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e-companion

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Electronic Companion—"Cross-Function and Same-Function Alliances: How Does Alliance Structure Affect the Behavior of Partnering Firms?" by Wilfred Amaldoss and Richard Staelin, *Management Science*, DOI 10.1287/mnsc.1090.1103.

Online Technical Appendix

Section A (Continued)

A.5 Lemma 3: If alliance partners have opportunities for learning, then in the Pareto-superior equilibrium the joint investment in cross-function alliance *i* is $X_i = \frac{V(N-1)(1+\alpha(n-1))}{n(N^2+\gamma-\gamma N)}$, while the investment by firm *j* in alliance *i* for the competition outside the scope of its alliance is $y_{ij} = \frac{V(N^2(n+\alpha-1-\alpha n)+m\gamma-\gamma nN)}{n^2(N^2+\gamma-\gamma N)}$.[1]

Proof. As each alliance is comprised of *n* partnering firms, the collective investment in alliance *i* is $X_i = \sum_{j=1}^{n} x_{ij}$, and the utility of the technology developed by cross-function alliance *i* is

$$U(i) = \beta_2 \prod_{j=1}^{n} x_{ij}, \qquad \text{A15}$$

where β_2 is a scaling constant.

As *N* alliance are competing in the inter-alliance competition, the probability of alliance *i* winning the technology competition, Pr(*i*), is given by:

$$\Pr(i) = \frac{U(i)}{\sum_{k=1}^{N} U(k)}. \qquad \text{A16}$$

[1] Note that each partner investing nothing in the first stage of the game is a symmetric pure-strategy equilibrium for cross-function alliances. In this equilibrium alliance partners earn nothing. Thus it gives a lower payoff than the payoff from the symmetric pure-strategy equilibrium identified in Lemma 3. Hence the equilibrium presented in Lemma 3 is Pareto superior.

Each partner in the alliance that wins the technology competition earns a direct payoff of $\frac{\alpha V}{n}$, where $\alpha \in (0,1)$ indicates the fraction of total gross profits that accrues as common benefit from the collaboration. Firm *j*'s learning from its cross-function alliance *i* is given by:

$$L_{ij} = \gamma \left(\prod_{m \neq j} x_{im} \right)^{\frac{1}{n-1}} \quad \text{A17}$$

where $\left(\prod_{m \neq j} x_{im} \right)^{\frac{1}{n-1}}$ is the geometric mean of the investments of firm *j*'s partners in the alliance and the parameter $\gamma > 0$ is a measure of firm *j*'s opportunity to learn from its partners.

As y_{ij} is the additional resources that firm j in alliance *i* invests in the second stage, the probability of firm j winning the competition outside the scope of its alliance is:

$$\Pr(j) = \frac{L_{ij} + y_{ij}}{\sum_{m=1}^{n} (L_{ij} + y_{im})} \quad \text{A18}$$

The gross profits from winning the second stage competition are $(1-\alpha)V$. Hence, the expected profits of firm j in alliance *i* are:

$$\pi_{ij} = -x_{ij} + \Pr(i)\left(\frac{\alpha V}{n} + \Pr(j)(1-\alpha)V - y_{ij} \right) . \quad \text{A19}$$

Now we proceed to solve this game backward. On differentiating equation A19 with respect to y_{ij}, setting it equal to zero and solving for y_{ij} we obtain:

$$y_{ij} = \frac{V(n + \alpha - \alpha n - 1)}{n^2} - \gamma L_{ij} \quad \text{A20}$$

As there are *n* contestants in the second stage of the game, the expected profit from winning the second stage of the competition is $\frac{(1-\alpha)V}{n} - y_{ij}$. After inserting this term and A20 into A19, we obtain the expected profit of winning the first stage of the competition for firm j in alliance *i*:

$$\pi_{ij} = -x_{ij} + \Pr(i)\left(\frac{\alpha V}{n} + \frac{(1-\alpha)V}{n} - \frac{V(n+\alpha-\alpha n-1)}{n^2} + \gamma L_{ij}\right) \quad \text{A21}$$

After substituting A17 into A21, we differentiate the expression with respect to x_{ij}, set it equal to zero, solve for x_{ij} and obtain:

$$x_{ij} = \frac{V(N-1)(1+\alpha(n-1))}{n^2(N^2+\gamma-\gamma N)} \quad \text{A22}$$

Therefore, the joint investment of the *n* partnering firms in the cross-function alliance is given by:

$$X_i = \frac{V(N-1)(1+\alpha(n-1))}{n(N^2+\gamma-\gamma N)} \quad \text{A23}$$

Using A20 and A22, and further noting that the firms are symmetric, we obtain:

$$y_{ij} = \frac{V(N^2(n+\alpha-1-\alpha n)+m\gamma-\gamma nN)}{n^2(N^2+\gamma-\gamma N)}. \quad \text{A24}$$

As long as $\alpha < 1 - \frac{\gamma n(N-1)}{N^2(n-1)}$, the second stage investment will remain positive.

A.6 <u>Lemma 4</u>: In the presence of learning, the equilibrium joint investment in same-function alliance *i* is $X_i = \frac{V(N-1)(1+\alpha(n-1))}{n(nN^2+\gamma-\gamma N)}$, while the investment by firm *j* in alliance *i* in the competition outside the scope of its alliance is $y_{ij} = \frac{V(N^2(n+\alpha-1-\alpha n)+\gamma-\gamma N)}{n(nN^2+\gamma-\gamma N)}$.

