Toward a Theory of Entrepreneurial Rents: Online Supplement

Mohammad Keyhani (University of Calgary), Moren Lévesque (York University), Anoop Madhok (York University & Vrije University)

A. Supplementary Tables

Table A1: Correspondence of rent mechanisms with theory, illustrative example, and modeling approach

Rent mechanism	Definition in Theory	Illustrative Example (Table 1a-1d)	Operationalized representation in model	Relevant modeling literature
Structural rent (Ricardian or monopoly rents)	Imperfections in factor markets (Barney, 1986) or product markets (Porter, 1980) lead to supernormal returns in equilibrium.	**Scenario 1:** Firm A is guaranteed to receive a $20 million equilibrium price for its technology due to the structure of the economy modeled in Table 1b.	A characteristic function represents the structure of the economy. We choose a structure for the characteristic function at time zero (Table 1e) that gives all players equal advantage in equilibrium (the core). This allows us to isolate entrepreneurial rents from structural ones.	**Modeling toolbox:** Traditional (static, non-repeated) cooperative game theory, especially the theory of the core in n-person characteristic function games (Debreu and Scarf, 1963; Rapoport, 1970; Scarf, 1967; Shubik, 1959) **Model representativeness:** Strategy researchers have suggested that the structure of characteristic function games and their core can represent competitive advantage in the form of Ricardian and monopoly rents (Brandenburger and Stuart, 1996; Lippman and Rumelt, 2003; MacDonald and Ryall, 2004; Stuart, 2002)
Kirznerian rent	The process of taking the economy towards equilibrium by discovering and exploiting existing opportunities (Kirzner, 1997)	**Scenario 2:** In any economy (such as Table 1a or 1b) where the possibility of a gain to trade between firms objectively exists but has not yet been realized, one firm may discover the potential and exploit it by engaging another firm and securing a contract.	**Discovery:** In a characteristic function game, a player identifies excess (non-exploited value) in a coalition, and forms that coalition if it is not already formed. The excess value is divided among the members of this coalition and added to their previous payoffs. See also the entry for 'discovery capability' in Table A2.	**Modeling toolbox:** Research modeling the process of coalition formation in a characteristic function until equilibrium is reached either in closed-form models (Arnold and Schwalbe, 2002; Hart and Kurz, 1983; Konishi and Ray, 2003) or computer simulation (Chavez, 2004; Dworman, Kimbrough, and Laing, 1995; Klusch and Gerber, 2002). **Model representativeness:** Littlechild (1979a, 1979b) and Reid (1993) model entrepreneurship as the discovery and exploitation of excess in a characteristic function game. Foss (2000) suggests the use of cooperative game theory to model the Kirznerian market process.
Schumpeterian rent	The process of taking the economy away from equilibrium by creating new opportunities (Schumpeter, 1934)	**Scenario 3:** Firm A comes up with an innovation that increases the value of its technology for all players, thus taking the economy from Table 1b to Table 1c or 1d, depending on the added value of the innovation.	**Creation:** In a characteristic function game, a player increases its added value (i.e., marginal contribution) to all possible coalitions including that player. See also the entry for 'creation capability' in Table A2.	**Modeling toolbox:** Research on repeated n-person cooperative games in which the characteristic function is allowed to change over time (Filar and Petrosjan, 2000). **Model representativeness:** Afuah (2009: 291) suggests that innovation can be modeled as the act of increasing marginal contribution in a characteristic function. Other research also suggests similar modeling representations of innovation in terms of increased added value in cooperative games (Adner and Zemsky, 2006; Chatain, 2010; Chatain and Zemsky, 2007; Grahovac and Miller, 2009).

