We will begin momentarily...

Improving Success In Collaborative R&D
By Selecting an Optimal Alliance Governance Structure and Partner Type

This paper extends the study of alliance governance structure design by examining what alliance structure, coordination mechanisms and partner type best promote the likelihood of Research and Development (R&D) success or performance.

Jeongho Choi, Ph.D.
St. John Fisher College

Farok Contractor, Ph.D.
Rutgers Business School

For more information, visit business.rutgers.edu/lerner
Improving Success in Collaborative R&D by Selecting an Optimal Alliance Governance Structure and Partner Type

Jeongho Choi
Farok J. Contractor

Campbell Pharmaceutical Seminar
10/26/2016
Contents

1. Research Background
   - General Trend: Alliances in Biopharmaceuticals

2. Introduction

3. Theory and Hypothesis Development

4. Methods

5. Results

6. Conclusion (Implications)
1. Research Background

*Why Pharmaceutical R&D is increasingly in alliances:*

- Sources of knowledge more widely scattered
  - Over firms
  - Across nations
- Different Scientific disciplines (e.g., Genomics, Physiology, Biochemistry, etc.)
- Different therapeutic areas (e.g., Oncology, Gastroenterology, Hematology, Immunology, Nephrology, Neurology, etc.)
- No single firm encompasses all fields
- Most pharmaceutical R&D does not result in commercialization
- Big-pharma business is risky (like buying lottery tickets)
- “Big Pharma” often has “dry pipelines” relying only on in-house research
- Hence R&D alliances with nimble biotech partners.
- No longer enough to categorize alliances as
  - Equity vs. Non-equity
- Need to go beyond the superficial classifications
1. Research Background

- The Protracted and Fragmented Nature of Bio-Pharmaceutical Research Alliances

**FIGURE 1:** An Illustration of R&D alliances (Vertex Pharmaceuticals)

Excerpted from the 10-K report of Vertex Pharmaceuticals Inc. (2007): “We have limited experience in conducting and managing the late-stage clinical trials necessary to obtain regulatory approvals, including approval by the FDA.”
1. Research Background

- The Protracted and Fragmented Nature of Bio-Pharmaceutical Research Alliances (cont’d)

**FIGURE 2:** An example of hypothesis-based clinical trial
1. Research Background

- Multiple Elements in Alliance Agreements

Recap Data: Pharmaceutical alliances 2000 ~ 2003

Loan (Lo): 1.1%; Licensing (L): 29.9%; Equity Joint Venture (EJV): 10.3%; Equity (E): 3.9%; Asset Purchasing (AP): 2.1%; Joint-Development (JD): 0.4%; Joint Research (JR): 4.6%; Cross-Licensing (CrL): 1.1%; Commercialization (Com): 1.8%; Distribution (Dist): 1.4%; Contract Development (CD): 1.8%; Contract Research (CR): 0.7%; Mixed modes (Mixed): 40.9%
2. Introduction

- R&D alliances with diverse partners (e.g., universities, research institutes, contract research organizations and biotech-pharma) at any stages in R&D are very common.

- Alliance contracts have become more complex

- Focus more on alliance details and structure to coordinate multiple tasks with a partner

- Using detailed contract provisions, allies
  - Govern inter-partner collaboration
  - Stipulate responsibilities and roles
  - Have options to flexibly respond to emerging contingencies

- An effective level of integration promotes inter-partner interaction and knowledge-sharing activity (Hoetker & Mellewigt, 2009)
2. Introduction

**Key Questions for Alliance Negotiators**

- What is the optimal degree of interaction between the allies?
  - How “Tight an Embrace” between the partners?
  - How complex or detailed should the agreement be?
  - How much **partner interaction** should be specified in negotiating the agreement?

- No longer enough to categorize alliances as
  - Equity vs. Non-equity
- Need to go beyond this bi-modal classification
- Because there is an entire range or spectrum of governance or inter-partner interaction alternatives:
2. Introduction

- Need to examine the actual structure of the alliance and details of inter-partner interactions
- All alliances (including EJVs) these days have a long agreement that specifies details such as
  - CONTRIBUTIONS
    - IP
    - Personnel
    - Finance and other assets
  - RIGHTS
    - Fruits of R&D (How split or shared?)
    - Patents
    - Territory
    - Product Scope
  - SAFEGUARDS
    - Monitoring
    - Joint governance (Joint Steering Committee) / participation
    - Veto powers
Determinants of R&D alliance governance mode choice

**Dependent Variable**
Rising Level of Overall Interaction Between the Partners

**Independent Variables**

1) Differences Between Home Countries of Allies
   - **Human Capital**
   - **Rule of Law**
   - **Power Distance**
   - **Long Term Orientation**
   - **Geographical Distance**