Proof. The proof for this lemma closely follows the proof of Lemma 3. There are *N* same-function alliances with each alliance comprised of *n* partnering firms. The collective investment in same-function alliance *i* is $X_i = \sum_{j=1}^{n} x_{ij}$, while the utility of the technology developed by the alliance *i* is

$$U(i) = \beta_1 \sum_{j=1}^{n} x_{ij} \ , \quad \text{A25}$$

where β_1 is a scaling constant. The probability of alliance *i* winning the technology competition is:

$$\Pr(i) = \frac{U(i)}{\sum_{k=1}^{N} U(k)}. \qquad \text{A26}$$

Each partner in the alliance that wins the technology competition earns $\frac{\alpha V}{n}$, where $\alpha \in (0,1)$ is the fraction of total gross profits that comes from the collaboration. Firm *j*'s learning from its same-function alliance *i* is given by:

$$L_{ij} = \frac{\gamma \sum_{m \neq j} x_{im}}{n-1}, \qquad \text{A27}$$

where $\frac{\sum_{m \neq j} x_{im}}{n-1}$ is the mean investment of firm *j*'s partners in the alliance. Note that $\gamma > 0$ is a measure of firm *j*'s opportunity to learn from its partners.

Recall that y_{ij} is the additional resources that firm *j* in same-function alliance *i* invests in the second stage. Therefore, the probability of firm *j* winning the competition outside the scope of the alliance is given by:

$$\Pr(j) = \frac{L_{ij} + y_{ij}}{\sum_{m=1}^{n} (L_{ij} + y_{im})} \qquad \text{A28}$$

The gross profits from winning the second stage competition are $(1-\alpha)V$. Hence, the expected profits of firm *j* in alliance *i* are:

$$\pi_{ij} = -x_{ij} + \Pr(i)\left(\frac{\alpha V}{n} + \Pr(j)(1-\alpha)V - y_{ij}\right). \qquad \text{A29}$$

Like in the previous lemma, we solve this game backward. On differentiating equation A29 with respect to y_{ij}, setting it equal to zero and solving for y_{ij} we have:

$$y_{ij} = \frac{V\left(n+\alpha-\alpha n-1\right)}{n^2} - \gamma L_{ij} \qquad \text{A30}$$

There are n contestants in the second stage of the game, and the expected profit from winning the second stage of the competition is $\frac{(1-\alpha)V}{n} - y_{ij}$. On inserting this term and A30 into A29, we obtain the expected profit of winning the first stage of the competition for firm j in alliance i:

$$\pi_{ij} = -x_{ij} + \Pr(i)\left(\frac{\alpha V}{n} + \frac{(1-\alpha)V}{n} - \frac{V\left(n+\alpha-\alpha n-1\right)}{n^2} + \gamma L_{ij}\right) \qquad \text{A31}$$

We insert A27 into A31. Thereafter, on differentiating the resulting expression with respect to x_{ij}, setting it equal to zero and solving for x_{ij}, we obtain:

$$x_{ij} = \frac{V\left(N-1\right)\left(1+\alpha\left(n-1\right)\right)}{n^2\left(nN^2+\gamma-\gamma N\right)} \qquad \text{A32}$$

Therefore, the joint investment of the n partnering firms in the same-function alliance is given by:

$$X_i = \frac{V\left(N-1\right)\left(1+\alpha\left(n-1\right)\right)}{n\left(nN^2+\gamma-\gamma N\right)} \qquad \text{A33}$$

By substituting A31 into A30, and then simplifying the expression, we find:

$$y_{ij} = \frac{V\left(N^2\left(n+\alpha-1-\alpha n\right)+\gamma-\gamma N\right)}{n\left(nN^2+\gamma-\gamma N\right)}. \qquad \text{A34}$$

The first and second stage investments will remain positive as long there are at least two partners in an alliance.

A.7 <u>Proof for Proposition 3:</u> We prove this proposition in parts.

<u>Proof for part (a).</u> We first prove the claims corresponding to cross-function alliances and then establish the claims corresponding to same-function alliances.

<u>*Cross-function alliance*</u>: From Lemma 3, we know that the joint investment in cross-function alliance i and the investment of partner j outside the scope of the alliance are

$X_i = \frac{V\left(N-1\right)\left(1+\alpha\left(n-1\right)\right)}{n\left(N^2+\gamma-\gamma N\right)}$ and $y_{ij} = \frac{V\left(N^2\left(n+\alpha-1-\alpha n\right)+\gamma-\gamma N\right)}{n^2\left(N^2+\gamma-\gamma N\right)}$, respectively.

As both N and n are at least equal to 2, it follows that:

$$\frac{\partial X_i}{\partial \gamma} = \frac{V(N-1)^2\left(1+\alpha(n-1)\right)}{n\left(N^2+\gamma-\gamma N\right)^2} > 0. \qquad \text{A35}$$

Furthermore, $\frac{\partial y_{ij}}{\partial \gamma} = -\frac{VN^2(N-1)\left(1+\alpha(n-1)\right)}{n^2\left(N^2+\gamma-\gamma N\right)^2} < 0.$ A36

Now note that the total investment of an individual partner across the two stages is given by $(x_{ij}+y_{ij})$ and on studying how the size of γ affects the total investment, we have:

$$\frac{\partial\left(x_{ij}+y_{ij}\right)}{\partial \gamma} = -\frac{V(N-1)\left(N^3-2N^2+2N-1\right)\left(1+\alpha(n-1)\right)}{n^2\left(N^2+\gamma-\gamma N\right)^2} < 0. \qquad \text{A37}$$

The above expression is negative as *N* and *n* are at least equal to 2.