Table A2: List of variables, operational definitions and values

Variable	**Operational definition**	**Default values**	**Robustness check**
Creation capability (Creation)	The probability that a player will add value to all possible coalitions including that player in a time period. (See also: innovation magnitude)	0 for passive players and 0.05 for active players.	A variety of values between 0.01 and 0.2 were tested systematically. In some cases values from 0.0025 up to 0.9 were tested for additional checks.
Discovery capability (Discovery)	The probability that a player will discover a coalition in which s/he can appropriate greater value, rally others to form that coalition, and divide a percentage of the value s/he can exploit with the members of this new coalition according to each member's bargaining power. (See also: exploitation efficiency, bargaining power)	0 for passive players and 0.05 for active players.	A variety of values between 0.01 and 0.2 were tested systematically. In some cases values from 0.0025 up to 0.9 were tested for additional checks.
Number of time periods (end time)	The number of time periods in each trial.	1000	Shorter time frame results were already visible within the 1000 periods; longer time frames of 2000 and 5000 were also tested.
Starting characteristic function	A function assigning a value to each possible coalition at the start of each trial. (It may later be changed within the trial through acts of creation).	$v(S) = 10(\|S\| - 1)$ as in Table 1e.	Coalition values were altered where relevant to test for the effect of providing some players with a starting potential payoff advantage over others or increasing the size of the economy.
Starting coalition structure and profit distribution	The actual coalitions formed at the start of each trial and the payoff each player in those coalitions is assigned at that time. The payoff distribution depends on the coalition structure because the sum of the payoffs for each player cannot exceed the characteristic function value of their actual coalition.	All players are assumed to start as singleton coalitions and thus receive zero payoffs.	Coalition structures and corresponding payoff distributions were altered where relevant to test for the effect of providing some players with a starting realized payoff advantage over others.
Innovation magnitude	The amount of value that a player's act of creation will add to all possible coalitions including that player.	1	Values between 0.1 and 10 were tested.
Exploitation efficiency	The percentage of the excess value of a coalition that a player's act of discovery can exploit and divide between the members of that coalition. 'Excess discovered' is the excess value of a blocking coalition times the exploitation efficiency of the discoverer.	70% (0.7)	Values between 0.1 and 1 were tested.
Bargaining power	The weight assigned to each player determining the share of value appropriated by that player when joining a new coalition and dividing its discovered value. The share of value appropriated by a player is in proportion to its bargaining power divided by the sum of all other coalition member's bargaining power.	1 for all players	Values were altered from 0.1 (10% of others) to 10 (1000% of others). These changes provided interesting insights and the full implications are beyond the scope of this paper. Therefore, only some general trends are discussed here.
Number of players	The number of players interacting in each trial.	4	Conditions with 5 and 6 players were also tested. Trends indicate that no major results are likely to change for higher numbers.

B. Outline of Simulation Algorithm

Variables and parameters in bold type are defined in Table A2. More details are presented along with the flowcharts.

For each time period do the following:

1. Choose a player between all players and a null player to initiate an act of **creation**. The probability of an agent being chosen is their **creation capability**. The probability of the null player (no one) being chosen is 1 minus the sum of all player's creation capabilities.

   1.1. The act of creation is executed by adding the chosen player's **innovation magnitude** to all possible coalitions that include the chosen player. This produces a new characteristic function.

2. Choose a player between all players and a null player to initiate an act of **discovery**. The probability of an agent being chosen is their **discovery capability**. The probability of the null player (no one) being chosen is 1 minus the sum of all player's discovery capabilities.

   2.1. For all possible coalitions S that include the chosen player, calculate total excess of those coalitions as $v(T) – x(T)$.

   2.2. If no possible coalition including the chosen player has total excess above zero, do nothing and move on to step 3.

   2.3. Else, i.e., If one or more coalitions including the chosen player has total excess above zero, choose the coalition with the highest excess per capita as the blocking coalition (if there is a tie, choose randomly between them). This coalition may be the coalition that the chosen player is already in, or a different coalition.

      2.3.1 Calculate the **excess discovered** as the excess of the blocking coalition times the **exploitation efficiency** of the chosen player.

      2.3.2. The new profit distribution and coalition structure are produced as follows: Form the blocking coalition, and increase each player's current profit by an amount equal to their weighted share of the **excess discovered**, where the weights are determined by each player's **bargaining power** (assumed to be equal by default). Reshape the rest of the coalition structure of the game as follows:

         2.3.2.1 For each coalition that has not lost a player to the blocking coalition, keep the coalition and the previous profit allocated to its members.

         2.3.2.2 For each coalition that has lost players to the blocking coalition, the remaining members stay together and the pie shared between them is just the sum of the profits they were already getting, unless this sum is larger than the value of their coalition as allowed by the characteristic function, in which case the pie is set to that value.

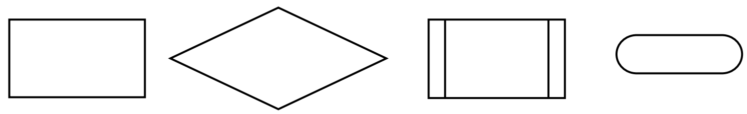
3. Record Distance from equilibrium, current profit of each player, cumulative profit of each player, current characteristic function, and current coalition structure.