2) Technical and Product Differences Between Partners
   - **R&D Intensity**
   - **Industry technical Specialization**
   - **Product Scope Differences**
Using the new governance mode classification as dependent variable, we examine the following model:

- **National**
  - Quality of Human Capital
  - Rule-of-law
  - Power Distance
  - Long-term orientation
  - Geographic Distance

- **Industry**
  - Industry R&D Intensity
  - Industry Tech. Specialization

- **Firm**
  - Product Scope Difference

- **Alliance Governance Modes**
  1. Low Integration
  2. Moderately-integrated
  3. High Integration
  4. EJVs

- **Moderating Effect**
  - R vs. D

Using a data from the biopharmaceuticals (US SIC: 2833~2836) during 2000~2003, we performed an Ordinal Logistic Regression.
## Hypotheses

<table>
<thead>
<tr>
<th>TABLE 1: HYPOTHESIS</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1</strong> The greater the difference in <em>the quality of human capital</em> of the home nations of the allies, the lower the likelihood of using a more integrated alliance mode. Moreover, this negative relationship will be even stronger when the R&amp;D is in the <em>development</em> phase rather than the research phase.</td>
<td>Partial Support</td>
</tr>
<tr>
<td><strong>H2</strong> As the difference between the nations of the allies increases, in terms of <em>institutional factors such as the rule of law</em>, there will be a greater likelihood of using a more integrated alliance mode. And this positive relationship will be even stronger when the R&amp;D is in the <em>development</em> phase rather than the research phase.</td>
<td>Supported</td>
</tr>
<tr>
<td><strong>H3A</strong> As <em>cultural difference in power distance</em> between partnering firms increases, the likelihood of using a more-integrated alliance mode will decrease. Moreover, this negative relationship will be stronger for R&amp;D in the <em>development</em> phase rather than in the research phase.</td>
<td>Supported</td>
</tr>
<tr>
<td><strong>H3B</strong> As <em>cultural difference in long-term orientation</em> between partnering firms increases, the likelihood of using a more-integrated alliance mode will decrease. Moreover, this negative relationship will be stronger for R&amp;D in the <em>development</em> phase rather than in the research phase.</td>
<td>Partial Support</td>
</tr>
</tbody>
</table>
### Hypotheses (cont’d)

<table>
<thead>
<tr>
<th>TABLE 1: HYPOTHESIS (cont’d)</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H4</strong></td>
<td>As <strong>geographic distance</strong> between partner firms increases, the likelihood of using a more-integrated alliance mode is increased. And this positive relationship will be stronger for R&amp;D in the <strong>research</strong> phase rather than in the development phase.</td>
</tr>
<tr>
<td><strong>H5A</strong></td>
<td>As the gap between allies in <strong>Industrial R&amp;D intensity</strong> increases, the likelihood of using a more-integrated alliance mode will decrease. And this negative relationship will be stronger for joint work in the <strong>development</strong> phase rather than in the research phase.</td>
</tr>
<tr>
<td><strong>H5B</strong></td>
<td>As the gap between allies in <strong>Industrial technology specialization</strong> increases, the likelihood of using a more-integrated alliance mode will decrease. And this negative relationship will be stronger for joint work in the <strong>development</strong> phase rather than in the research phase.</td>
</tr>
<tr>
<td><strong>H6</strong></td>
<td>As the <strong>Product scope or Sub-sectoral Difference</strong> between allies increases, the likelihood of using a more-integrated alliance mode will decrease. And this negative relationship will be stronger in the <strong>development</strong> phase than in the research phase.</td>
</tr>
</tbody>
</table>
Method

- Data and Sample
  - Current Agreement Database
  - All Alliances announced in between 2000 and 2003 in the Pharmaceutical industry (US SIC: 2833 ~ 2836)
  - Sample: 237 alliances

- Variables
  (1) Dependent Variables: Degree of Overall Integration (or Alliance Governance Modes)
  Low-Integration “1” < Moderately-Integrated “2” < High-Integration “3” < EJV “4”

Ranking Ordered: Ordinal Logistic Regression

Difference measurement formula: \[
\sum_{i=1}^{4} \frac{(\text{Index}_{iX} - \text{Index}_{iY})^2}{V_i} / 4
\]
## Results