Same-function alliance: Lemma 4 shows that joint investment in same-function alliance *i* and the investment of partner *j* outside the scope of the alliance are

$X_i = \frac{V(N-1)\left(1+\alpha(n-1)\right)}{n\left(nN^2+\gamma-\gamma N\right)}$, while the investment by firm *j* in alliance *i* in the competition outside the scope of its alliance is $y_{ij} = \frac{V\left(N^2(n+\alpha-1-\alpha n)+\gamma-\gamma N\right)}{n\left(nN^2+\gamma-\gamma N\right)}$.

Therefore, we have:

$$\frac{\partial X_i}{\partial \gamma} = \frac{V(N-1)^2\left(1+\alpha(n-1)\right)}{n\left(nN^2+\gamma-\gamma N\right)^2} > 0, \text{ and} \qquad \text{A38}$$

$$\frac{\partial y_{ij}}{\partial \gamma} = -\frac{VN^2(N-1)\left(1+\alpha(n-1)\right)}{n\left(nN^2+\gamma-\gamma N\right)^2} < 0 \qquad \text{A39}$$

as both *N* and *n* are at least equal to 2. Then on differentiating $(x_{ij}+y_{ij})$ with respect to γ, we find that:

$$\frac{\partial\left(x_{ij}+y_{ij}\right)}{\partial \gamma} = -\frac{V(N-1)\left(1-N+nN^2\right)\left(1+\alpha(n-1)\right)}{n^2\left(nN^2+\gamma-\gamma N\right)^2} < 0.$$

Proof for part (b). Like before, we sequentially prove the claims corresponding to cross-function and same-function alliances.

Cross-function alliance: Lemma 3 gives the joint investment in cross-function alliance *i* and the investment of partner *j* outside the scope of the alliance: namely,

$$X_i = \frac{V(N-1)(1+\alpha(n-1))}{n(N^2+\gamma-\gamma N)} \text{ and } y_{ij} = \frac{V(N^2(n+\alpha-1-\alpha n)+\gamma-\gamma N)}{n^2(N^2+\gamma-\gamma N)}.$$

As $N > 2$, it follows that:

$$\frac{\partial X_i}{\partial N} = -\frac{VN(N-2)(1+\alpha n-\alpha)}{n(N^2+\gamma-\gamma N)^2} < 0 \text{ and} \quad \text{A40}$$

$$\frac{\partial y_{ij}}{\partial N} = \frac{VN\gamma(N-2)(1+\alpha(n-1))}{n^2(N^2+\gamma-\gamma N)^2} > 0. \quad \text{A41}$$

On studying how the total investment of an individual partner changes with *N*, we have:

$$\frac{\partial(x_{ij}+y_{ij})}{\partial N} = \frac{VN(N-2)(1+\alpha(n-1))(\gamma-1)}{n^3(N^2+\gamma-\gamma N)}. \quad \text{A42}$$

As $N > 2$, this expression is negative when $0 < \gamma < 1$ but positive when $\gamma > 1$.

Same-function alliance: Lemma 4 shows that joint investment in same-function alliance *i* and the investment of partner *j* outside the scope of the alliance are

$X_i = \frac{V(N-1)(1+\alpha(n-1))}{n(nN^2+\gamma-\gamma N)}$, while the investment by firm *j* in alliance *i* in the competition outside the scope of its alliance is $y_{ij} = \frac{V(N^2(n+\alpha-1-\alpha n)+\gamma-\gamma N)}{n(nN^2+\gamma-\gamma N)}$.

Therefore, we have:

$$\frac{\partial X_i}{\partial N} = -\frac{VN(N-2)(1+\alpha n-\alpha)}{(nN^2+\gamma-\gamma N)^2} < 0, \text{ and} \quad \text{A43}$$

$$\frac{\partial y_{ij}}{\partial N} = \frac{VN\gamma(N-2)(1+\alpha(n-1))}{n(nN^2+\gamma-\gamma N)^2} > 0 \quad \text{A44}$$

as $N > 2$ and *n* is at least equal to 2. Then on differentiating $(x_{ij}+y_{ij})$ with respect to γ, we find that:

$$\frac{\partial\left(x_{ij}+y_{ij}\right)}{\partial N}=\frac{VN\left(N-2\right)\left(1+\alpha\left(n-1\right)\right)\left(\gamma-1\right)}{n^{2}\left(nN^{2}+\gamma-\gamma N\right)^{2}}. \qquad \text{A45}$$

As $N>2$, the above expression is negative when $0<\gamma<1$ but positive when $\gamma>1$.

A.8 Additional claims on the extended model.

