitive advantage. One of the key underlying assumptions of resource-based thinking is the heterogeneity of resources across firms (Barney, 1991; Hoopes, Madsen & Walker, 2003; Peteraf, 1993), which implies that resources differ. By identifying the characteristics of resources that possess the potential to yield a sustained competitive advantage, Barney (1991) specifically highlighted the idea that all resources are not equally able to create an advantage. The various branches of resource-based thinking also reinforce the idea that all resources do not possess the same ability to yield competitive advantage since knowledge (Grant, 1996; Kogut & Zander, 1996), capabilities (Richardson, 1972), and dynamic capabilities (Teece et al., 1997) each represent a focal set of resources for a group of scholars. Hence, resource-based thinking provides a theoretical foundation for the mixed findings regarding the influence of R&D on firm performance given that not all R&D effort is equal, and supports further inquiry into understanding the factors that enable R&D effort to yield positive performance effects.

In an attempt to further refine our understanding of why or how R&D effort can represent a source of competitive advantage and contribute to enhanced firm performance, insights were also drawn from accumulation theory. The emphasis on organizational processes (or flows) over resources (or stocks) in accumulation theory resonates with the work of Penrose (1959) within the resource-based view. However, the insight of accumulation theory emanates from the idea that the accumulation process represents the isolating mechanism that enables the resources to yield an advantage as a result of asset mass efficiencies, time compression diseconomies, interconnectedness of asset stocks, asset erosion, and causal ambiguity (Dierickx & Cool, 1989). Parallels to this argument are also present in the dynamic capabilities perspective (Teece et al., 1997) in which path dependence and learning through repetition and experimentation play a salient role in the development of organizational capabilities that foster a competitive advantage (Teece et al., 1997). If these insights are correct, then it would be expected to see firms rewarded with strong performance

as a result of the competitive advantage accruing from the continued repetition of key activities. However, empirical results from both R&D research (Lin et al., 2006; Schoenecker & Swanson, 2002; Hsieh et al., 2003) and accumulation theory (Adams & Jaffe, 1996; Knott et al., 2003) suggest that there is more to the story.

Specifically, the empirical studies in accumulation theory show that stocks and flows are both important factors in a firm's production function and have comparable explanatory power (Adams & Jaffe, 1996; Knott, Bryce & Posen, 2003). While these findings are important to the stream of work in accumulation theory because they establish that the accumulation process alone may not convey sustainable advantage (Knott et al., 2003), insight from these findings informs the study of R&D effort by highlighting the potential gained from a consideration of the "stocks" that accrue from the "flow" of R&D effort. Hence, the empirical results from accumulation theory suggest that the effectiveness of R&D effort in creating recognized innovative output represents a relevant factor to consider in exploring the relationship between R&D effort and firm performance.

The insight taken from accumulation theory also resonated with ideas from the roots of resource-based thinking, which emphasized "skillful manipulation" (Penrose, 1959) and suggested that the effectiveness of R&D effort is a relevant factor to consider. Specifically, the focus was on effectiveness of R&D effort in yielding recognized innovative output as an intervening factor that influences the relationship between R&D effort and firm performance. R&D activities are expected to influence firm performance, especially in knowledge-based, research intensive settings, but these activities may not necessarily lead to higher profits if the firm is unable to leverage them into creating innovative output (Yeoh & Roth, 1999). Hence, the ability of R&D effort to produce "applied" innovative outputs is critical in knowledge or research intensive settings. The ability to develop applied innovations enabled these firms to generate revenues, to remain competitive and to exploit opportunities in the market.

A consideration of the effectiveness of R&D effort as an intervening factor in the relationship between R&D effort and firm performance also provides the opportunity to address a salient counterargument from institutional theory. The institutional perspective emphasized the importance of legitimacy; and the connection, approval, or support of the institutional environment (Meyer & Rowan, 1977; Scott & Meyer, 1983). This perspective argued that the relationship between R&D effort and firm performance results from R&D effort representing a signal of firm legitimacy to the institutional environment. For instance, the R&D effort indicated by research expenditures could serve as a signal of the relative likelihood of achieving future scientific breakthroughs to the investment and financial community (Zimmerman & Zeitz, 2002). If the institutional argument predominates, it would be expected that R&D effort and innovative output have separate and independent effects on firm performance, given their roles as signals to the external environment. Hence, the empirical investigation of the effectiveness of R&D effort as an intervening factor in the relationship between R&D effort and firm performance also has the potential to inform the ongoing institutional versus economic debate.