- **Ordinal Logistic Regression (full sample 237 used)**

<table>
<thead>
<tr>
<th>Variables for hypotheses</th>
<th>Model 1: Controls (Sample A)</th>
<th>Model 2: Country-factors (Sample A)</th>
<th>Model 3: Industry-factors (Sample A)</th>
<th>Model 4: Firm-factor (Sample A)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AGE Difference</strong></td>
<td>0.373 (.031)</td>
<td>0.036 (.032)</td>
<td>0.031 (.032)</td>
<td>0.032 (.032)</td>
</tr>
<tr>
<td><strong>SIZE Difference</strong></td>
<td>0.017 (.028)</td>
<td>0.025 (.029)</td>
<td>0.012 (.033)</td>
<td>0.008 (.030)</td>
</tr>
<tr>
<td><strong>Alliance Experience</strong></td>
<td>-0.376 (.396)</td>
<td>-0.380 (.343)</td>
<td>-0.351 (.354)</td>
<td>-0.355 (.356)</td>
</tr>
<tr>
<td><strong>Research Institute</strong></td>
<td>-0.504 (.438)</td>
<td>-0.591 (.556)</td>
<td>-0.448 (.543)</td>
<td>-0.392 (.554)</td>
</tr>
<tr>
<td><strong>Quality of Human Capital (H1)</strong></td>
<td>-0.062 (.037)*</td>
<td>-0.068 (.041)*</td>
<td>-0.066 (.042)*</td>
<td>-0.066 (.042)*</td>
</tr>
<tr>
<td><strong>Rule-of-Law (H2)</strong></td>
<td>0.399 (.262)*</td>
<td>0.111 (.256)</td>
<td>0.108 (.258)</td>
<td>0.108 (.258)</td>
</tr>
<tr>
<td><strong>Power Distance (H3A)</strong></td>
<td>-0.560 (.300)**</td>
<td>-0.484 (.277)*</td>
<td>-0.487 (.278)*</td>
<td>-0.487 (.278)*</td>
</tr>
<tr>
<td><strong>Long-Term Orientation (H3B)</strong></td>
<td>-0.238 (.118)**</td>
<td>-0.149 (.124)</td>
<td>-0.149 (.123)</td>
<td>-0.149 (.123)</td>
</tr>
<tr>
<td><strong>Geographic Distance (H4)</strong></td>
<td>0.002 (.000)**</td>
<td>0.001 (.000)**</td>
<td>0.001 (.000)**</td>
<td>0.001 (.000)**</td>
</tr>
<tr>
<td><strong>Industrial R&amp;D intensity (H5A)</strong></td>
<td>0.078 (.062)</td>
<td>0.076 (.062)</td>
<td>0.076 (.062)</td>
<td>0.076 (.062)</td>
</tr>
<tr>
<td><strong>Industrial Technology Specialization (H5B)</strong></td>
<td>0.299 (.213)</td>
<td>0.296 (.211)</td>
<td>0.296 (.211)</td>
<td>0.296 (.211)</td>
</tr>
<tr>
<td><strong>Product Scope Difference (H6)</strong></td>
<td>-0.976 (.874)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>-2 Log likelihood</strong></td>
<td>511.121</td>
<td>500.656</td>
<td>498.021</td>
<td>497.025</td>
</tr>
<tr>
<td><strong>Chi-square</strong></td>
<td>31.98***</td>
<td>46.27***</td>
<td>48.91***</td>
<td>49.91***</td>
</tr>
<tr>
<td><strong>Cox and Snell R-square</strong></td>
<td>0.126</td>
<td>0.177</td>
<td>0.186</td>
<td>0.190</td>
</tr>
<tr>
<td><strong>Number of observations</strong></td>
<td>237</td>
<td>237</td>
<td>237</td>
<td>237</td>
</tr>
</tbody>
</table>
### Results (cont’d)