Claim 1. *In the extended model, if $\alpha=1$ we can recover the results in Proposition 1 and Proposition 2.*

Proof: First note that when $\alpha=1$ there is nothing to compete for outside the scope of the alliance and hence also no room to leverage a firm's learning outside the scope of its alliance. From Lemma 3, we know that the joint investment in a cross-function alliance is:

$$X_{i}=\frac{V\left(N-1\right)\left(1+\alpha\left(n-1\right)\right)}{n\left(N^{2}+\gamma-\gamma N\right)}. \qquad \text{A46}$$

Now if $\alpha=1$ and $\gamma=0$, this expression reduces to:

$$X_{i}=\frac{V\left(N-1\right)}{N^{2}}. \qquad \text{A47}$$

Similarly, we know from Lemma 4 that the joint investment in a same-function alliance is

$$X_{i}=\frac{V\left(N-1\right)\left(1+\alpha\left(n-1\right)\right)}{n\left(nN^{2}+\gamma-\gamma N\right)}. \qquad \text{A48}$$

On setting $\alpha=1$ and $\gamma=0$ in the above expression, we obtain:

$$X_{i}=\frac{V\left(N-1\right)}{nN^{2}}. \qquad \text{A49}$$

Now it is easy to see that difference between A47 and A49 is positive, implying that partners in a cross-function alliance investment more than their counterparts in a same-function alliance. Thus, we recover the results in Proposition 1.

Furthermore, it also follows from A47 that in the case of a cross-function alliance $\frac{\partial X_{i}}{\partial n_{i}}=0$. On the other, hand, we can see from A49 that in the case of a same-function alliance $\frac{\partial X_{i}}{\partial n_{i}}=-\frac{(N-1)V}{n^{2}N^{2}}<0$. Thus we can recover the results in Proposition 2.

Claim 2: *In the extended model, the joint investment in a cross-function alliance is more than that in a same-function alliance.*

Proof. From Lemma 3, we know that the joint investment in a cross-function alliance is:

$$X_i = \frac{V(N-1)(1+\alpha(n-1))}{n(N^2+\gamma-\gamma N)}, \quad \text{A50}$$

and according to Lemma 4 the joint investment in a same-function alliance is

$$X_i = \frac{V(N-1)(1+\alpha(n-1))}{n(nN^2+\gamma-\gamma N)}. \quad \text{A51}$$

As the denominator of A46 is larger than that of A45, the joint investment is a cross-function remains larger in the extended model.

Claim 3: *If* $\delta < 1/n$*, partners in same-function alliances will invest more than those in cross-function alliances.*

Proof*:* The utility of a product developed by a cross-function on allowing for inefficiencies in pooling is given by:

$$U(i) = \prod_{j=1}^{n} x_{ij}^{\delta} \quad \text{A52}$$

where $0 < \delta \leq 1$. As indicated in (6) the payoff partner *1* in alliance *i* earns on investing x_{i1} is:

$$\pi_{i1} = -x_{i1} + \Pr(i).\frac{V}{n} \quad \text{A53}$$

where $\Pr(i)$ is as given in (5). Setting $\frac{\partial \pi_{i1}}{\partial x_{i1}} = 0$ and noting that the players are symmetric, we find:

$$x_{ij} = \frac{(N-1)V\delta}{nN^2}. \quad \text{A54}$$

The payoff π_{i1} is concave in x_{i1}, as

$$\frac{\partial^2 \pi_{i1}}{\partial x_{i1}^{\ 2}} < 0 \quad . \quad \text{A55}$$

On adding the investments of all partners in cross-function alliance *i*, we obtain the joint investment:

$$X_i = \frac{(N-1)V\delta}{N^2} \qquad \text{A56}$$

Then using Lemma 2 and A56, we obtain the difference in the joint investment between same-function alliance (with no pooling inefficiency) and cross-function (with inefficiencies in pooling):

$$\Delta^I = \frac{(N-1)V}{nN^2} - \frac{(N-1)V\delta}{N^2} \qquad \text{A57}$$

Now it is easy to see that $\Delta^I > 0$, only if $\delta < \frac{1}{n}$.

Section B.1

SURVEY 1: Managerial Decision Making Experiment

This is an experiment in managerial decision making, which might last for approximately 15 minutes. If you can spare 15 minutes of undivided attention to this experiment please read further.

In this experiment we want to investigate your ability to forecast the performance of an alliance with two partners. You will play the role of a manager who is responsible for one of the partnering firms.

In the following questionnaire we describe two alliances. Each alliance has two partnering firms who contribute some effort toward the joint endeavor (money, personnel, technology, etc). For each pair of effort levels we want you to estimate the performance level of the alliance relative to that level that would be obtained if each partnering firm contributes 100 percent of the effort level needed to make the alliance very successful. For example, assume your partner put in 75% of the effort it needed to put in to the alliance while you put in 100%. Then the question that you need to answer is: What would be your estimate of the performance level of the alliance relative to the case where both of you put in 100%? Your response could range from 0% to over 100%.

As the quality of your response is critical for our research, please carefully read the descriptions of the two alliances and then fill your response for each question.

Before proceeding to read about each of the alliances, please fill the following personal information:

Name _____

Number of years of work experience _____

Alliance 1

Alliance 1 is a new technology alliance between two major automobile manufacturers with one located in the US and the other in Asia. You are the key manager of the US firm. The mission of this alliance is to jointly develop a new fuel cell car that will be marketed by both manufacturers under their own brand names. Both of you will provide R&D personnel toward the project. Some of these personnel will be co-located at a central R&D center set up for this purpose; others will remain at their current locations. Overall management of the project will be handled by a staff of managers who come from both companies. The new cars resulting from the new technology will be individually marketed by the two companies in their respective markets.

Please legibly enter the likely performance of Alliance 1 for each of the given combinations of effort by you and the partnering firm.