In sum, the effectiveness of R&D effort in generating useful innovative outputs is a salient and influential characteristic of interest for firms operating in research-intensive

settings (Yeoh & Roth, 1999), given the presence of a range in the effectiveness or functionality of R&D effort across firms (Helfat & Peteraf, 2003). For instance, lower effectiveness leads to fewer innovative outputs, which in turn compromises a firm's ability to neutralize threats from competitors or to exploit new product market opportunities (Barney, 1991). Hence, the effectiveness of R&D effort as a variable that refers to the ability of R&D to yield a desired set of innovative outputs is defined, and this variable as an intervening factor in the relationship between R&D effort and firm performance is explored. The investigation of the effectiveness of R&D efforts in producing recognized innovative output as an intervening factor provides the opportunity to extend the discussion of isolating mechanisms within resource-based thinking and accumulation theory, in addition to addressing a potential counterargument from institutional theory.

Hypothesis Development

The existence of multiple factors at work in research and innovation has been documented by other researchers. For instance, successful innovations that enhance firm performance are the result of two processes: research and commercialization decisions (Burgleman & Sayles, 1986). Hence, only examining the direct relationship between R&D effort and firm performance may mask important nuances in the distinct impact of R&D on performance (Ray, Barney & Muhanna, 2004).

First, the relationship between R&D effort and the generation of innovative output for thoroughness is revisted. Generally, there is agreement that increased R&D effort precipitates greater innovative outputs, but the details regarding the specific nature of this relationship are not clear. Prior work finds a positive relationship between R&D and innovative outputs (Graves & Langowitz, 1993; Henderson & Cockburn, 1996). These results echo and support the idea of the innovation funnel, in which increased effort fosters increased output since the ratio of new ideas to new products/processes is on the order of thousands to one (Schilling, 2005).

However, the point of contention is whether R&D efforts exhibit increasing (Henderson & Cockburn, 1996) or decreasing (Graves & Langowitz, 1993) returns. Both of these studies focus on innovative outputs, such as important patent grants and new chemical entities (NCEs) respectively, within the pharmaceutical industry. However, there are a few key differences that shed light on the conflict in these findings. First, there is a difference in the levels of analysis across these two studies. Henderson and Cockburn (1996) focused primarily on research programs, and concluded that larger firms are more productive based on results that revealed spillover effects at this level. Alternatively, Graves and Langowitz (1993) focused on the firm level of analysis. Second, Henderson and Cockburn (1996) did not include a squared term in their models to explicitly examine curvilinear trends, but Graves and Langowitz (1993) did test squared and cubic terms.

The methodological differences across these two studies lead to different, yet still important, conclusions regarding returns to R&D. The increasing returns of Henderson and Cockburn (1996) are increasing returns to size resulting from the spillover effects of multiple programs within a research portfolio. This result suggests

that there are advantages to being involved in multiple concurrent research programs, which is a benefit that accrues at firms with larger research expenditures. On the other hand, the decreasing returns of Graves and Langowitz (1993) relate to the finding that NCEs increase at a decreasing rate as R&D expenditures rise. This finding implies that returns to scale in R&D effort are limited.

However, the insight provided by these two studies does not resolve the question of whether greater R&D effort yields increasing or decreasing returns. In addressing this issue, it is acknowledged that the primary function of R&D is the generation of applied knowledge (Henderson & Cockburn, 1996; Kogut & Zander, 1992). Second, the dynamic capabilities perspective of resource-based thinking is drawn on since this perspective explicitly incorporates the role of learning. The dynamic capabilities perspective (Teece et al., 1997) emphasizes the role and potential of learning as a vehicle for the improvement of organizational processes and their performance. Specifically, organizational learning represents the development of knowledge, insights, and associations between past actions, the effectiveness of past actions, and future actions (Fiol & Lyles, 1985). Hence, an entity learns if any of its units acquire knowledge potentially useful to the organization (Huber, 1991). The increased productivity generated by prior R&D success (Henderson & Cockburn, 1996) represents the embodiment of learning or knowledge within R&D activities and suggests the importance of R&D effort to informing future efforts in a way that increases the likelihood of success. This benefit of learning gained through R&D effort supports the presence of increasing returns to R&D.