- **Ordinal Logistic Regression**
  (with samples in Research “B” and samples in Development “C”)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 5 (Sample B)</th>
<th>Model 6 (Sample C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE Difference</td>
<td>0.018 (.035)</td>
<td>0.274 (.115)**</td>
</tr>
<tr>
<td>SIZE Difference</td>
<td>0.040 (.031)</td>
<td>-0.025 (.058)</td>
</tr>
<tr>
<td>Alliance Experience</td>
<td>-0.442 (.412)</td>
<td>-0.374 (.561)</td>
</tr>
<tr>
<td>University</td>
<td>-2.974 (.837)**</td>
<td>-16.991 (1.28)</td>
</tr>
<tr>
<td>Research Institute</td>
<td>-0.574 (.602)</td>
<td>0.686 (.100)</td>
</tr>
<tr>
<td>Quality of Human Capital (H1)</td>
<td>-0.071 (.041)*</td>
<td>-0.068 (.151)</td>
</tr>
<tr>
<td>Rule-of-Law (H2)</td>
<td>-0.330 (.338)</td>
<td>3.134 (1.488)**</td>
</tr>
<tr>
<td>Power Distance (H3A)</td>
<td>-0.491 (.292)</td>
<td>-1.373 (.673)**</td>
</tr>
<tr>
<td>Long-Term Orientation (H3B)</td>
<td>-0.058 (.195)</td>
<td>-0.232 (.241)</td>
</tr>
<tr>
<td>Geographic Distance (H4)</td>
<td>0.001 (.000)**</td>
<td>-0.000 (.000)</td>
</tr>
<tr>
<td>Industrial R&amp;D intensity (H5A)</td>
<td>0.024 (.081)</td>
<td>0.024 (.145)</td>
</tr>
<tr>
<td>Industrial Technology Specialization (H5B)</td>
<td>0.652 (.275)</td>
<td>-1.372 (.561)**</td>
</tr>
<tr>
<td>Product Scope Difference (H6)</td>
<td>0.175 (1.032)</td>
<td>-3.206 (1.718)*</td>
</tr>
<tr>
<td>-2 Log likelihood</td>
<td>320.894</td>
<td>151.679</td>
</tr>
<tr>
<td>Chi-square</td>
<td>43.39***</td>
<td>21.83**</td>
</tr>
<tr>
<td>Cox and Snell R-square</td>
<td>0.224</td>
<td>0.250</td>
</tr>
<tr>
<td>Number of observations</td>
<td>161</td>
<td>76</td>
</tr>
</tbody>
</table>
Findings

(1) The likelihood of using a more-integrated alliance mode decreases as the difference between nations of alliance partner firms increases in terms of human capital and cultural distance.

(2) Greater geographic and institutional environment (e.g., rule-of-law) difference is positively related with the choice of more-integrated alliance governance modes (followed by KBV and TCE perspectives).

(3) But firms in research stage (rather than development) are more likely to choose a more-integrated alliance mode when there is greater geographic distance.

(4) And firms in development stage are more likely to use less-integrated modes when they face greater cultural, industrial and technological base difference.
Conclusions

(1) Negotiators designing alliance agreements need to think about “how tight an embrace” they wish to have between the partners.

(2) This research has provided an approach to thinking about this issue in two dimensions

- Degrees/Directionality of interactions between the allies (no-way; one-way and two-way)
- Number of deal elements and length of agreement

(3) The overall degree of desirable integration between partners depends on

- Country differences between partners
- Industry technological specialization
- Product scope or sub-sectoral differences
Overall Question

How does the success (or “performance”) of a biopharmaceutical R&D project depend on the design of the alliance agreement
2. Introduction

- **Negative Aspects** of detailed (complex) contract and increased inter-partner interaction for complex (multi-task) alliances

  However, greater frequency of interaction and complex coordination in contractual alliances, or culminating in a hierarchical structure (e.g., EJV) can
  - Increase **bureaucratic costs**
  - Increase **information processing costs**
  - Increase the **initial investment**

**Objective:** What alliance governance structure helps balance the benefits and costs side of interaction and coordination, and then best promotes the likelihood of successful R&D performance?
2. Introduction

- **Optimal communication and coordination** positively affects alliance performance
  
  *(Gulati and Singh, 1998; Poppo and Zenger, 2002)*

- **Moderating effects of Partner Diversity**
  
  (i) Organizational Diversity (Universities, research institutes or contract research organizations vs. firms)
  
  (ii) Technological Base Diversity between alliance partners
3. Theory & Hypotheses

- **Hypothesis**
  
  (1) *R&D alliance structure and performance (a base model)*

- Increasing interaction and more detailed contracts enhance tacit knowledge transfer and promote common understanding of technology.

- But too much detail, joint tasks, and bureaucracy - beyond an optimal level - can increase information-processing costs and technology appropriation difficulties.

**H1:** The likelihood of successful R&D alliance performance will be highest for those R&D alliances adopting a governance mode with a moderate or intermediate degree of overall communication and coordination.
3. Theory & Hypotheses

- **Hypothesis**

  (2) *Moderating Effects of Partner Diversity*

  - Greater **Organizational Diversity** (universities, research institutes or contract research organizations vs. Others)

    - Opportunism/ Uncertainty and Unintended knowledge spillover greatly REDUCED
    - Tend not to directly compete
    - Pool diverse knowledge sources for innovation

**H2:** *Organizational diversity in R&D alliances (e.g., those with a university, (non-profit) research institute or CRO) positively moderates the curvilinear relationship between the successful alliance performance and the overall degree of coordination and communication in a given R&D alliance mode*
3. Theory & Hypotheses

- Hypothesis

(2) Moderating Effects (cont’d)

- Technological Base Diversity: Partners with distinct/idiosyncratic technologies can promote R&D performance