Serial Number	Your effort (%)	Your partner's effort (%)	**Likely Success of the alliance** (Response range = 0% to 100%) Please enter your response in this column
1	100	100	100%
2	110	80	
3	100	80	
4	120	60	
5	40	140	
6	150	30	
7	30	140	
8	30	130	
9	20	140	
10	150	10	
11	75	80	
12	100	50	
13	125	25	
14	20	130	
15	50	90	
16	20	120	
17	120	20	
18	75	60	
19	40	90	
20	90	40	
21	70	50	
22	80	40	
23	100	20	
24	50	60	
25	60	40	

Kindly please verify again whether you have entered the likely performance in each row in the above table.

Alliance 2

A large global engineering firm with expertise in fuel cell technology and a US automobile manufacturer have joined hands to develop and market new fuel cell car.. Again you are the key manager at the US firm. It is the engineering firm's responsibility to develop an efficient "engine". Your firm, on the other hand, will produce the car and market it. Profit allocation from this venture was arrived via negotiation and this allocation was approved by both firm's board of directors.

Please legibly enter the likely performance of Alliance 2 for each of the given combinations of effort by you and the partnering firm.

Serial Number	Your effort (%)	Your partner's effort (%)	**Likely Performance of the alliance** (Response range = 0% to 100%) Please enter your response in this column
1	100	100	100%
2	110	80	
3	100	80	
4	120	60	
5	40	140	
6	150	30	
7	30	140	
8	30	130	
9	20	140	
10	150	10	
11	75	80	
12	100	50	
13	125	25	
14	20	130	
15	50	90	
16	20	120	
17	120	20	
18	75	60	
19	40	90	
20	90	40	
21	70	50	
22	80	40	
23	100	20	
24	50	60	
25	60	40	

Kindly please verify again whether you have entered the likely performance in each row in the above table.

Thank You!

Section B.2

SURVEY 2: Managerial Decision Making Experiment

This is an experiment in managerial decision making, which might last for approximately 15 minutes. If you can spare 15 minutes of undivided attention to this experiment please read further.

In this experiment we want to investigate your ability to forecast the performance of an alliance with two partners. You will play the role of a manager who is responsible for one of the partnering firms.

In the following questionnaire we describe two alliances. Each alliance has two partnering firms who contribute some effort toward the joint endeavor (money, personnel, technology, etc). For each pair of effort levels we want you to estimate the performance level of the alliance relative to that level that would be obtained if each partnering firm contributes 100 percent of the effort level needed to make the alliance very successful. For example, assume your partner put in 75% of the effort it needed to put in to the alliance while you put in 100%. Then the question that you need to answer is: What would be your estimate of the performance level of the alliance relative to the case where both of you put in 100%? Your response could range from 0% to over 100%.

As the quality of your response is critical for our research, please carefully read the descriptions of the two alliances and then fill your response for each question.

Before proceeding to read about each of the alliances, please fill the following personal information:

Name _____

Number of years of work experience _____

Alliance 1

Alliance 1 is a new technology alliance between two major automobile manufacturers with one located in the US and the other in Asia. You are the key manager of the US firm. The mission of this alliance is to jointly develop a new fuel cell car that will be marketed by both manufacturers under their own brand names. Both of you will provide R&D personnel toward the project. Some of these personnel will be co-located at a central R&D center set up for this purpose; others will remain at their current locations. Overall management of the project will be handled by a staff of managers who come from both companies. The new cars resulting from the new technology will be individually marketed by the two companies in their respective markets.

In this alliance there is **no** opportunity for your alliance partner to learn about your best practices and technological know-how and leverage it at a later date. Similarly, there is no opportunity for you to learn about your partner's best practices and technological know-how and leverage it at a later date

Please legibly enter the likely performance of Alliance 1 for each of the given combinations of effort by you and the partnering firm.

Serial Number	Your effort (%)	Your partner's effort (%)	**Likely Performance of the alliance** (Response range = 0% to 100%) Please enter your response in this column
1	100	100	100%
2	110	80	
3	100	80	
4	120	60	
5	40	140	
6	150	30	
7	30	140	
8	30	130	
9	20	140	
10	150	10	
11	75	80	
12	100	50	
13	125	25	
14	20	130	
15	50	90	
16	20	120	
17	120	20	
18	75	60	
19	40	90	
20	90	40	
21	70	50	
22	80	40	
23	100	20	
24	50	60	
25	60	40	
26	100	0	

Kindly please verify again whether you have entered the likely performance in each row in the above table.

Alliance 2

A large global engineering firm with expertise in fuel cell technology and a US automobile manufacturer have joined hands to develop and market new fuel cell car. Again you are the key manager at the US firm. It is the engineering firm's responsibility to develop an efficient "engine". Your firm, on the other hand, will produce the car and market it. Profit allocation from this venture was arrived via negotiation and this allocation was approved by both firm's board of directors.

In this alliance there is **no** opportunity for your alliance partner to learn about your best practices and technological know-how and leverage it at a later date. Similarly, there is no opportunity for you to learn about your partner's best practices and technological know-how and leverage it at a later date

Please legibly enter the likely performance of Alliance 2 for each of the given combinations of effort by you and the partnering firm.

Serial Number	Your effort (%)	Your partner's effort (%)	**Likely Performance of the alliance** (Response range = 0% to 100%) Please enter your response in this column
1	100	100	100%
2	110	80	
3	100	80	
4	120	60	
5	40	140	
6	150	30	
7	30	140	
8	30	130	
9	20	140	
10	150	10	
11	75	80	
12	100	50	
13	125	25	
14	20	130	
15	50	90	
16	20	120	
17	120	20	
18	75	60	
19	40	90	
20	90	40	
21	70	50	
22	80	40	
23	100	20	
24	50	60	
25	60	40	
26	100	0	

Kindly please verify again whether you have entered the likely performance in each row in the above table.