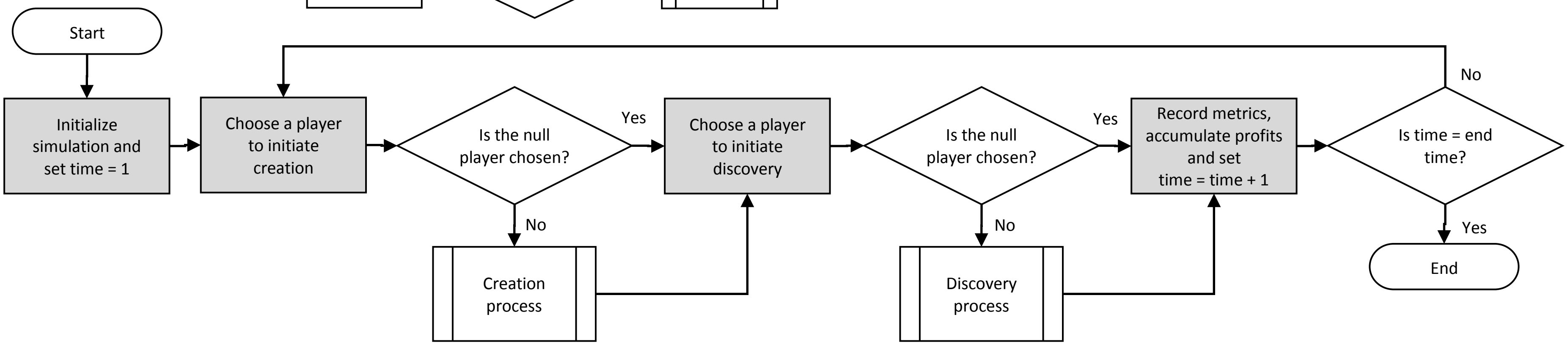
C. Flowcharts & Algorithm Details

Top level flowchart of the simulation algorithm

Shaded boxes are described in more detail below the flowchart. The flowcharts for the creation and discovery sub-processes are presented separately.

Legend of Flowchart Symbols: Process: Decision: Sub-process: Terminator:





Initialize Simulation: This process involves setting up all the main constructs and giving them the default values shown in Table A2. This includes the characteristic function, the profit distribution, the cumulative profit distribution, the coalition structure, the number of players, the “end time” or the number of time periods the simulation is to run, as well as each player’s creation capability, discovery capability, innovation magnitude, exploitation efficiency, and bargaining power.

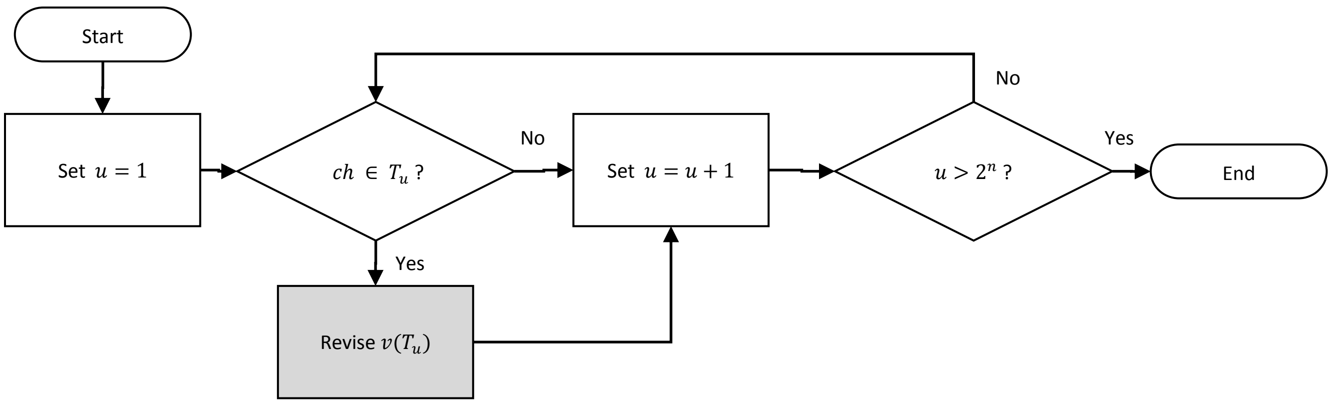
Choose a player to initiate creation: This process uses Matlab’s **randsample** function to generate a random weighted sample of size 1 (i.e., choose one player) from the set of all players plus a null player, where the probability of each player being chosen is their creation capability, and the probability of the null player being chosen is 1 minus the sum of all players’ creation capabilities.

Choose a player to initiate discovery: This process uses Matlab’s **randsample** function to generate a random weighted sample of size 1 (i.e., choose one player) from the set of all players plus a null player, where the probability of each player being chosen is their discovery capability, and the probability of the null player being chosen is 1 minus the sum of all players’ discovery capabilities.

Record metrics, accumulate profits and set time = time + 1: At this point the current time period ends so profit is accumulated by adding each player’s current profit to their accumulated profit. The status of the game at the end of each period is archived by recording the current profit distribution, characteristic function, coalition structure, and distance from equilibrium.