However, technological obsolescence, organizational forgetting, and organizational unlearning represent forces that counteract the benefits of learning in the repetition and experimentation within the research process. Particularly relevant in research-intensive, high-technology contexts, technological obsolescence lessens the value of knowledge generated through R&D (Dierickx & Cool, 1989). Furthermore, organizational knowledge is also lost or discarded both accidently and intentionally as a result of organizational forgetting and organizational unlearning. Organizational forgetting highlights the accidental loss of knowledge as a result of degradation, dissipation, or suspension (de Holan & Phillips, 2004) while organizational unlearning highlights the intentional discarding (Tsang & Zahra, 2008) or purging of routines (de Holan & Phillips, 2004).

Since continued research activities are processes that embody learning through repetition and experimentation (Teece et al., 1997), they build the foundation of firm's absorptive capacity (Cohen & Levinthal, 1990) in ways that are cumulative and path-dependent (Kale, 2010; Hoang & Rothaermel, 2010). Since absorptive capacity facilitates future knowledge acquisition as a result of past experience, the gains in absorptive capacity that accrue from ongoing R&D efforts yield benefits that persist even in the presence of forces that dissipate organizational knowledge. Therefore, we hypothesize that increased R&D efforts lead to increasing returns to scale in regards to the yield of recognized innovative output.

Hypothesis 1: Increased R&D effort yields increasing returns to scale in the creation of recognized innovative output.

Next, attention is turned to understanding the impact that both research efforts and research effectiveness have on firm performance. A number of previous studies examined the impact of research activities on firm performance and outcomes (e.g. Deeds, 2001; Deeds, DeCarolis & Coombs, 1997; Hill & Snell, 1989; Yeoh & Roth, 1999). Once again, the findings of these studies were mixed, which suggests that other factors may have influenced this relationship. For example, Hambrick and MacMillan (1985) found that external or contextual factors influenced the innovative efficiency of firms.

Yeoh and Roth (1999) emphasized the importance of innovative output as an intervening outcome in generating greater firm profitability. They argued that R&D efforts do not lead to higher firm performance directly, but rather must be leveraged into intermediate outcomes such as patents, trademarks, licenses and organizational knowledge. Building on Yeoh and Roth (1999), these recognized research outputs actually serve as mediators through which R&D activities act upon firm profits. Since these outputs also serve as indicators of research effectiveness, it is further hypothesized that the effectiveness of R&D efforts, which is indicated through innovative outputs, is a critical determinant of their impact on firm profitability.

The argument that these recognized research outputs are the pathway through which R&D efforts influence firm profits is also supported by accumulation theory (Adams & Jaffe, 1996; Dierickx & Cool, 1989; Knott et al., 2003). As articulated by Dierickx and Cool (1989), many intangible resources (stocks) important to a firm's competitive advantage accumulate as a result of the consistent repetition of certain activities over time (flows). In this context, stocks consist of innovative output while flows consist of R&D efforts. In addition, the stock (i.e. innovative output) reflects the productivity of flows (i.e. R&D efforts), which is also consistent with accumulation theory. While Dierickx and Cool (1989) claimed that the accumulation process represents a key isolating mechanism, later work found that outputs, such as intangible asset stocks (accumulated flows) and inputs, such as R&D efforts (current flows) are both important factors in a firm's production function and have comparable explanatory power with regard to firm performance (Adams & Jaffe, 1996; Knott et al., 2003).

The mixed empirical findings of R&D research and the empirical findings from accumulation theory suggest that intangible assets (a "stock" variable), which reflect the effectiveness of R&D efforts, serve as an intervening factor in the relationship between R&D efforts (a "flow" variable) and firm performance. Hence, drawing from both the resource-based perspective and accumulation theory, we purport that the effectiveness of R&D efforts in creating intangible asset stocks serves as the pathway through which R&D effort impacts firm performance.

Hypothesis 2: The effectiveness of R&D effort in creating stocks of intangible assets mediates the relationship between R&D effort and firm performance.

Methods

Given the focus on R&D effort, the pharmaceutical industry was selected as the setting to empirically test the role of effectiveness in R&D efforts because R&D represents a predominant endeavor for these firms. The pharmaceutical industry

includes a number of industry subsectors including biotechnology, pharmaceuticals, and medicinals/botanicals. However, the critical role of R&D activity represents a common thread across all of the included industries. An entire sector, Pharmaceutical Products (SIC 2833, 2834, 2835 and 2836), was examined instead of a single industry so that the findings could be more easily generalized, and so important differences between industry subgroupings could be identified. This sector includes firms engaged in manufacturing, fabricating or processing medicinal chemicals and pharmaceutical products as well as those involved in the grading, grinding and milling of botanicals (U.S. Census Bureau).

