Real Options Analysis on Ecosystem for Agri-biotechnology Start-ups in Indonesia

Anjani Putri[1], Takao Fujiwara[2]
[1]Department of Architecture and Civil Engineering, Toyohashi University of Technology, Toyohashi, Japan
[2]Institute of Liberal Arts and Science, Toyohashi University of Technology, Toyohashi, Japan

Abstract--**Indonesia as the country that has great biological resource is considering the development of Biopark, a kind of Science Park that focuses on biotechnology. The government of Indonesia already made Biopark development plan in 2009, but to date it has not been realized. The possible problem is that the project seems to have a negative net present value (NPV). It needs appropriate way to assess the value of investment in Biopark, considering more than one source of uncertainty and potential growth in the future. The way to commercialize the result of research and development by Biopark, which is done by start-up or established company, is also considered. Real option analysis, especially growth option, can be a useful framework to value the investment in Biopark. Valuation of investment in Biopark by real option analysis is expected to encourage the stakeholders to start the project as soon as possible. This research has a role in valuing potential unique project, Biopark, especially in condition of Indonesia.**

I. INTRODUCTION

Intellectual capital is important in knowledge-based organizations, where the intangible assets that generate value to an organization are more important than the traditional physical asset [6]. Biopark is one of example of organization where intangible assets drive the value to an organization. The objective of this paper is to value the Biopark project in Indonesia using real option analysis. Real option analysis is a proper framework to value the project since the stakeholder has flexibilities in decision-making. The flexibility, in other words is to acquire organizational capability to respond rapidly to environmental change, develop new technologies, and promote business development, is crucial [4]. In the first section, we will discuss the background of problem. In the second session, we will make clear the research question of this paper. In the third section, we will use real option analysis approach to value the project. Five scenarios have been developed to represent the value of the project, which will improve by using real options analysis. First, we will value the project by NPV (Net Present Value) approach, assuming business activities will end if the R&D (research and development) process already completed. Second, we will value the project assuming investors pre-commit to found start-up to commercialize result of R&D, or assuming investors pre-commit to out-license the result of R&D to established company by NPV approach. Third, we will value the project by real options analysis assuming the investors have flexibility to found start-up or abandon the project. Fourth, we will value the project assuming the investors have mutually exclusive alternatives for commercialization by founding start-up, out-licensing to established company, or abandoning the project. In the fourth section, sensitivity analysis is done to check the robustness of the model and to understand the relationship between variable and parameter. Fifth, we will derive conclusion of the paper and proposed the future expected progress of this paper, considering strategic value in relation to global competition. Strategic value is inevitable driver of market value of the firm [11].

II. BACKGROUND

A. Potential of Biological Resource in Indonesia

A report states that Green-economics value of Indonesian biological diversity is estimated to be at least one trillion US dollar per year over the next 20 years. Indonesia is also one of the centers of mega-biodiversity in the world which has 47 ecosystem types ranging from deep lakes to shallow swamps, from spectacular coral reefs to sea-grass meadows and mangrove swamps, and from ice fields and alpine meadows in Papua to a wide variety of humid lowland forests. This diversity of ecosystems and species naturally lead to biological diversity. Based on previous studies, approximately 17 percent of the total number of species in the world is found in Indonesia, details of which are listed in table 1 [9].

B. Industrial fields contributing to Indonesia's GDP

Despite the diversity of biological resource in Indonesia, oil and gas processing is the field which account for the largest contribution to Indonesia's GDP, with the details as shown in figure 1 [7]. This kind of natural resources will be depleted over time. Biotechnology, which is application of science to utilize life organism to produce chemical substance useful for human being, could be applied to invent and discover new foods, medicines, pharmaceutical products, agriculture products, and so on. Biotechnology is expected to improve Indonesia's competitive advantage for the global market in producing biotechnological product.

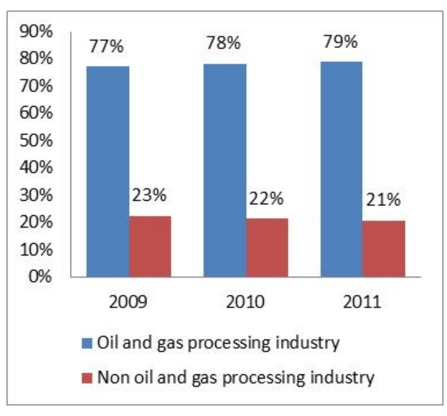

Figure 1. Comparison of the contribution of each industrial field to GDP
Source : Industrial Ministry of Indonesia (2012)