Flowchart of the creation process assuming player ch has been chosen to initiate creation

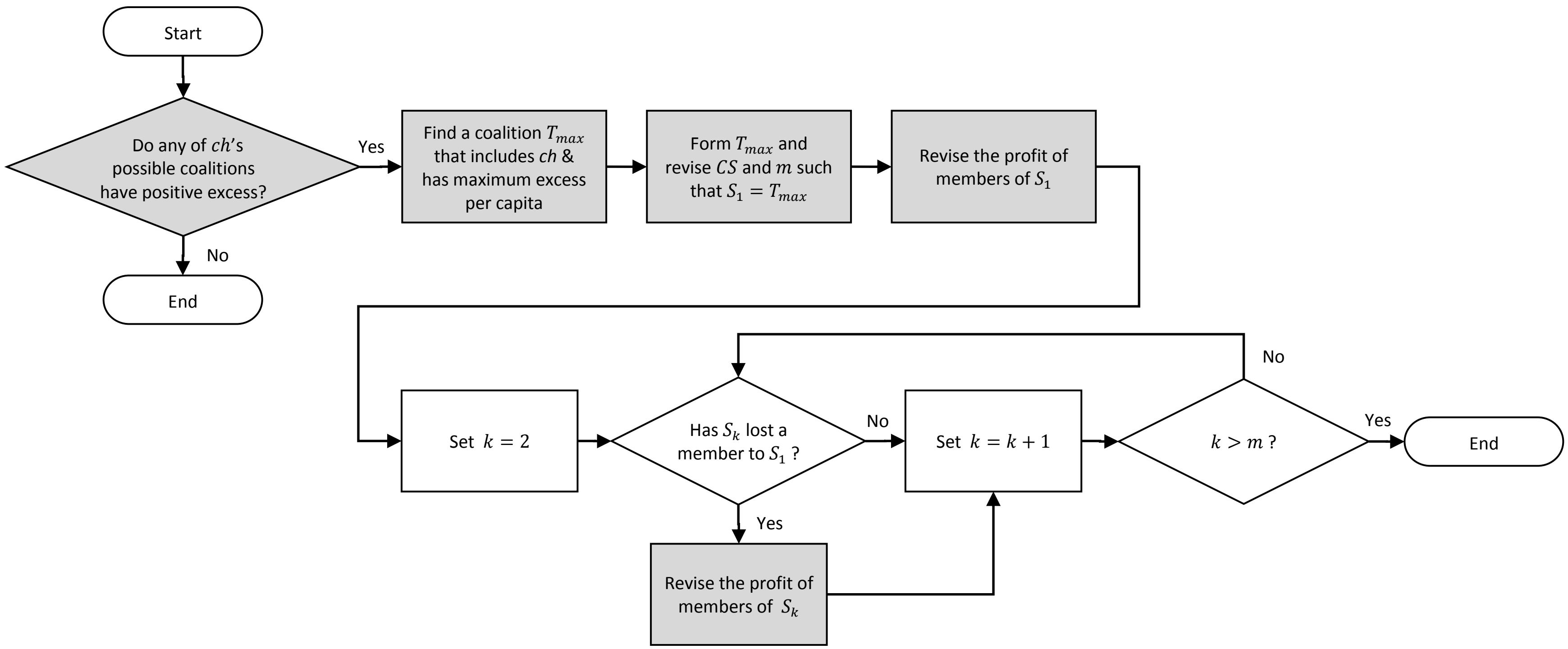
Shaded box is described in more detail below the flowchart. Note that $\Omega = \{T_1, T_2, \ldots, T_{2^n}\}$ denotes the set of all subsets of N or the set of all possible coalitions.



Revise $v(T_u)$: Here we update the value of the characteristic function for the focal coalition. If the chosen player is a member of T_u the value of this coalition is increased by the chosen player's innovation magnitude. In other words, $v(T_u)$ is set to $v(T_u) + innovation\ magnitude\ of\ ch$.

Flowchart of the discovery process assuming player ch has been chosen to initiate discovery

Shaded boxes are described in more detail below the flowchart. Note that $CS = \{S_1, S_2, \ldots, S_m\}$ is the set of actual coalitions or the set of coalitions currently formed at the start of the discovery process, where m is the number of currently formed coalitions. $\Omega = \{T_1, T_2, \ldots, T_{2^n}\}$ denotes the set of all subsets of N or the set of all possible coalitions. $x = (x_1, x_2, \ldots, x_n)$ denotes the profit distribution where x_i denotes the current payoff of player i, $x(S_k) = \sum_{j \in S_k} x_j$ denotes the sum of the current payoffs of the members of S_k, and $b = (b_1, b_2, \ldots, b_n)$ is the bargaining power vector such that b_i denotes the bargaining power of player i.



Do any of ch's possible coalitions have positive excess? This decision point asks whether any possible coalition T_u exists that contains ch (i.e., $ch \in T_u$) and that has positive excess (i.e., $v(T_u) - x(T_u) > 0$).