A desire to examine a large international sample of firms motivated the use of the Global Vantage database, which is provided by Standard & Poor's Research Insight (formerly Compustat). Financial statements (income statements, balance sheets, and statements of cash flow information) and product and industry information is available on over 12,000 international firms.

Selecting firms in SIC codes 2833-2836 yielded a total of 496 companies. A total of 193 companies from the sample were eliminated based on the requirement that firms have the following data: intangible assets, goodwill, R&D expenses, employees, sales, total assets, and pre-tax income. The final dataset included a total of 303 firms distributed across SIC codes as illustrated in Table 1. The Global Vantage database provided the firm SIC code classifications.

Table 1: *Distribution of Data Sample by SIC Code*

SIC Code	Description	Observations
2833	Medicinals and Botanicals	18
2834	Pharmaceutical Preparations	187
2835	Diagnostic Substances	34
2836	Biological Products, except Diagnostic	64

Measures

Table 2 summarizes the dependent, independent and control variables.

Dependent variable. Pre-tax Income (PI) represents operating and non-operating income, excluding interest expense and before extraordinary items. This figure was

chosen as the basis for measuring firm performance in order to capture firm profitability without the influence of one-time events such as asset sales. The elimination of non-recurring events provides a measure of performance more clearly linked to continuing firm operations, as opposed to measures that incorporate extraordinary items.

Independent Variables. *Research efforts* were operationalized by using R&D intensity which is *R&D expenditures/number of employees*. Given that patterned and established research activity requires funding for scientists, laboratories, equipment and plant personnel, the level of R&D expenses incurred by a firm represents a good indication of the magnitude of its research activity or effort. Furthermore, R&D expenditures represent a measure that more closely captures the presence and magnitude of the process, as opposed to the outcome of the process (Schoenecker & Swanson, 2002). Since this study is interested in decoupling the existence of firm efforts from their outcomes to investigate intervening factors that influence this relationship, we operationalize research efforts by using R&D expenditures to avoid measures that reflect outcomes of this process.

Research effectiveness was operationalized by using intangible asset intensity which is *intangible assets/number of employees*. Intangible assets reflect valued outcomes of research activities and processes for a number of reasons. First, intangible assets embody the two knowledge-based outputs of research efforts discussed in Pisano (2000): 1) project specific product or process technologies, and 2) broad based technical knowledge regarding general underlying cause and effect relationships. For example, patents, trademarks and licenses embody the results of specific technologies, as well as reflect the potential gain in technical knowledge from engaging in the process of these discoveries.

Second, intangible assets represent a measure that reflects the construct of R&D effort effectiveness. The trademarks, patents, licenses and organizational knowledge measured by intangible assets are relevant and recognized innovative output (Yeoh & Roth, 1999), and can be leveraged to enhance firm performance. In addition, intangible assets are defined as resources controlled by a firm from which future economic benefit is expected (e.g. cash inflows or other assets) (International Accounting Standards Board, 2004).

Third, intangible assets in the pharmaceutical sector are generated primarily by R&D expenditures as opposed to advertising and marketing. Knott et al. (2003) found not only that advertising expenditures are half or less of R&D spending for pharmaceutical firms, but that advertising and R&D intensities were only weakly correlated. Therefore, it is unlikely that these intangible asset measures will be biased by advertising.

Please reference Table 2 on the following page.

Table 2: *Dependent and Independent Variables*

Variable	Description
Dependent	
Pre-tax Income	Net operating and non-operating income, excluding interest expense; is a component of income before extraordinary items
Independent	
R&D Expense	All costs relating to development of new products and services, including amortization of software costs, company sponsored research and development, software expenses; excludes customer or government-sponsored research and development expense
R&D Intensity	R&D Expense / Employees
Intangible Assets	Including patents, trademarks and trade names, copyrights, licenses, organizational expense, design costs, contract rights, operating rights; excludes pending patents, firm development costs and unamortized research and development expense; also excludes goodwill.
Intangible Asset Intensity	Intangible Assets / Employees
Controls	
Employees	All employees of consolidated subsidiaries including part time and seasonal, excluding consultants, contract workers and employees of unconsolidated subsidiaries.
Total Acquisitions	Number of domestic and international firms acquired from 1962 to 2007
Biological Products, Except Diagnostic	Dummy Variable = 1 if SIC code = 2836
Diagnostic Substances	Dummy Variable = 1 if SIC code = 2835
Pharmaceutical Preparations	Dummy Variable = 1 if SIC code =2834
Medicinals and Botanicals	Dummy Variable = 1 if SIC code =2833