TABLE 1. DIVERSITY OF BIOLOGICAL RESOURCES IN INDONESIA

Taxonomic group	Species	Endemic species	Percent endemism	Species' number in Indonesia compared to species' number in the world
Plants	25,000	15,000	60.00%	11% (flowering plant)
Mammals	380	172	45.26%	12%
Birds	769	142	18.47%	17%
Reptiles	452	243	53.76%	15-16%
Amphibians	244	196	80.33%	
Freshwater fishes	950	350	36.84%	25-37% (water fish)

Source: Park, Junaedi, Li (2010)

C. Biotechnological development program

However, biotechnology development program still face some challenges and problems, such as lack of funding, insufficient research facilities, inappropriate human resource capability, lack of program integration, and weak institutional capacity. The solutions may include developing an integrated biotechnology plan, progressive scenarios, spread out strategic alliances and networking, and upgrading and building of competitive research infrastructure. Biopark, a kind of Science Park engaged in biotechnology, is an approach to establish the modern research facilities. It will be combined with a strategic and integrated approach and it is expected to be a world-class biotechnology research center [8].

In the future, Biopark is expected to be a stimulus for foundation of start-up or economic growth of established company. Biopark can do basic research to create innovative product and this kind of research is suitable to be commercialized by start-up since it is better in risk-taking, speed, and cost. Established companies are more reluctant to commercialize innovative product since it has uncertainty in the size of market. On the other hand, start-up has owns shortcoming which is vulnerable in facing the Death Valley, initial negative profits period.

The existence of Biopark, start-up, and established companies makes easily forming a biotech cluster. Cluster itself means a set of these parties who works in one special same field in the same geographic location. In developed countries, the cluster system already exists and has been proven to improve productivity, competitiveness, interconnection, and in the future, it will boost the economy of the country. There are less than 25 countries in the world, which has biotech-cluster, and the United States of America is the country that has the highest number of biotech clusters, which are seven. Japan also has three biotech clusters located in Kanto, Kansai, and Hokkaido. The other examples are Singapore and India [2].

D. Overview of Indonesia's biotechnological development program

Ministry of research and technology has proposed the plan in establishment of Biopark, called Serpong Biopark, which located close to Jakarta, the capital city of Indonesia (figure 2). Ministry of national development planning has already considered the project in 2009. Activities in establishment of Serpong Biopark are :

a. Building construction and equipment installation of bio-prospecting, bio-informatics, bio-industry, germ-plasma and biology molecular laboratories
b. Upgrading several research facilities on existing biotechnology laboratories and units
c. Operation and maintenance
d. Collaborative research and dissemination program
e. R&D capacity building (fellowship and training)
f. National strategic program for biotechnology development

The priority of the development of Biopark is revitalization of agriculture, rural, marines, and fisheries [8].

Serpong, one of sub-district in South Tangerang city, is selected to be a location of Biopark establishment since the science and technological research center owned by government is located there. However, it has not included yet in priority list of the project funding by foreign investors and government. Then we wish to value the potential of project.

Figure 2. Location of development plan of Serpong Biopark (A)
Source: Google Map. Access date: December 30th, 2013

E. The valuation of Serpong Biopark development plans

The focus of Serpong Biopark is to carry out research and development. R&D project is a prerequisite in a chain of establishment biotech cluster. Investment in Serpong Biopark may open the future opportunities, such as invention of new-generation product, establishment of start-ups, etc. Although its calculation of Net Present Value (NPV) seems negative, the infrastructure, experience, and potential by-products generated during the development of the first generation product can be a milestone for developing higher-quality future generations [10].

Real option valuation, especially growth option, is useful framework to value this kind of project. The purpose of this paper is to value the real option in Serpong Biopark investment, by considering uncertainty in technological aspect and market, future growth, and commercialization process by start-ups or established companies.