Find a coalition T_{max} that has maximum excess per capita: choose the coalition that maximizes the function $\frac{v(T_u)-x(T_u)}{|T_u|}$ where $|T_u|$ denotes the number of members in T_u. In other words, find T_{max} such that $\frac{v(T_{max})-x(T_{max})}{|T_{max}|} \geq \frac{v(T_u)-x(T_u)}{|T_u|}$, $\forall u \mid ch \in T_u$. If there is more than one coalition that satisfies this condition, choose randomly between them.

Form T_{max} and revise CS and m such that $S_1 = T_{max}$: In this step the coalition structure changes. We save a copy of the current coalition structure in $CS' = \{S'_1, \ldots, S'_{m'}\}$. We create the new CS as follows. First the coalition T_{max} is formed by taking its members out of current coalitions and setting it as the first coalition in the new coalition structure, i.e., $S_1 = T_{max}$. The rest of the coalitions in the new CS are constructed by setting $S_k = S'_{k-1} - S_1$ using Matlab's **setdiff** command and then removing all the S_k sets that are empty. Finally, the number of sets in the new CS is counted and m is set to this value.

Revise the profit of members of S_1: For each $i \in S_1 = T_{max}$ we set:

$$x_i = x_i + excess\ discovered\ by\ ch \times relative\ bargaining\ power\ of\ player\ i$$

In other words, increase the profit of each member of the blocking coalition $S_1$by that player's share of the excess discovered by ch. Excess discovered is calculated by multiplying excess by the exploitation efficiency of the discoverer. The size of each player's share of the excess discovered is determined by their relative bargaining power. More specifically:

$$x_i = x_i + \big(v(T_{max}) - x(T_{max})\big) \times (exploitation\ efficiency\ of\ ch) \times \frac{b_i}{\sum_{j \in T_{max}} b_j}$$

In the default condition where all players' bargaining powers are equal, the above reduces to:

$$x_i = x_i + \frac{excess\ discovered\ by\ ch}{|T_{max}|}$$

Revise the profit of members of S_k: If S_k has lost a member to S_1, the coalition is reshaped and its members may not be able to earn the same amount of profit as when they were in a larger coalition. Whether or not the size of the pie to be divided between the members of S_k is changed, the loss of players changes the relative bargaining power of the remaining players, so another round of bargaining to determine each player's share is also necessary. So in this step, for each $i \in S_k$ we set:

$$x_i = pie \times relative\ bargaining\ power\ of\ player\ i$$

Where pie is the lesser value among $x(S_k)$ and $v(S_k)$. More specifically:

$$x_i = \min\{x(S_k), v(S_k)\} \times \frac{b_i}{\sum_{j \in S_k} b_j}$$

D. Further Results of Robustness Checks

Some robustness checks involve manipulating variables not central to our simulation experiments or findings not central to our theory development, yet the results merit mention:

Figure 2 (1 discoverer, 3 passives): Robustness analysis showed that if we increase the bargaining power of the discoverer, the player gains a performance advantage over the passive players exactly proportional to the relative difference in bargaining power. In reality entrepreneurs who discover an opportunity often have to rally incumbent players to join their coalition. These incumbent players can have higher bargaining power than the entrepreneurs themselves. A full discussion of the effect of variations in the bargaining power of passive players is beyond the scope of this paper. Robustness tests also showed that if the characteristic function had been different, the discoverer may have easily been able to use the passivity of other players to its advantage. For example, if the characteristic function was such that the discoverer had a disadvantage in equilibrium compared to some state in disequilibrium, it would not equilibrate the market beyond that point (Keyhani and Lévesque, 2011). This could happen if the discoverer in our example was one of the game producers, and would like to keep the other game producer out of the picture, because although a two-game package would sell better than one, the other partners would be less dependent on the discoverer if another game producer was involved.

Figure 3 (1 discoverer, 1 creator, 2 passives): Robustness analyses revealed that starting with advantageous positions in the characteristic function or an advantageous coalition structure and profit distribution can hasten the arrival of the breakaway point when the creator and discoverer start making more profit than passive players.

Figure 5b (2 discoverers, 1 creator, 1 passive): Robustness analysis provides further indications of the devastating toll of competition on pure discoverers. Increasing the level of discovery capability or the level of exploitation efficiency (see Table A2) for the competing discoverers is of no help to them. However, a discoverer with higher bargaining power or a potential advantage according to the starting characteristic function may be able to surpass passive players and less advantaged discoverers. Also, the larger the size of the economy, the later the creator is able to break away in terms of performance advantage over passive players and competing discoverers.