- Similar domains of technology: Miscommunication, information-processing costs can be reduced. But there will be a weak synergetic effect

- Too much unique/idiosyncratic technology: Not automatically complement

H3: The earlier posited curvilinear relationship between the alliance performance and the overall degree of coordination and communication in a given R&D alliance mode will be positively moderated by a moderate degree of technological base diversity between allies.
4. Methods

- **Sample and Data**
  - Alliances announced in between 2000 and 2004 in the Biopharmaceutical industry (US SIC: 2833 ~ 2836)
  - Sample: 269 (initially 357) alliances
  - Current Agreement Database

- **Dependent Variable**
  - *Successful R&D Alliance Performance*: measures whether a particular phase of R&D was followed by a decision to proceed to the next stage (i.e., “Success” coded as ‘1’ and otherwise as ‘0’)

  - Binary Logistic Regression analysis
4. Methods

- **Dependent Variable (cont’d)**

**Pharmaceutical R&D Process and Four Decision Points**

<table>
<thead>
<tr>
<th>R&amp;D PROCESS</th>
<th>Research</th>
<th>Development</th>
<th>FDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-discovery</td>
<td>Target Identification</td>
<td>Phase I</td>
<td>FDA Approval</td>
</tr>
<tr>
<td>Target Validation</td>
<td>Target Validation</td>
<td>Phase II</td>
<td></td>
</tr>
<tr>
<td>Drug Discovery</td>
<td>Drug Discovery</td>
<td>Phase III</td>
<td></td>
</tr>
<tr>
<td>Early Safety Test</td>
<td>Lead Optimization</td>
<td>Preclinical Testing</td>
<td></td>
</tr>
</tbody>
</table>

3 - 6 Years

- 6 - 7 Years
- 0.5 - 2 Years

**Four Decision Points:** Whether to Terminate or Continue to Next Phase

- Investigational new drug application
- Application to FDA Seeking Approval
4. Methods

- **Main Independent Variables**

  ‘The Overall Degree of Communication and Coordination’ (ODCC) in
  a given alliance:

  *Four Part Classification Based on Discriminant Analysis*

  Low integration (1), Moderately integrated (2), High integration (3),
  and Equity Joint Ventures (4)

- **Independent Variables (cont’d)**

  - **Organizational Diversity:** Alliances with (non-profit) Universities, Research
    Institutes or Contract Research Organizations ‘1’ and ‘0’ for otherwise

  - **Technology Base Diversity:** Number of commercialized drugs in specific
    therapeutic classes (USC 3- Uniform System of Classification by IMS Health)

  \[
  \text{Technological Base Diversity} = 1 - \frac{T_iT_j'}{\sqrt{(T_iT_i')(T_jT_j')}}
  \]
Typical Deal Components in Agreements

Contractual Provisions / Ingredients

I. Asset Purchase (AP)
II. Contract Development (CD)
III. Contract Research (CR)
IV. Cross-Licensing (CrL)
V. Passive Equity Purchase (E)
VI. Joint Development (JD)
VII. Joint Research (JR)
VIII. License (L)
IX. Loan (Lo)
X. Manufacturing (M)
XI. Supply(S)

Equity Investment

XII. Active Equity Purchase
    Equity Joint Venture (EJV)

Coding Each Agreement for its Content

- Coding – leads to Inductive reasoning -- to hypotheses – to econometric testing
## Identifying and Classifying Alliance Governance Modes

### 2 Dimensions:

1. **Degree of inter-partner task Interaction** (Thompson, 1967; Contractor, 1984; Steensma, 1996; Narula and Duysters, 2004; Kuittinen et al., 2009):
   - Workflows; No-way = 1, One-way = 2 and Two-way = 3
   - The sum of workflows of alliance deal components

<table>
<thead>
<tr>
<th>Agreement Elements and Degrees of interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alliance Type</td>
</tr>
<tr>
<td>Asset Purchasing, Loan and Equity</td>
</tr>
<tr>
<td>License, Contract Research, Contract Development, Manf. and Supply</td>
</tr>
<tr>
<td>Cross-License, Joint Research and Joint Development</td>
</tr>
</tbody>
</table>

2. **Degree of Contract Complexity:**
   - The number of deal elements (e.g., licensing + Joint Research + Joint Development)
   - The number of pages of alliance agreement (Hagedoorn and Hesen, 2009)
   - The Size of contract file (html format size such as kbyte)
Classifying Alliance Governance Modes (cont’d)

- An example of alliance governance mode classification
- Cross-license + Joint Research
- Degree of Interaction: 3+3 = 6
- Degree of Complexity: 105 pages/ size of contract file (KB)
A New Classification of (non-equity) Alliance Governance Mode