III. RESEARCH QUESTION

From the background explained, it can be understood that it is necessary to start the founding of Biopark project as soon as possible. Government of Indonesia as a key player might be interested in the valuation of the project. Biopark needs a huge investment, while its return is uncertain and it should be endured in deficit condition in long time. NPV will not be the suitable method to value the project because the valuation result must be negative and no one want to invest in the project. It should be real option analysis, which consider flexibility of strategic decision and uncertainty, which will be the suitable one. Growth option, as one of the kind of real option, would be considered since the project will open future growth. How can be a growth option would be a useful framework to convince investors that Biopark project is worth to start? From the perspective of Ministry of Research and Technology, how can encourage the Ministry of National Development Planning to start the investment in Biopark as soon as possible? Or from the perspective of Ministry of National Development Planning, how can encourage the foreign investors to invest in biotech cluster as soon as possible? The right method valuation will lead to better decision. Furthermore, we want to know how is growth options created in detailed? Example of growth of the project in the future is we could commercialize the research result of Biopark. There is possibility that government of Indonesia want to encourage the number of local companies by founding start-up. However, there is another choice to commercialize the research result, which is out-license to established company that could be foreign owned company or local company. Real option analysis could value the project by handling mutually exclusive alternative of commercialization. How can be real option valuation would be a useful framework to compare commercialization by start-ups or established companies in handling mutually exclusive alternative?

IV. REAL OPTIONS MODEL OF BIOTECH CLUSTER ESTABLISHMENT

A. Growth option (Sequential Compound Option)

Growth option is valuable when the investment in first stage or investment in pioneer project or base investment seems have negative NPV. Investing in pioneer project is like buying an option premium, giving the option holder the right to acquire new cash flow stream in commercialization project [13]. In the case of Serpong Biopark, the initial investment is investment in basic activities as already stated in section 2.4, while the second investment is investment in infrastructure for start-up foundation. Existence of Biopark, start-up, and established companies mean establishment of biotech cluster as illustrated in figure 3. If the result of research and development by Biopark is successful, then it can be considered to invest in infrastructure of start-up, or later called second stage investment, as illustrated in figure 4.

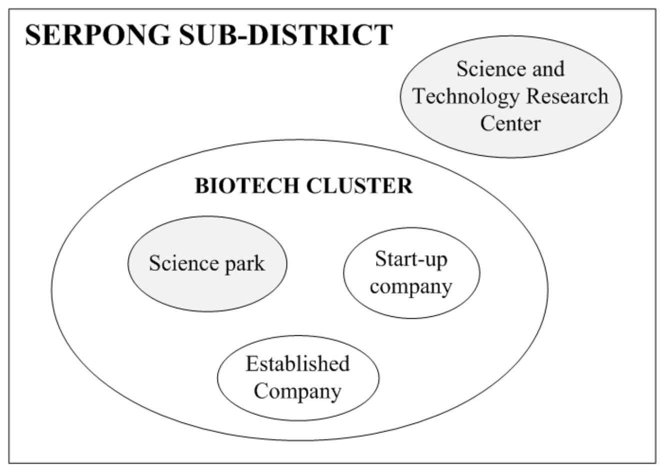

Figure 3. Overview of the development of Serpong Biopark

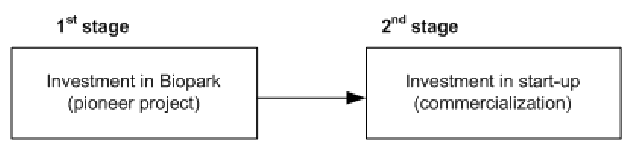

Figure 4. Step of investment in Biotech cluster project

It means the detail of growth option is sequential compound option. The second option (investment in start-ups infrastructure which its exercise price is amount of money required for investment) is created only when the first option (option to invest in Biopark) is exercised. The first option means the right to buy a second option.

B. Rainbow option

Rainbow option means options that are driven by multiple sources of uncertainty [1]. In the case of Biopark investment, the first one is uncertainty in research and development stage by Biopark (assumed to be not correlated with the market), and the second one is uncertainty in product/market (assumed to be correlated with the market). We will consider technological uncertainty too since success will depend, in the end, on whether the company bought the right researchers, and whether they can produce marketable products or techniques [3].

C. Real option analysis handling mutually exclusive alternatives

There is a difference between valuing a project by NPV and by real options. The NPV approach treats the alternative as mutually exclusive alternative, while real options approach is able to reduce the choice between the alternatives to an option that has single value (a value that captures the flexibility of choosing between alternatives) conditional on the state of nature at a future date. Real option value will have greater or at least the same NPV value without flexibility [1].

In the case of investment in Biopark, the alternatives are to commercialize R&D result by constructing infrastructure to found start-up or licensing it to established company.