Figure 5c (1 discoverer, 2 creators, 1 passive): Robustness tests indicate other variables can also result in a competitive advantage for one creator over another when they are both competing for just one discoverer. A higher creation capability or innovation magnitude gives advantage to a creator compared to another. It also benefits the discoverer as expected. These tests also show that in our model, a lower innovation magnitude can be compensated by higher innovation capability and vice versa. Bargaining power can also set one creator apart from others, and unlike increased creation capability or innovation magnitude, a creator’s higher bargaining power does not also benefit the discoverer (i.e., returns to bargaining power are zero-sum rather than win-win).

E. Experimental Design

The main variables we manipulate as the input to our simulation experiments are the creation and discovery capabilities of each of four players. Assuming a binary condition of having or not having each of these capabilities, the total number of possible combinations can be calculated with the following formula: since we have n=4 players, each of which can have r=4 possible combinations of capabilities (none, only creation, only discovery, both) and since the ordering of players is not important, the formula is[1]:

$$\binom{n+r-1}{r}$$

In our case, this amounts to $\binom{7}{4} = \mathbf{35}$ **possible combinations**. We can list them all as follows:

{None,None,None,None} {None,None,None,Discovery} {None,None,None,Creation} {None,None,None,Both} {None,None,Discovery,Discovery} {None,None,Discovery,Creation} {None,None,Discovery,Both} {None,None,Creation,Creation} {None,None,Creation,Both} {None,None,Both,Both} {None,Discovery,Discovery,Discovery} {None,Discovery,Discovery,Creation} {None,Discovery,Discovery,Both} {None,Discovery,Creation,Creation} {None,Discovery,Creation,Both} {None,Discovery,Both,Both} {None,Creation,Creation,Creation} {None,Creation,Creation,Both} {None,Creation,Both,Both} {None,Both,Both,Both} {Discovery,Discovery,Discovery,Discovery} {Discovery,Discovery,Discovery,Creation} {Discovery,Discovery,Discovery,Both} {Discovery,Discovery,Creation,Creation} {Discovery,Discovery,Creation,Both} {Discovery,Discovery,Both,Both} {Discovery,Creation,Creation,Creation} {Discovery,Creation,Creation,Both} {Discovery,Creation,Both,Both} {Discovery,Both,Both,Both} {Creation,Creation,Creation,Creation} {Creation,Creation,Creation,Both} {Creation,Creation,Both,Both} {Creation,Both,Both,Both} {Both,Both,Both,Both}

Below, we go through various groups of the above combinations and consider how they are addressed in our study. In the {None,None,None,None} combination, nothing happens. **We have 34 remaining combinations to explore.**

The remaining combinations with no discovery happening (4 in total) are all similar scenarios:

{None,None,None,Creation} {None,None,Creation,Creation} {None,Creation,Creation,Creation} {Creation,Creation,Creation,Creation}

Although potential value and distance from equilibrium are increased due to creation activity, no actual performance is observed because no profits are realized. We have covered this scenario in the base case of Figure 1. The only difference between the combinations would be the coalitions for which potential value (unexploited opportunities) are increased. There is no performance heterogeneity. **We have 30 remaining combinations to explore.**

There are 4 remaining combinations with only discovery happening, and these are also similar scenarios:

{None,None,None,Discovery} {None,None,Discovery,Discovery} {None,Discovery,Discovery,Discovery} {Discovery,Discovery,Discovery,Discovery}

[1] The formula and its derivation can be found at:
http://www.mathsisfun.com/combinatorics/combinations-permutations.html
An online calculator for the formula can be found at:
http://www.mathsisfun.com/combinatorics/combinations-permutations-calculator.html

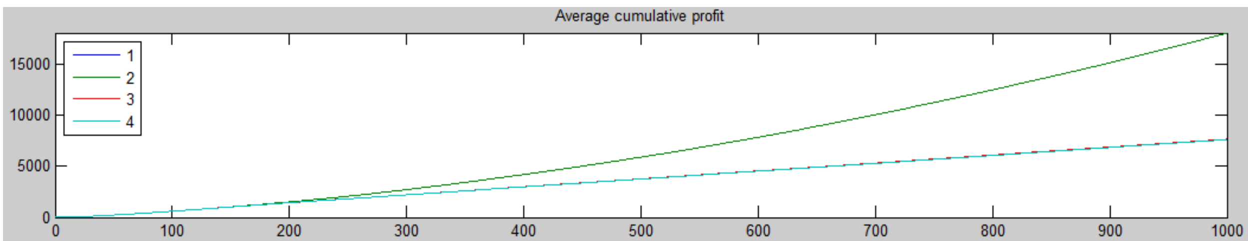
Since there is no creation activity, the characteristic function does not change and throughout the game we are dealing with the starting characteristic function (Table 1e), in which the most profitable opportunity for all players is the grand coalition. Thus in all these scenarios, similar to the one covered in Figure 2, the economy quickly reaches equilibrium and stays there because there is no creation activity to disrupt it. The only difference between the combinations is how quickly equilibrium is achieved. Increased discovery activity speeds up equilibration. Assuming equal bargaining power, the discoverers and passive players all attain the same performance in these scenarios because ultimately the grand coalition needs to be formed and its value is divided equally. So under this assumption Figure 2 is an adequate representative of all 4 combinations.