Thank You!

Section B.3

SURVEY 3: Managerial Decision Making Experiment

This is an experiment in managerial decision making, which should take about 15 minutes. If you can spare 15 minutes of undivided attention to this experiment please read further. In this experiment you will play the role of a manager who is responsible for one of the partnering firms in a two-partner alliance.

In following questionnaire, we describe two alliances. Each alliance has two partnering firms who contribute some effort toward the joint endeavor (in terms of money, personnel, technology, etc). For each effort level of your partner, we want you to indicate the effort you will contribute for the alliance. For example, assume your partner put in 75% of the effort it needed to put in to the alliance. Then you need to specify how much effort you will contribute. Your response could range from 0% to over 100%.

As the quality of your response is critical for our research, please carefully read the descriptions of the two different alliances and then fill your response for each question.

Before proceeding to read about each of the alliances, please fill the following personal information:

Name _____

Number of years of work experience _____

Alliance 1

Alliance 1 is a new technology alliance between two major automobile manufacturers with one located in the US and the other in Asia. You are the key manager of the US firm. The mission of this alliance is to jointly develop a new fuel cell car that will be marketed by both manufacturers under their own brand names. Both of you will provide R&D personnel toward the project. Some of these personnel will be co-located at a central R&D center set up for this purpose; others will remain at their current locations. Overall management of the project will be handled by a staff of managers who come from both companies. The new cars resulting from the new technology will be individually marketed by the two companies in their respective markets.

In this alliance there is no opportunity for your alliance partner to learn about your best practices and technological know-how and leverage it at a later date. Similarly, there is no opportunity for you to learn about your partner's best practices and technological know-how and leverage it at a later date.

Please legibly enter your effort level for each of the given effort level of the partnering firm.

Serial Number	Your partner's effort (%)	Your effort (%) *Please enter your response in this column*
1	100	
2	80	
3	60	
4	140	
5	30	
6	75	
7	130	
8	10	
9	50	
10	25	
11	90	
12	120	
13	20	
14	40	
15	0	

Kindly please verify again whether you have entered your effort level in each row in the above table.

Alliance 2

A large global engineering firm with expertise in fuel cell technology and a US automobile manufacturer have joined hands to develop and market new fuel cell car. Again you are the key manager at the US firm. It is the engineering firm's responsibility to develop an efficient "engine". Your firm, on the other hand, will produce the car and market it. Profit allocation from this venture was arrived via negotiation and this allocation was approved by both firm's board of directors.

In this alliance there is no opportunity for your alliance partner to learn about your best practices and technological know-how and leverage it at a later date. Similarly, there is no opportunity for you to learn about your partner's best practices and technological know-how and leverage it at a later date

Please legibly enter your effort level for each of the given effort level of the partnering firm.

Serial Number	Your partner's effort (%)	Your effort (%) *Please enter your response in this column*
1	100	
2	80	
3	60	
4	140	
5	30	
6	75	
7	130	
8	10	
9	50	
10	25	
11	90	
12	120	
13	20	
14	40	
15	0	

Kindly please verify again whether you have entered your effort level in each row in the above table.

Thank You!

Section C

C.1 Same-function alliance with two partners (n=2)

You will participate today in a decision making experiment concerning competition between two alliances. Each alliance is comprised of two firms. You will be asked to make many decisions in the course of this decision making experiment, and you will be paid depending on your decisions and the decisions of other subjects.

In the present experiment, you are asked to represent a firm that jointly develops a new product with an alliance partner. Three other subjects participate in this experiment. One subject represents another firm that joins you in the alliance, whereas the other two subjects represent manufacturers who join in an alliance to produce a competing product.

The experiment involves many trials. At the beginning of each trial, each subject will be provided with some investment capital and then asked how much of it he or she wishes to invest in his/her alliance's product. The four subjects will be provided with the same amount of investment capital, and asked to make independent investment decisions.

Rules of the Investment Game. The rules of this investment game are quite simple.

1) The sum of the investments made by the partners in an alliance determines the *utility* of the product developed by the alliance.
2) The winner of the competition between the alliances will be determined *in proportion* to the utilities of the two competing products. In particular, the probability of your alliance winning the competition will be determined as follows:

$$probability\ of\ your\ alliance\ winning = \frac{Utility\ of\ your\ product}{Utility\ of\ your\ product + Utility\ of\ the\ competing\ product}$$

3) The capital invested by alliance partners is consumed in developing the product and thus completely nonrecoverable. Therefore, once invested the money is lost irrespective of the outcome of the competition.
4) Members of the winning alliance will equally share a fixed reward. The fixed reward represents profits from producing and marketing the new product. Each member of the losing alliance receives nothing.

Experimental Procedure.

As discussed above, there are two partners in each alliance. At the beginning of each trial each subject will be given the same investment capital, which will remain unchanged from trial to trial. The investment capital will be stated in terms of a laboratory currency called "francs". At the end of the experiment your earnings will be converted to US dollars.