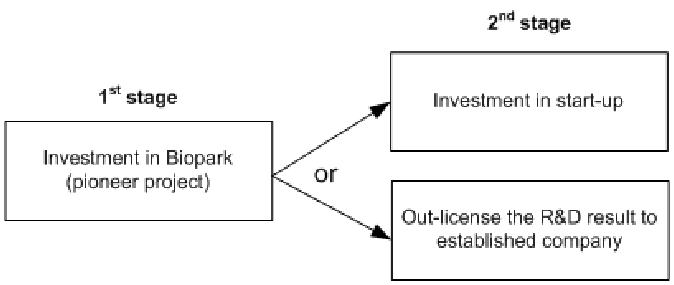

Figure 5. Mutually exclusive alternatives of commercialization

D. Real option framework for Investment in Biopark

There will be five scenarios, which the value of project will be calculated. The symbol, value, and explanation of each parameter are figured in table 2.

1) Valuation of project when it is just at R&D stage in NPV

In this case, amount of base investment (I_1) is assumed to be \$27.5 million and founding phase for Biopark takes 1 year (t_1). The R&D process spend 1 year (t_2), and at the end of second year, there is a probability that result of R&D will produce great product (10%), mediocre product (20%), or fail (70%). The result of R&D is assumed to have each value \$50 million for great product, \$25million for mediocre product, and \$0 for failed product. The scheme and calculation of this scenario is illustrated in figure 6.

Node D

$$Expected\ PV_D = \frac{(10\% \times 50) + (20\% \times 25) + (70\% \times 0)}{1 + r_f}$$

Node E

$$Expected\ PV_E = \frac{Expected\ PV_D}{1 + WACC}$$

$$NPV_E = Expected\ PV_E - I_0 = -19 < 0$$

In this case, the NPV is negative so the stakeholders seem to be reluctant to start project.

TABLE 2. PARAMETER OF MODEL

Parameter	Symbol	Value	Explanation
Base investment	I_1	27.5	in million USD
Duration of 1st construction	t_1	1	year
Duration of research and development	t_2	1	year
Second investment	I_2	75	in million USD
Duration to found start-up	t_3	1	year
Market uncertainty (volatility)	σ	0.3	
Risk free rate	r_f	7%	
Weighted averaged cost of capital	WACC	10%	
Up movement	u	1.35	
Down movement	d	0.74	
Technological uncertainty (probability)	p_s	10%	success product
	p_m	20%	mediocre product
	p_f	70%	failed product
Annual revenue	Great	50	in million USD
	Mediocre	25	in million USD
	Failed	0	in million USD
Royalty of out-licensing	λ	70%	Percentage of revenue (royalty) obtained from established company's selling the product that has been licensed.

2) Valuation of project assuming investors pre-commit to found start-up in NPV

In this case, base investment (I_1), the time required to found Biopark (t_1), and the time required for R&D process (t_2), have the same values with first scenario. In the end of second year, there is a probability that result of R&D will produce great product (10%), mediocre product (20%), or fail (70%). If the product will be commercialized, it requires $75 million to found start-up (I_2). The founding process will take 1 year (t_3) and the revenue of commercialization will be $50 million annually for great product, $25 million annually for mediocre product, and $0 for failed product, starting from the end of year 4. The cost of capital (WACC) is 10% while the risk free rate (r_f) is 7%. The value of company at 1 year before constantly selling the product will be $500 million ($50 million/10%) if it is great product, $250 million if it is mediocre product, and $0 million if it is failed. This expected value can go up or down by 30% each year. This is illustrated in event tree on the right side of figure 7. The calculation is illustrated in figure 8.

Node A, node B, node C, if first revenue starts from time point 4

$$PV_A = \frac{500}{WACC} \times u = \frac{500}{0.1} \times 1.34$$

Node D, node E, node F

$$PV_D = \frac{500}{WACC} \times d = \frac{500}{0.1} \times 0.74$$

Node G, node H, node I

$$PV_G = \frac{PV_A}{1+WACC} = \frac{674.92}{1+0.1},\ NPV_G = PV_G - I_2$$

Node J, node K, node L

$$PV_J = \frac{PV_D}{1+WACC} = \frac{370.41}{1+0.1},\ NPV_J = PV_J - I_2$$

Node M, node N

$$Expected\ PV_M = \frac{(10\% \times NPV_G) + (20\% \times NPV_H) + (70\% \times NPV_I)}{1 + \frac{r_f}{2}}$$

where, $NPV_I < 0$

Node O (risk neutral probability approach)

$$p = \frac{(1 + r_f) - d}{u - d} = \frac{(1 + 7\%) - 0.74}{1.35 - 0.74} = 0.54$$

$$1 - p = 1 - 0.54 = 0.45$$

$$Expected\ PV_O = \frac{p \times NPV_M + (1 - p) \times NPV_N}{(1 + r_f/2)}$$

Node V

$$Expected\ PV_V = \frac{EPV_O}{1 + WACC} = 39.37$$

$NPV_V = EPV_V - I_0 = 11.87$ (NPV_v is greater than I_2 invest in base investment even if there are not any options)