- A Two-Way Classification of Alliances

A New Continuum of Alliance Governance Mode
4. Methods

- **Controls**
  - *Firm size* (Number of employee) and *Age* gap between alliance partners
  - *Cultural Difference*: Hofstede’s 5 Cultural Index
  - *Prior Alliance Experience*: with the same partners
  - *Absorptive Capacity*: Accumulated number of patents from the year established to the year alliance formed (based on 24 patent classes)
  - *A Priori R&D Uncertainty*: Technical difficulties in R&D process

  Drug discovery (6/5,000 to 10,000); Phase I (64%); Phase II (39%) and Phase III trial (66%).
5. Results

- Findings (TABLE 1: Logistic Regression with Consolidated ODCC Measurement)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Overall Degree of Communication and Coordination Consolidated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>Age</td>
<td>0.064 (.04)*</td>
</tr>
<tr>
<td>Size</td>
<td>0.015 (.03)</td>
</tr>
<tr>
<td>Alliance Experience</td>
<td>0.689 (.51)</td>
</tr>
<tr>
<td>R&amp;D Uncertainty</td>
<td>-0.181 (.14)</td>
</tr>
<tr>
<td>Absorptive Capacity</td>
<td>-0.012 (.06)</td>
</tr>
<tr>
<td>Cultural Difference</td>
<td>0.035 (.13)</td>
</tr>
<tr>
<td>Inverse Mills Ratio</td>
<td>1.204 (1.10)</td>
</tr>
</tbody>
</table>

- **H1**: ODCC in a Given Alliance
- **H2**: Organizational Diversity
- **H3**: ODCC * Technical Base Diversity

<table>
<thead>
<tr>
<th></th>
<th>Included</th>
<th>Included</th>
<th>Included</th>
<th>Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2 Log Likelihood</td>
<td>332.42</td>
<td>325.88</td>
<td>321.105</td>
<td>318.31</td>
</tr>
<tr>
<td>Chi²</td>
<td>24.62***</td>
<td>31.16***</td>
<td>35.94***</td>
<td>38.23***</td>
</tr>
<tr>
<td>NagelKerke R²</td>
<td>0.11</td>
<td>0.15</td>
<td>0.18</td>
<td>0.18</td>
</tr>
<tr>
<td>N</td>
<td>269</td>
<td>269</td>
<td>269</td>
<td>269</td>
</tr>
</tbody>
</table>

Robust standard errors are in parentheses
*P < .10; **P < .05; ***P < .01
5. Results

- Findings (cont’d)

A Moderating Effect of Organizational Diversity
6. Conclusions

(1) Probability of successful R&D performance depends on the overall degree of coordination and communication; *a moderate degree* of ODCC contributes to better R&D performance. (Inverted-U-Shaped with the optimum closer to the left hand side)

(2) A more integrated alliance structure and detailed language facilitates needed interdependency/interaction for R&D – but only up to a point.

(3) However, interaction and contract complexity beyond an optimal level negatively affects R&D outcomes / performance
   - Bureaucratic Costs (dispute, re-negotiation and bargaining costs)
   - Liabilities of Contractual Exchange

(4) Allying with Research Institutes, Universities and CROs a firm can enhance R&D performance, because of
   - Reduced opportunism
   - Idiosyncratic resources (e.g., knowledge/technologies)
6. Conclusions

(5) When allying with a partner with a dis-similar organizational milieu (Universities, CROs, etc) it is desirable to write somewhat more complex agreements with greater ODCC.

(6) As seen in the Figure, partnering with dis-similar organizations
   • Raises the likelihood of a successful R&D outcome, but also
   • Pushes the optimal point further to the right
(7) The measure of R&D success in this paper is not based on unreliable criteria such as
• Company-wide indicators such as No. of R&D programs, or
• Surveys of R&D satisfaction

(8) Rather, here it is project-specific and based on an unambiguous criterion – whether to spend millions to continue the research to the next phase, OR NOT.
THANKS FOR YOUR ATTENTION