Once each player is provided with the investment capital, he or she must decide how much to invest in his or her alliance's product. You may invest any number of francs (including zero), provided your investment does not exceed your endowment (investment capital allotted for the trial). After all the four players have made their investment decisions, privately and anonymously, the computer will compute the utilities of each of the competing product bundles. The probability that 1 alliance wins the competition will be computed from the equation shown above. Then the computer will randomly choose a number between 0 and 1 to determine the winning alliance. If this random number falls in the interval between 0 and the probability that alliance 1 wins the competition, then alliance 1 will be declared the winner. Otherwise, if the random number is greater than alliance 1's probability of winning, the competing alliance will win the competition. Members of the winning alliance will equally share a reward of known size (in francs), whereas members of the losing bundle will receive nothing.

Note that if you invest more you increase the probability of winning the competition. However, the same reasoning applies to all the firms. Moreover, investing more does not guarantee winning the competition, as the winning alliance is determined probabilistically.

Computation of Individual Payoffs. The individual payoffs for a trial will be computed as follows:

Payoff to a member of the winning alliance = endowment for the trial - investment made by the firm in the trial + half of reward for winning the competition.

Payoff to a member of the losing alliance = endowment for the trial - investment made by the firm in the trial.

Outcome Information. At the end of each trial, the computer will display the following information on the computer screens:

1) The utility of the products developed by the winning and losing alliances,
2) The alliance winning the competition,
3) Your payoff for the trial.
4) Your cumulative earnings

It is important to note that only you know your investment decision. This decision is made anonymously.

Alliance Membership. Alliance membership will vary randomly from trial to trial. On each trial you will be paired with a different person in this room, and both of you will compete as a group against another new group of two players. Therefore, you will never know the identity of your partner on any give trial.

The following two examples are provided to help you understand how your payoff is computed at the end of each trial.

Example 1. Suppose that the capital endowed to each subject at the beginning of a trial is 24 francs, and the reward for winning the competition is 160 francs, and therefore each member of the winning alliance will receive 80 francs. Also suppose that you invest 15 francs and your partner invests 10 francs in developing your product bundle. Thus, the utility of your product bundle is 25 (that is, 15+10). Assume that partners in the competing alliance invest 15 and 5 francs, and consequently the utility of the competing product bundle is 20 (that is, 15 +5). Then,

$$probability\ of\ your\ alliance\ winning = \frac{Utility\ of\ your\ product}{Utility\ of\ your\ product\ +\ Utility\ of\ the\ competing\ product}$$

$$\frac{25}{25+20} = \frac{25}{45} = 0.556$$

Suppose that the random number randomly chosen by the computer is 0.512. As this random number is *smaller* than 0.556, your alliance is the winner. Therefore, each member of your alliance receives a reward of 80 francs. The payoffs in this case will be:

Your payoff = endowment - your investment + reward = 24 - 15 + 80 = 89 francs.

Your partner's payoff = endowment - your partner's investment + reward

= 24 - 10 + 80 = 94 francs.

Example 2. Now suppose that the capital endowed to each subject at the beginning of a trial is 24 francs, and the reward for winning the competition is 160 francs, and therefore each member of the winning alliance will receive 80 francs. Also suppose that you invest 15 francs and your partner invests 10 francs in developing your product bundle. Thus, the utility of your product bundle is 25 (that is, 15+10). Assume that partners in the competing alliance invest 15 and 5 francs, and consequently the utility of the competing product bundle is 20 (that is, 15 +5). Then,

$$probability\ of\ your\ alliance\ winning = \frac{Utility\ of\ your\ product}{Utility\ of\ your\ product\ +\ Utility\ of\ the\ competing\ product}$$

$$\frac{25}{25+20} = \frac{25}{45} = 0.556$$

This time the random number randomly chosen by the computer is 0.856. As this random number is *larger* than 0.556, your alliance loses the competition. Therefore, the payoffs are as follows:

Your payoff = endowment – your investment + reward

= 24 - 15 + 0 = 9 francs.

Your partner's payoff = endowment – your partner's investment + reward

= 24 - 10 + 0 = 14 francs.

This concludes the description of the decision task. Paper and pencil are placed beside the computer terminal in case you wish to record the investments made in your product and in the competing product.

At the end of the experiment, your accumulated payoff will be converted to US dollars at the rate of 1000 francs = 2 dollars. If you have any questions, please raise your hand and the supervisor will assist you.

After all the participants have understood the instructions, we will start the experiment. In order to help you become familiar with the decision task, you will participate in five practice trials. Thereafter, you will play 120 trials of the game.

C.2 Cross-function alliance with two partners (n=2)

You will participate today in a decision making experiment concerning competition between two alliances. Each alliance is comprised of two firms. You will be asked to make many decisions in the course of this decision making experiment, and you will be paid depending on your decisions and the decisions of other subjects.

In the present experiment, you are asked to represent a firm that jointly develops a new product with an alliance partner. Three other subjects participate in this experiment. One subject represents another firm that joins you in the alliance, whereas the other two subjects represent manufacturers who join in an alliance to produce a competing product.

The experiment involves many trials. At the beginning of each trial, each subject will be provided with some investment capital and then asked how much of it he or she wishes to invest in his/her alliance's product. The four subjects will be provided with the same amount of investment capital, and asked to make independent investment decisions.

Rules of the Investment Game. The rules of this investment game are quite simple.

5) The product of the investments made by the partners in an alliance determines the *utility* of the product developed by the alliance.