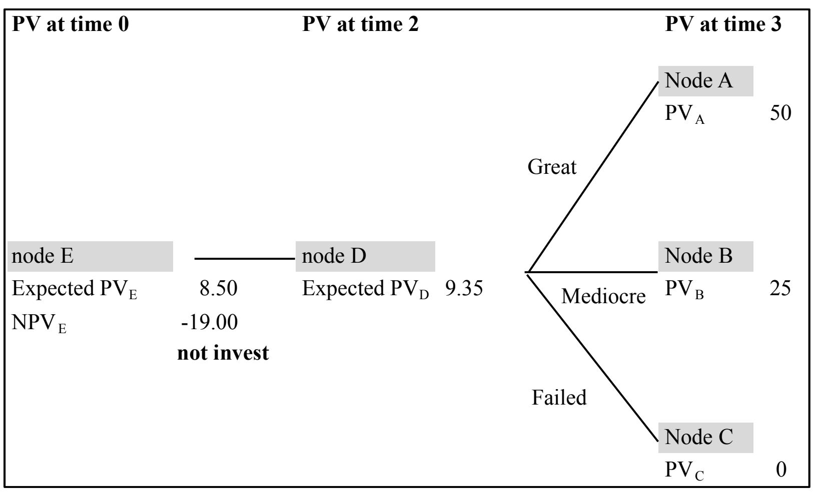

Figure 6. NPV when it is just at R&D stage

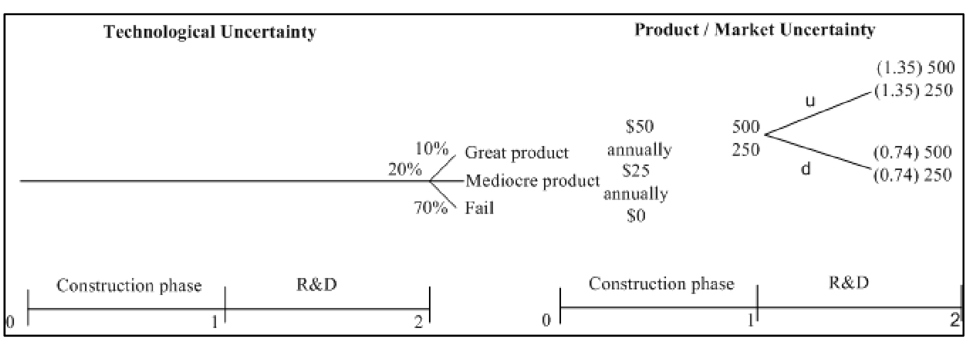

Figure 7. Event tree for technological and product / market uncertainties

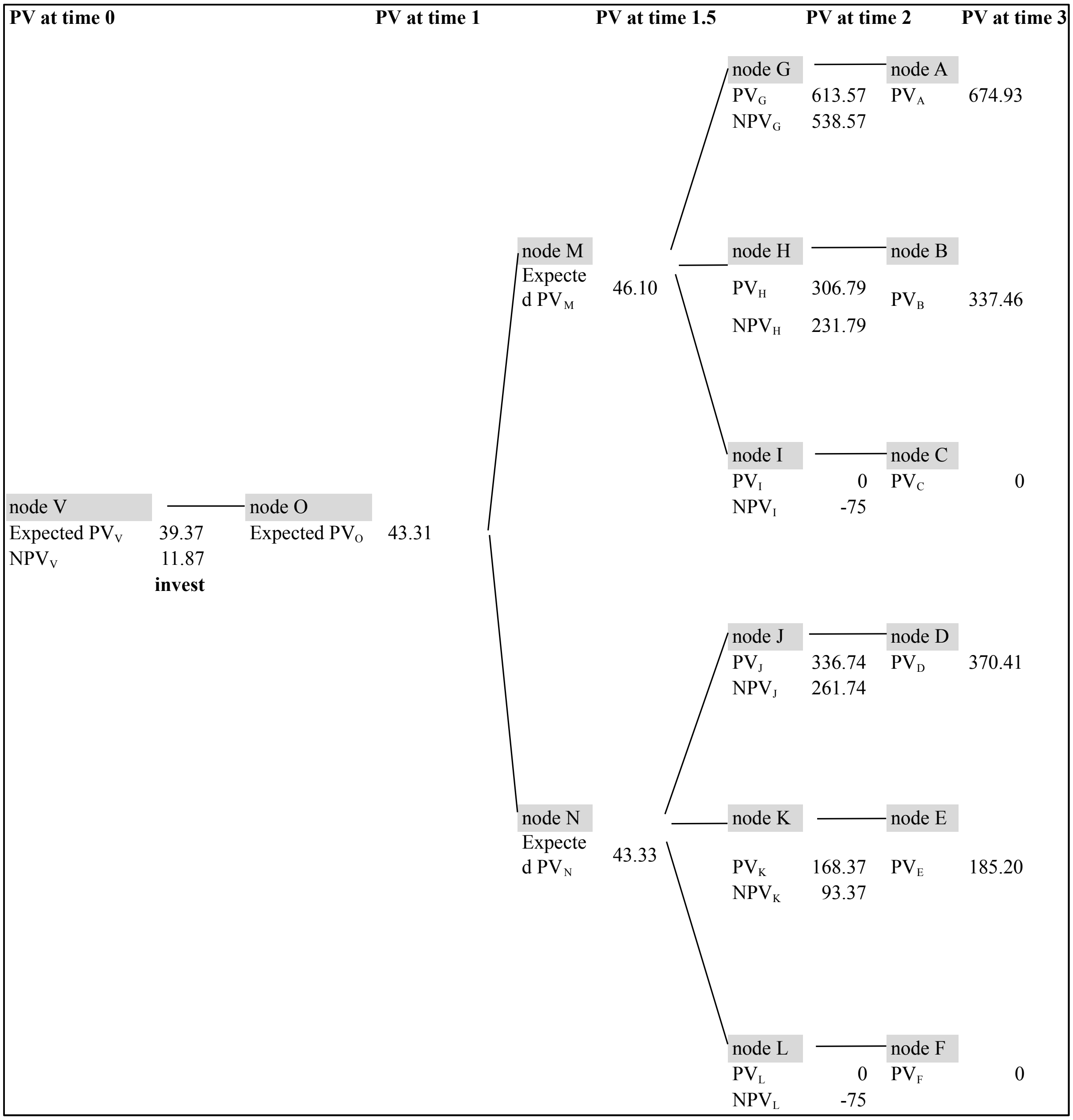

Figure 8. Valuation of project assuming investor pre-commits to found start-up by NPV

3) Valuation of project assuming investors pre-commit to out-license R&D result to established company in NPV

In this case, all the conditions with the case in section 4.4.2, except the way to commercialize the result of R&D. The stakeholders decide to pre-commit to out-license R&D result to established company. First party will get 70% of revenue obtained from established company from the sale of product that has been out-licensed (λ). The calculation is illustrated in figure 9.