Control Variables. Following Helfat (1997), Graves and Langowitz (1993), Yeoh and Roth (1999), for organization size was controlled by using the number of employees in the denominator of our intensity measures (e.g. *R&D/employees* and *intangible assets/employees*). Since R&D expenditures tend to rise linearly with firm size, an R&D intensity variable can effectively control for organization size (Helfat, 1997).

The total *number of domestic* and *international acquisitions* was used from 1962 to 2007 to control for the impact of purchased innovative output on firm performance. Purchased innovative output does not result directly from the R&D efforts of the firm and could produce upwardly biased measures of R&D effectiveness.

Industry dummy variables were used to control for industry effects. The study examined each of the four-digit SIC codes in the sample, which included SIC 2833, 2834, 2835, and 2836. However, none of these industry subsectors were significant as indicated in the baseline models of Table 4 and 5.

Results

Table 3 presents the descriptive statistics and Pearson correlations for key dependent and independent variables. Only five of the fifteen correlations between continuous variables are greater than .50, which indicates that this analysis will not be affected by excessive multicollinearity. The correlations between the four industry dummy variables are technically Phi coefficients, which measure the association between two binary variables and are numerically identical to Pearson correlations (Yule, 1912). Significant negative Phi coefficients indicate that most of the data for these industry dummy pairs lies outside the diagonal cells (Yule, 1912).

Given that all of the measures are derived from financial statements, except for the number of acquisitions, the Harman's single factor test for common method variance (Harman, 1976) was conducted to determine the existence of a natural relationship between these measures beyond what is being explained. In this test, an exploratory factor analysis was performed, and if only one factor with an eigenvalue greater than one was extracted, then this finding supports the presence of such a natural relationship since this single underlying factor explains much of the variation in the data. A Harman's single factor test conducted on this data resulted in the extraction of two orthogonal factors with eigenvalues exceeding one, which does not support the presence of this type of relationship. To investigate the hypotheses, ordinary least squares multiple regression was used given the presence of continuous dependent variables.

Table 3: *Means, Standard Deviations, and Correlations* [a]

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9
1 Pre-tax Income	759.56	6683.70									
2 R&D Expense	277.39	1098.72	.53**								
3 R&D Intensity	135.87	415.53	.69**	.27**							
4 Intangible Assets	433.13	2747.55	.37**	.71**	.18**						
5 Intangible Asset Intensity	105.86	888.1	.91**	.24**	.68**	.31**					
6 Total Acquisitions	4.35	9.2	.12*	.46**	-.08	.34	-.01				
7 Medicinals & Botanicals	.06	.24	-.03	-.06	-.06	-.04	-.03	-.07			
8 Pharmaceutical Preparations	.62	.49	.09	.15*	-.03	.10	.05	-.15**	-.32**		
9 Diagnostic Substances	.11	.32	-.04	-.08	-.02	-.05	-.02	-.08	-.09	-.45*	
10 Biological Products	.21	.41	-.06	-.08	.08	-.05	-.02	-.08	-.13*	-.66**	-.18*

[a] n = 303.

** *Correlation is significant at the 0.01 level (2-tailed)*

* *Correlation is significant at the 0.05 level (2-tailed)*

Table 4 provides the results of regression analyses measuring the impact of research efforts on innovative output as set forth in Hypothesis 1. Models 1 and 2 of Table 4 illustrate the effect of research efforts on research effectiveness in comparison to a baseline model. The total number of acquisitions is not statistically significant in any of the models of Table 4. Model 1 reveals that research effort positively impacts research effectiveness (b=0.69, p<0.005) and Model 2 tests the curvilinear aspects of this relationship. The linear research effort term is negative and significant and the squared research effort term is positive and significant, indicating the presence of an inverted-U relationship. This finding is consistent with the presence of increasing returns, which lends support to Hypothesis 1.