Now let’s hear from you
BLANK SLIDE
### APPENDIX

- Robustness Test (TABLE A-1: Logistic Regression with separated ODCC measurements)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Overall Degree of Communication and Coordination Separated</th>
<th>Task Interaction (Communication)</th>
<th>Contractual Complexity (Coordination)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 5</td>
<td>Model 6</td>
<td>Model 7</td>
</tr>
<tr>
<td>Age</td>
<td>0.052 (.04)</td>
<td>0.040 (.04)</td>
<td>0.064 (.04)</td>
</tr>
<tr>
<td>Size</td>
<td>0.010 (.03)</td>
<td>0.016 (.03)</td>
<td>0.003 (.03)</td>
</tr>
<tr>
<td>Alliance Experience</td>
<td>0.563 (.51)</td>
<td>0.475 (.57)</td>
<td>0.628 (.51)</td>
</tr>
<tr>
<td>R&amp;D Uncertainty</td>
<td>-0.169 (.14)</td>
<td>-0.201 (.14)</td>
<td>-0.159 (.14)</td>
</tr>
<tr>
<td>Absorptive Capacity</td>
<td>-0.014 (.01)</td>
<td>-0.035 (.02)*</td>
<td>-0.009 (.01)</td>
</tr>
<tr>
<td>Cultural Difference</td>
<td>0.066 (.14)</td>
<td>0.074 (.13)</td>
<td>0.061 (.13)</td>
</tr>
<tr>
<td>Inverse Mills Ratio</td>
<td>2.010 (1.29)</td>
<td>5.750 (3.75)</td>
<td>1.452 (1.27)</td>
</tr>
<tr>
<td>Task Interaction</td>
<td>0.377 (.16)**</td>
<td>0.378 (.17)**</td>
<td></td>
</tr>
<tr>
<td>Task Interaction^2</td>
<td>-0.026 (.01)**</td>
<td>-0.027 (.01)**</td>
<td></td>
</tr>
<tr>
<td>Organizational Diversity</td>
<td>-36.746 (2.18)**</td>
<td>-43.519 (2.5)**</td>
<td></td>
</tr>
<tr>
<td>Task Interaction*Organizational Diversity</td>
<td>19.878 (.90)**</td>
<td>-1.155 (.05)**</td>
<td></td>
</tr>
<tr>
<td>Contractual Complexity</td>
<td>0.352 (.16)**</td>
<td>0.349 (.17)**</td>
<td></td>
</tr>
<tr>
<td>Contractual Complexity^2</td>
<td>-0.025 (.01)**</td>
<td>-0.025 (.01)**</td>
<td></td>
</tr>
<tr>
<td>Contractual Complexity*Organizational Diversity</td>
<td>23.766 (1.13)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Dummies (2000 ~ 2004)</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>-2 Log Likelihood</td>
<td>324.828</td>
<td>316.874</td>
<td>325.941</td>
</tr>
<tr>
<td>Chi^2</td>
<td>32.22***</td>
<td>40.17***</td>
<td>29.08***</td>
</tr>
<tr>
<td>Nagelkerke R^2</td>
<td>0.15</td>
<td>0.19</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Robust standard errors are in parentheses

*P < .10; **P < .05; ***P < .01
APPENDIX: Discriminant Analysis

- Classifying Alliance Governance Structure based on the Coordination and Communication Mechanism

- Discriminant Analysis (Sample 208)
  (1) Low-Integration: 109
  (2A) Moderately-Integrated: 45
  (2B) Moderately-Integrated: 25
  (3) High-Integration: 66

- TABLE A-3: Canonical Discriminant Analysis (N=245)

<table>
<thead>
<tr>
<th>Function</th>
<th>Eigen</th>
<th>Degree of Contract Complexity</th>
<th>l.f.</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.149</td>
<td>87.3</td>
<td>87.3</td>
<td>.871</td>
</tr>
<tr>
<td>2</td>
<td>.458</td>
<td>12.7</td>
<td>100.0</td>
<td>.561</td>
</tr>
</tbody>
</table>
APPENDIX: Discriminant Analysis

- Discriminant Analysis (cont’d)

- TABLE A-4: Classification Results

<table>
<thead>
<tr>
<th>Governance Mode</th>
<th>Predicted Group Membership</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2A</td>
</tr>
<tr>
<td>Original Count</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>108</td>
<td>1</td>
</tr>
<tr>
<td>2A</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>2B</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2A</th>
<th>2B</th>
<th>3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>99.1</td>
<td>.9</td>
<td>.0</td>
<td>.0</td>
<td>100.0</td>
</tr>
<tr>
<td>2A</td>
<td>.0</td>
<td>100.0</td>
<td>.0</td>
<td>.0</td>
<td>100.0</td>
</tr>
<tr>
<td>2B</td>
<td>4.0</td>
<td>.0</td>
<td>96.0</td>
<td>.0</td>
<td>100.0</td>
</tr>
<tr>
<td>3</td>
<td>.0</td>
<td>19.7</td>
<td>.0</td>
<td>80.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>
## APPENDIX: Descriptions