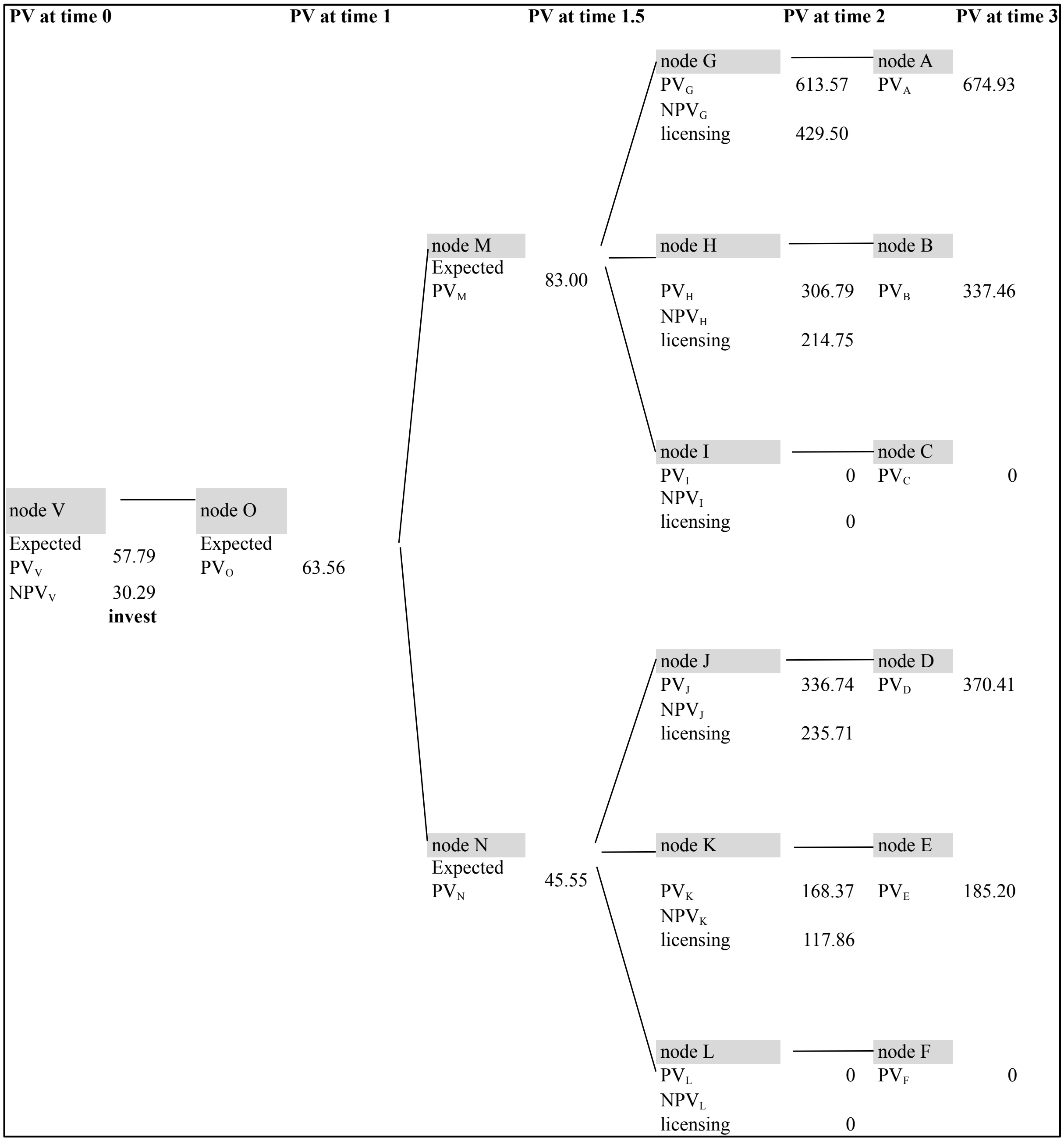

Figure 9. Valuation of project assuming investors pre-commit to out-license R&D result to established company in NPV

The way to calculate project value is similar to calculation in section 4.4.2, except its in node G, H, I, J, K, L

Node G, node H, node I, node J, node K, node L
$PV_G licensing = PV_G \times 70\%$

4) Valuation of project with option to found start-up

In this case, all the condition and parameters are the same with its in section 4.4.2, except there is flexibility to invest in second stage. Stakeholders can abandon the project if the result of R&D is unfavorable.

The way to calculate project value is similar to calculation in section 4.4.2, except it's in node G, H, I, J, K, L where there is option to abandon the project if the R&D result is unfavorable. The calculation in node O is using replicating portfolio method. The calculation is illustrated in figure 10.

Node G, node H, node I
$PV_G = \frac{PV_A}{1+WACC} = \frac{674.92}{1+0.1}$ (PV_G is greater than I_2, so invest in second investment)

$PV_H = \frac{PV_B}{1+WACC}$ (PV_H is greater than I_2, so invest in second investment)

$PV_I = \frac{PV_C}{1+WACC}$ (PV_I is less than I_2, so abandon the project)

Node J, node K, node L

$PV_J = \frac{PV_D}{1+WACC} = \frac{370.4}{1+0.1}$ (PV_J is greater than I_2, so invest in second investment)

$PV_K = \frac{PV_E}{1+WACC}$ (PV_K is greater than I_2, so invest in second investment)

$PV_L = \frac{PV_F}{1+WACC}$ (PV_L is less than I_2, so abandon the project)

Node O (replicating portfolio method)

$V_O = (10\% \times \frac{50}{r_f}) + (20\% \times \frac{25}{r_f}) + (70\% \times \frac{0}{r_f})$

$uV_O = (10\% \times \frac{50}{r_f} \times u) + (20\% \times \frac{25}{r_f} \times u) + (70\% \times \frac{0}{r_f} \times u)$

$dV_O = (10\% \times \frac{50}{r_f} \times d) + (20\% \times \frac{25}{r_f} \times d) + (70\% \times \frac{0}{r_f} \times d)$

$muV_O + (1 + r_f)B = NPV_{\boldsymbol{M}}$
$mdV_O + (1 + r_f)B = NPV_{\boldsymbol{N}}$
$m = 0.88$
$B = -21$
$PV_O = mV + B = 66.83$

Expanded NPVv > NPVv
This is reflecting abandonment as put option

5) Valuation of project with option to found start-up, out-license to established company, or abandon the project

In this case, in the end of year 2, stakeholders have the flexibility to choose mutually exclusive alternatives whether founding start-up or out-licensing to established company. The overview of the project valuation as sequential compound rainbow option is illustrated in figure 11.