Table 4: Regression Analyses: *The Impact of Research Efforts on Research Outputs* [a]

Variable	Baseline	Model 1	Model 2
R&D Intensity		.69***	-.58***
(R&D Intensity)^2			1.35***
Total Acquisitions	-.02	.04	.01
Pharmaceutical Preparations	.08	-.01	.04
Diagnostic Substances	.01	-.03	.04
Biological Products	.03	-.09	.09
Adjusted R^2	-.01	.47	.70

[a] n = 303. The dependent variable is intangible asset intensity.

* *p<0.05*

** *p<0.01*

*** *p<0.005*

Table 5 provides the results of the models used to investigate the impact of research effort and the results of research effectiveness on firm performance. The total number of acquisitions is significantly and positively associated with the pre-tax income in Models 1, 2 and 3, which indicates that greater numbers of acquisitions are associated with increases in size and profits. In the test of intangible assets as a mediator, the study followed Baron and Kenny (1986), and first estimated Model 1 to examine the relationship between the independent variable (research effort) and the dependent variable (firm performance). Then, Model 2 was estimated to examine the relationship

between the mediator (research effectiveness) and the dependent variable (firm performance). Lastly, Model 3 estimated to test the role of research effectiveness as a mediator between research effort and firm performance as set forth in Hypothesis 2.

The results provided strong support for Hypothesis 2. Both research effort (b=0.72, p<0.005) and effectiveness (b=0.91, p<0.005) had a significant positive relationship with firm performance as shown by Models 1 and 2, respectively. In Model 3, both research effort and effectiveness retained their significance at p<0.005. However, the impact of research effort diminished as indicated by the decrease in the coefficient for research effort from Model 1 (b=0.72) to Model 3 (b=0.16). These results suggest that effectiveness partially mediates the relationship between research efforts and firm performance. To confirm the mediating role of effectiveness, the Aroian version of the "Sobel test," was performed which Baron and Kenny (1986) popularized as the Sobel test. The Sobel test represents a formal test of the indirect effect of the independent variable (research capability) on the dependent variable (firm performance) that is carried via the mediator (effectiveness). The results of this test echo the initial regression results and provide further empirical support for the mediating role of effectiveness (z = 13.88, p <0.001).

Table 5: *Regression Analyses: Impact of Intensity of Research Efforts and Intensity of Research Outputs on Firm Performance* [a]

	Baseline	Model 1	Model 2	Model 3
Research Intensity		.72***		.16***
Intangible Asset Intensity			.91***	.80***
Total Acquisitions	.11	.17***	.13***	.14***
Pharmaceutical Preparations	.06	-.03	-.01	-.02
Diagnostic Substances	-.01	-.05	-.02	-.03
Biological Products	-.01	-.13	-.03	-.06
Adjusted R^2	.01	.52	.84	.86

[a] n = 303. The dependent variable is pre-tax income.

* *p<0.05*

** *p<0.01*

*** *p<0.005*

Discussion and Conclusion

The empirical results revealed an interesting set of relationships between research effort, research effectiveness, and firm performance. First, increases in R&D effort do lead to increases in research effectiveness and at an increasing rate. The coefficient of the squared term was positive and significant. The finding of increasing returns supported the findings of Henderson and Cockburn (1996) and indicated that R&D efforts have an increasingly positive impact on the absorptive capacity of the firm.

Secondly, it was found that effectiveness mediates the relationship between research efforts and firm performance. While the existence of research efforts alone has a small positive effect on firm performance – which suggests a possible signaling effect – the effectiveness of those efforts in yielding innovative output has a stronger impact. These results support the idea that recognized research outputs such as intangible assets are an important factor in the value creation of research activities (Pike, Roos & Marr, 2005) since effectiveness acts as a conduit that carries the positive influence of research efforts to firm performance.

A learning perspective also suggests that the difference between effective and ineffective research efforts lies in the relevance of the knowledge they embody. The presence of recognized research outcomes with future economic or commercial viability suggests that the knowledge embodied in the firm's research capabilities fosters the creation of innovative outputs that can potentially enhance performance. On the other hand, ineffective research efforts appear to be less likely to embody the knowledge necessary to produce useful innovative outputs (Yeoh & Roth, 1999).