Experimenting with different bargaining power levels here produces interesting results that due to the need for extended discussion, we have chosen not to cover in this paper due to length limitations. We may want to assume different bargaining power because we may want to give discoverers more credit for being the one to discover the value divided, or we may want to give passive players higher bargaining powers to model the interaction between start-ups and passive but more powerful incumbents. In either case, our results indicate that relative and absolute performance do not predictably rise with increased bargaining power and the bargaining power – performance relationship in the "no creation activity" scenarios follows an unusual pattern that needs to be investigated more thoroughly. Currently, we suspect that the unusual pattern observed has to do with the effect of bargaining power in the sequencing of negotiations (i.e., the sequence of coalition changes and bargaining processes before finally reaching equilibrium). **We have 26 remaining combinations to explore.**

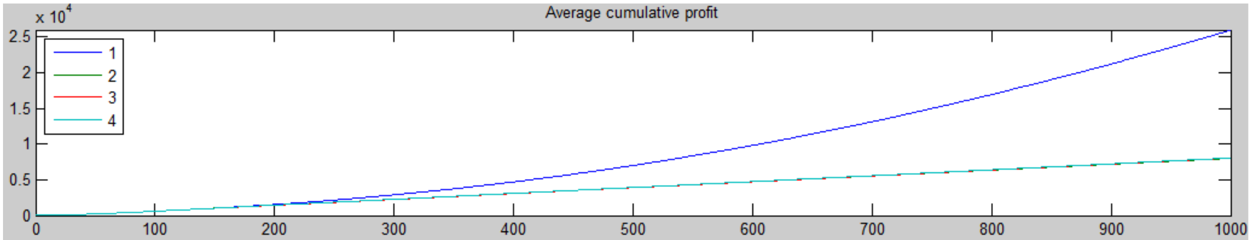
There are 4 combinations in which we only have passive players and players with both creation and discovery capabilities:

{None,None,None,Both} {None,None,Both,Both} {None,Both,Both,Both} {Both,Both,Both,Both}

The first combination {None,None,None,Both} is analogous to the combination {None,None,Discovery,Creation} that is covered in Figure 3 in the main paper. The Figure 3 cumulative performance results are:



The results for the {None,None,None,Both} combination are:

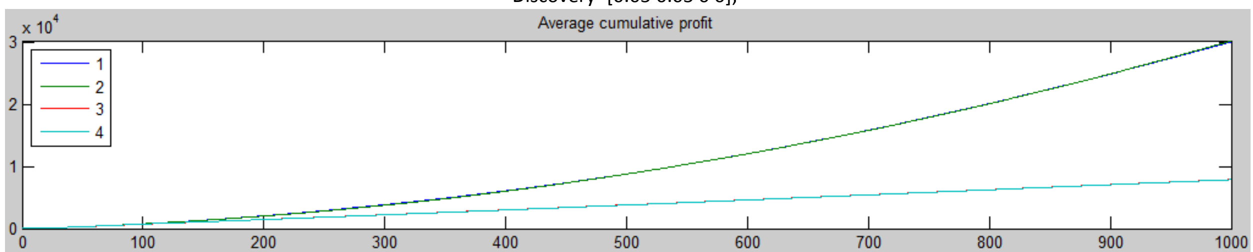


Where player 1 (blue line) is the dual-capability player. In fact this is almost identical with the results of Figure 5b, where competition among discoverers drives their rents to zero to the benefit of the creator. Here too, the creator is the only one benefiting from the discovery activity.

The only difference with Figure 3 is that profits are accrued by one agent instead of two, which is a predictable outcome and the reason why we do not allocate a specific figure to it in the paper. Though much higher, the profit level is not exactly double the case of Figure 3, because 1) the discovery capability level of 0.05 is higher than the saturation point necessary for the dual-capability player to gain all profits made possible by its own creation activity, and 2) in the partnership scenario in Figure 3, the two players are already able to earn a larger-than-half portion of the maximum profits possible if they were merged into one player. The results for the {None,None,None,Both} combination do not really illustrate anything beyond the synergy of creation and discovery and the non-linear returns to increased discovery, which are both points illustrated by experiments covered in the paper.