6) The winner of the competition between the alliances will be determined *in proportion* to the utilities of the two competing products. In particular, the probability of your alliance winning the competition will be determined as follows:

$$probability\,of\ your\ alliance\,winning = \frac{Utility\ of\ your\ product}{Utility\,of\ your\ product + Utility\,of\,the\,competing\ product}$$

7) The capital invested by alliance partners is consumed in developing the product and thus completely nonrecoverable. Therefore, once invested the money is lost irrespective of the outcome of the competition.

8) Members of the winning alliance will equally share a fixed reward. The fixed reward represents profits from producing and marketing the new product. Each member of the losing alliance receives nothing.

Experimental Procedure.

As discussed above, there are two partners in each alliance. At the beginning of each trial each subject will be given the same investment capital, which will remain unchanged from trial to trial. The investment capital will be stated in terms of a laboratory currency called "francs". At the end of the experiment your earnings will be converted to US dollars.

Once each player is provided with the investment capital, he or she must decide how much to invest in his or her alliance's product. You may invest any number of francs (including zero), provided your investment does not exceed your endowment (investment capital allotted for the trial). After all the four players have made their investment decisions, privately and anonymously, the computer will compute the utilities of each of the competing product bundles. The probability that alliance 1 wins the competition will be computed from the equation shown above. Then the computer will randomly choose a number between 0 and 1 to determine the winning alliance. If this random number falls in the interval between 0 and the probability that alliance 1 wins the competition, then alliance 1 will be declared the winner. Otherwise, if the random number is greater than alliance 1's probability of winning, the competing alliance will win the competition. Members of the winning alliance will equally share a reward of known size (in francs), whereas members of the losing bundle will receive nothing.

Note that if you invest more you increase the probability of winning the competition. However, the same reasoning applies to all the firms. Moreover, investing more does not guarantee winning the competition, as the winning alliance is determined probabilistically.

Computation of Individual Payoffs. The individual payoffs for a trial will be computed as follows:

Payoff to a member of the winning alliance = endowment for the trial - investment made by the firm in the trial + half of reward for winning the competition.

Payoff to a member of the losing alliance = endowment for the trial - investment made by the firm in the trial.

Outcome Information. At the end of each trial, the computer will display the following information on the computer screens:

1) The utility of the products developed by the winning and losing alliances,

2) The alliance winning the competition,

3) Your payoff for the trial.

4) Your cumulative earnings

It is important to note that only you know your investment decision. This decision is made anonymously.

Alliance Membership. Alliance membership will vary randomly from trial to trial. On each trial you will be paired with a different person in this room, and both of you will compete as a group against another new group of two players. Therefore, you will never know the identity of your partner on any give trial.

The following two examples are provided to help you understand how your payoff is computed at the end of each trial.

Example 1. Suppose that the capital endowed to each subject at the beginning of a trial is 24 francs, and the reward for winning the competition is 160 francs, and therefore each member of the winning alliance will receive 80 francs. Also suppose that you invest 15 francs and your partner invests 10 francs in developing your product bundle. Thus, the utility of your product bundle is 150 (that is, 15 × 10=150). Assume that partners in the competing alliance invest 15 and 5 francs, and consequently the utility of the competing product bundle is 75 (that is, 15 × 5=75). Then,

$$probability\ \ of\ \ your\ \ alliance\ \ winning = \frac{Utility\ \ of\ \ your\ \ product}{Utility\ \ of\ \ your\ \ product\ +\ Utility\ \ of\ \ the\ \ competing\ \ product}$$

$$\frac{150}{150+75} = \frac{150}{225} = 0.667$$

Suppose that the random number randomly chosen by the computer is 0.512. As this random number is *smaller* than 0.667, your alliance is the winner. Therefore, each member of your alliance receives a reward of 80 francs. The payoffs in this case will be:

Your payoff = endowment - your investment + reward = 24 - 15 + 80 = 89 francs.

Your partner's payoff = endowment - your partner's investment + reward

= 24 - 10 + 80 = 94 francs.

Example 2. Now suppose that the capital endowed to each subject at the beginning of a trial is 24 francs, and the reward for winning the competition is 160 francs, and therefore each member of the winning alliance will receive 80 francs. Also suppose that you invest 15 francs and your partner invests 10 francs in developing your product bundle. Thus, the utility of your product bundle is 150 (that is, 15 × 10=150). Assume that partners in the competing alliance invest 15 and 5 francs, and consequently the utility of the competing product bundle is 75 (that is, 15 × 5=75). Then,

$$probability\ of\ your\ alliance\ winning = \frac{Utility\ of\ your\ product}{Utility\ of\ your\ product + Utility\ of\ the\ competing\ product}$$

$$\frac{150}{150+75} = \frac{150}{225} = 0.667$$

This time the random number randomly chosen by the computer is 0.856. As this random number is *larger* than 0.556, your alliance loses the competition. Therefore, the payoffs are as follows:

Your payoff = endowment – your investment + reward

= 24 - 15 + 0 = 9 francs.

Your partner's payoff = endowment – your partner's investment + reward

= 24 - 10 + 0 = 14 francs.

This concludes the description of the decision task. Paper and pencil are placed beside the computer terminal in case you wish to record the investments made in your product and in the competing product.

At the end of the experiment, your accumulated payoff will be converted to US dollars at the rate of 1000 francs = 2 dollars. If you have any questions, please raise your hand and the supervisor will assist you.

After all the participants have understood the instructions, we will start the experiment. In order to help you become familiar with the decision task, you will participate in five practice trials. Thereafter, you will play 120 trials of the game.