- **Types of Alliance**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Degree of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asset Purchase (AP)</strong></td>
<td>One company acquires legal control of one or more physical assets such as <strong>manufacturing plants/equipment, all finished or work-in-progress product inventories, all laboratory supplies, laboratory animals and so on.</strong></td>
<td>1</td>
</tr>
</tbody>
</table>
| **Joint Development (JD) : clinical Trial stages** | Both parties participate in and **share the costs and risks of clinical Development and/or commercial expenses;**  
- Both parties may form a JSC (Joint Steering Committee- an advisory committee) to design and monitor the clinical development plan  
- Both parties are responsible for all direct and indirect costs and expenses incurred in carrying out Development Activities  
- Both parties prepare and review protocols for clinical trials  
One party conducts a clinical trial and keeps informed of its progress to the other party by providing summary reports, while the other party provides or transfers technology for clinical trials. | 3                     |
## APPENDIX: Descriptions

- Types of Alliance (cont’d)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Degree of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Passive Equity Purchase (not a JV) (E)</strong></td>
<td>An agreement in which one company issues shares of its stock to the other company, either in exchange for cash or as repayment of a loan. Many agreements utilize Equity investments as part of the upfront or continuing compensation to the originating company; - Equity purchase is a method of payment for certain research services (e.g., screening and analysis) - Equity purchase as research funding; any costs incurred by a party performing research activities can be reimbursed by the other party</td>
<td>1</td>
</tr>
<tr>
<td><strong>Joint Research (JR) : drug discovery stage</strong></td>
<td><strong>Both parties participate in research activities.</strong> The term collaboration is used for describing collaborative activities in research phase; - Both parties shall cooperate in the performance of the research program at its own cost - Both parties may exchange such data, information and materials necessary for other party to perform its obligations under any research plan - Either party may supply the other party with proprietary materials for use in the research program - Collaboration activities include screening assays for identifying and testing the activity of compounds, and selecting lead compounds for clinical development and commercialization</td>
<td>3</td>
</tr>
</tbody>
</table>
## APPENDIX: Descriptions

• Types of Alliance (cont’d)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Degree of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cross-Licensing (Crl)</strong></td>
<td>One party obtains a license to intellectual property of the other party in exchange for granting a license to its own intellectual property</td>
<td>3</td>
</tr>
<tr>
<td><strong>Contract Development (CD)</strong></td>
<td><strong>One party sponsors clinical trials</strong> at the other company (e.g., a pharma company sponsors clinical trials at a small biotech, where the biotech completes all developments (i.e., clinical trials on its own); one party conducts, monitors and governs clinical trials in accordance with the protocols. And the sponsoring party can request status reports to the sponsored party. Or, in other case, one party is responsible to conduct clinical trials and bear all expenses for the trials; doing it on its own</td>
<td>2</td>
</tr>
</tbody>
</table>
**APPENDIX: Descriptions**

- **Types of Alliance (cont’d)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Degree of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>License (L)</strong></td>
<td>One party obtains a License under the other party's intellectual property to research, develop, make, use, sell, or market or promote a product or technology. Under a License agreement, the originator of the technology typically retains some rights in the product/technology and receives continuing payments such as milestone payments and royalties on net sales of the product/technology throughout the term of the agreement</td>
<td>2</td>
</tr>
<tr>
<td><strong>Loan (Lo)</strong></td>
<td>A Loan is a payment or promise of future payment from one party to another. Repayment may be in the form of cash or equity from the borrowing company. Loan can be used as study or research funding. And in return, the party proving the fund will receive a royalty payment upon any achievements in clinical stages and/or regulatory stage</td>
<td>1</td>
</tr>
</tbody>
</table>
APPENDIX: Descriptions

- Types of Alliance (cont’d)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Degree of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>In a Manufacturing agreement, <strong>one party manufactures a product</strong>, usually a compound, for use by the other company in clinical development or commercialization stages. And the manufacturing agreement normally does not include supply/delivery of the product</td>
<td>2</td>
</tr>
</tbody>
</table>
| Supply        | In a Supply agreement, the company will make or have made a product for use or sale by the Client company. And the major difference between supply agreement and manufacturing is that **supply agreement usually contains delivery/distribution of products to the client company** as opposed to manufacturing focuses on the manufacture of certain compounds
- Supply agreement shall contain the supply of lead compound for clinical development as well as a drug substance using as the active pharmaceutical ingredient in a human drug product | 2                     |
APPENDIX: Descriptions

- Types of Alliance (cont’d)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Degree of Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contract Research (CR)</strong></td>
<td>In a Research agreement, a sponsoring party engages another party to perform research services in the discovery and/or lead stages of an R&amp;D project; in a shorter term, it is a contract research</td>
<td>2</td>
</tr>
<tr>
<td><strong>Equity Joint Venture (EJV)</strong></td>
<td>Company A and company B (or more parties) create a new separate legal entity</td>
<td>N/A</td>
</tr>
</tbody>
</table>