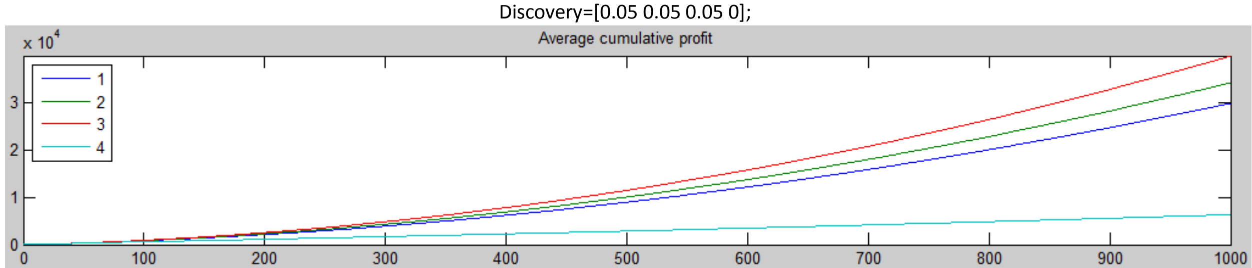
Any additional dual-capability players added to this scenario also produce results predictable from the patterns already discussed in the paper. Any dual-capability players perform higher than passive players and perform exactly at the same level as each other if they have the same level of capabilities. This level is higher than that of the single player mode because players can take advantage of each other's creation activity (and discovery if needed, i.e., if saturation has not yet occurred).

{None,None,Both,Both}
Creation=[0.05 0.05 0 0];
Discovery=[0.05 0.05 0 0];



If we give them different levels of creation capabilities, this will produce a predictable difference in performance between them as suggested by the results covered in the paper.

{None,Both,Both,Both}
Creation=[0.05 0.06 0.07 0];
Discovery=[0.05 0.05 0.05 0];



Differences in discovery capability will only create performance differentials if the overall discovery activity available to any players becomes lower than that player's saturation point given the overall level of opportunities made available to it by the overall level of creation activity.

Although the above scenarios serve to further illustrate the points already made in the paper, they do not significantly add to the findings discussed in the paper and that is why we have made the decision to save space by omitting them. **We have 22 remaining combinations to consider.**

{None,None,Discovery,Creation} is already covered in Figure 3

{None,Discovery,Discovery,Creation} is already covered in Figure 5b (competition among discoverers)

{Discovery,Discovery,Discovery,Creation} this combination produces results virtually identical to Figure 5b because the mechanism is the same, i.e., competition among discoverers is driving their rents to zero compared to passive players to the benefit of the creator, and the additional discovery activity produces no added value for the creator who already has access to enough discovery activity to reach the saturation point.

{None,Discovery,Creation,Creation} is already covered in Figure 5c (competition among creators)

{Discovery,Creation,Creation,Creation} this combination produces predictable results that further demonstrate the mechanism that produces the results of Figure 5c. The results are similar to Figure 5c with all players performing at the same level, but a higher level than Figure 5c because there is now more creation activity that all players can benefit from.

{Discovery,Discovery,Creation,Creation} this combination also produces results easily predictable given the results already discussed in Figures 5b and 5c. Here, competition among discoverers drives their rents to the level of passive players and the profits are accrued to creator players, who perform at the same level.

Thus the above 6 combinations are either covered or similar to those covered in the paper. **We have 16 remaining combinations to consider.**

{None,None,Discovery,Both} is already covered in Figure 6b. The addition of more discoverers as in {None,Discovery,Discovery,Both} or {Discovery,Discovery,Discovery,Both} produces results virtually identical to Figure 6b because the mechanism is the same (competition among discoverers driving their rents to the level of passive players). Only the player with some level of creation capability makes superior profits.

{None,None,Creation,Both} is already covered in Figure 6a. The addition of more creators as in {None,Creation,Creation,Both} and {Creation,Creation,Creation,Both} produces results similar to Figure 6a. The results produced demonstrate the same mechanism that produced Figure 5c compared to 5a. The additional creators benefit from each other's creations and the discovery activity of the dual-capability player.

Thus again, the above 6 combinations are either covered or similar to those covered in the paper. **We have 10 remaining combinations to consider. But the remaining 10 combinations also produce predictable results that demonstrate the same mechanisms covered above**: {None,Discovery,Both,Both} {Discovery,Discovery,Both,Both} {None,Creation,Both,Both} {Creation,Creation,Both,Both} {None,Discovery,Creation,Both} {Discovery,Discovery,Creation,Both} {Discovery,Creation,Creation,Both} {Discovery,Creation,Both,Both} {Discovery,Both,Both,Both} {Creation,Both,Both,Both}.

Whenever there is more than one player with discovery capability, only players with any creation capability perform better than the passive player level. Whenever there is more than one player with creation capability, the creators complement each other.

In conclusion, the patterns covered in the manuscript (substitution effect of discovery, complementarity effect of creation, saturation of opportunities, etc.) adequately cover all patterns observed in simulation of all 35 possible combinations. With the only exception being patterns observed regarding bargaining power which we have consciously decided to exclude from the scope of this paper.

Online Supplement References

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