Advancing understanding of the relationship between research efforts and firm performance represented the overall aim of this study. The discovery of effectiveness as an important intervening factor in the relationship between R&D activities and firm performance is a critical finding since managers in research-intensive industries base many strategic resource allocation decisions on the assumed influence of R&D on firm performance. Specifically, the findings suggested that the benefit of increased R&D may be lessened if these processes do not embody knowledge relevant to the creation of recognized research outcomes. This not only provides a more encouraging picture for the pharmaceutical industry than that painted by Graves and Langowitz (1993), but also establishes R&D effectiveness in creating the desired research outcomes as key to obtaining the benefits of scale from acquisition activity.

Overall, the empirical results implied that research effectiveness represents a neglected factor that contributes to the lack of consensus in previous work investigating the relationship between R&D and firm performance. Furthermore, the presence of any significant impact of effectiveness, such as in the results presented here, supports the importance of considering this factor in studies of research and development efforts.

In addition to attempting to integrate and resolve the mixed findings of previous work in this area and to evaluate the impact of expanding the study of research outputs beyond patents, this study provided a number of important implications. First, research effectiveness is a positive function of effort. The finding of increasing returns to research activity highlights the importance of learning in the exercise of research efforts. Research activities embody learning through the repetition and

experimentation involved in the research process (Teece et al., 1997), which enables continued research activity to enhance the absorptive capacity of the firm (Cohen & Levinthal, 1990) at an increasing rate.

Second, since the results revealed increasing returns, they demonstrated that effectiveness or functionality is not fixed in research efforts, but rather improves with the exercise of those efforts. This suggests that continued usage of and investment in research efforts enables firms to obtain the most value from their efforts by improving effectiveness. Since highly utilized activities generate more value than those that are not employed with the same intensity and consistency, firms have an avenue for enhancing the value of their efforts.

Thirdly, in a research context, the most valuable elements of research activities appear to be those that yield economically useful outcomes. While the economic impact on firm performance is quite powerful, we found that the presence of research activity also enhances firm performance to a lesser degree, which suggests that research expenditures may also have a signaling function that enhances firm legitimacy. This implied that the value of research efforts can be multi-dimensional, and that it is critical for managers to understand the relative importance of each dimension.

Limitations and Future Research

The authors' hope is that this work encourages conversation and additional research regarding the impact of research effectiveness. However, an important limitation of this study was its focus on a single sector of research or knowledge intensive firms. This raises the possibility that our findings apply only to the pharmaceutical sector and may not be as applicable to other research settings. Nevertheless, several potentially fruitful avenues of investigation to pursue can be seen.

First, additional research could explore the generalizability of these results by using alternative measures or samples. For example, the results of this study could be confirmed and augmented with investigations that employ alternative measures of research effectiveness, such as counts of patents, patent citations, or new product developments. Also, similar questions could be explored across different industry contexts.

Second, future work could investigate the impact of lagged effects on research efforts and effectiveness on firm performance. Convention in R&D productivity research compares R&D expenditure and accumulated R&D stocks from the same year (Griliches, 1984). Recent empirical findings also support the use of R&D expenditure and R&D outcomes from the same year since intangible asset stocks and flows have similar explanatory power even in industries such as pharmaceuticals, where extended periods of time exist between research activity and recognized research outcomes or commercial success (Knott et al., 2003). Despite the methodology of convention and recent empirical work, the use of lagged variables could explore the presence and role of learning over time and the impact of temporal dimensions of research flows and stocks on effectiveness and firm performance.

Another interesting avenue for further investigation would be to explore the relative importance of economic and signaling effects of research efforts across different industry contexts. In particular, the concurrent and explicit empirical investigation

of economic and institutional variables has the potential to provide more definitive conclusions regarding the relative influence of these two sets of factors. Investigations of this nature could provide an interesting test of the relative importance of economic and institutional factors on firm performance, as well as providing some insight regarding the contextual influences determining the salience of one perspective over the other.

Lastly, future research could further integrate the results of this study and other investigations by exploring additional factors influencing the relationship between research activities, innovation, and firm performance. A fruitful avenue of investigation that builds off of this study and its predecessors would examine a broader scope of intervening factors in the relationship between research activities and firm performance. Prior research has explored internal factors such as the availability of slack resources and performance aspirations (Greve, 2003), and has discussed the contingent impact of process management on innovation (Benner & Tushman, 2003). On the other hand, investigators have also examined external factors such as technological opportunity and market position (Hambrick & MacMillan, 1985). Studies encompassing factors from both the internal and external situation of the firm represent a logical next step in continuing to advance our understanding of the link between research activities and firm performance.

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