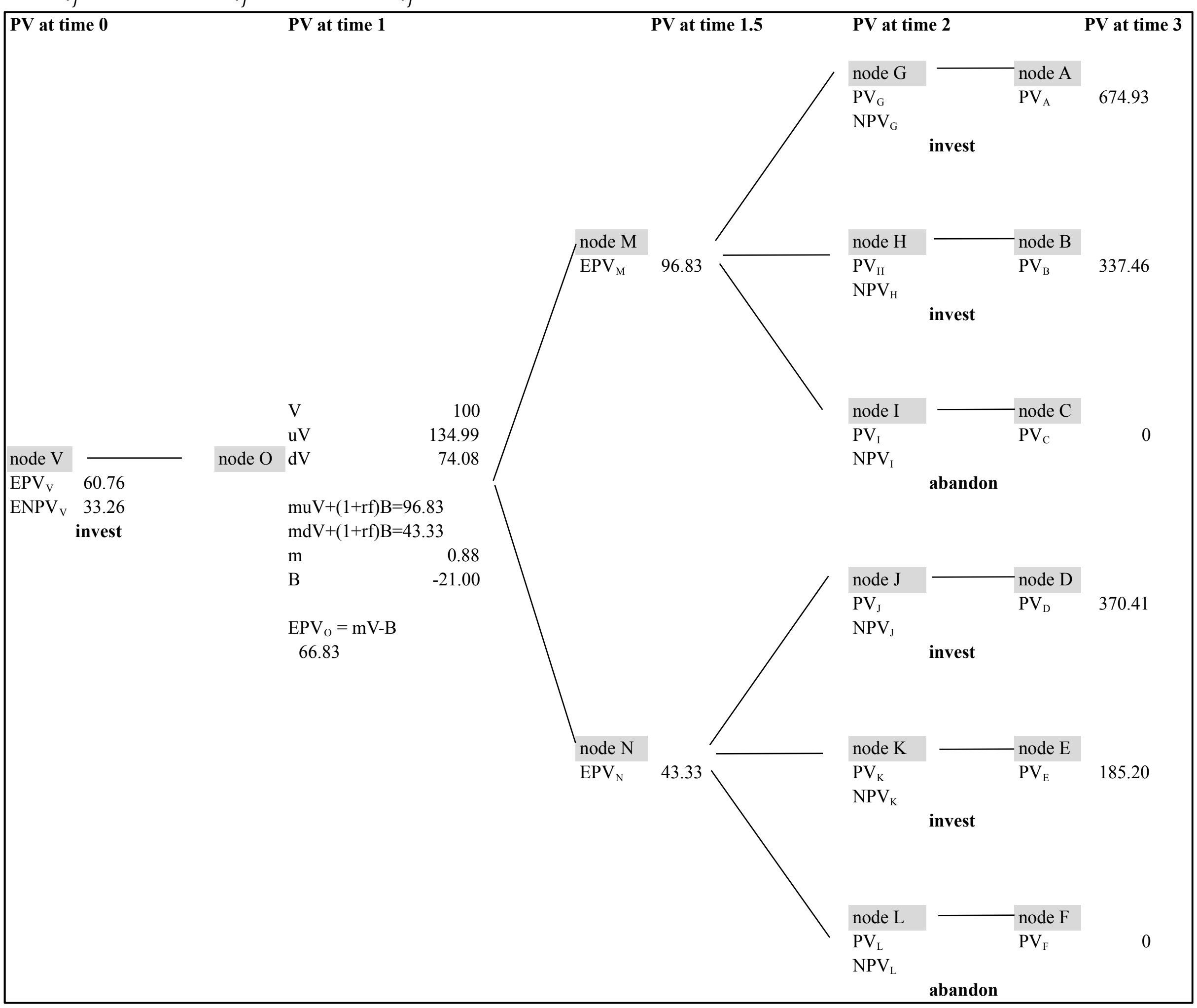

Figure 10. Valuation of project with option to found start-up or abandon the project

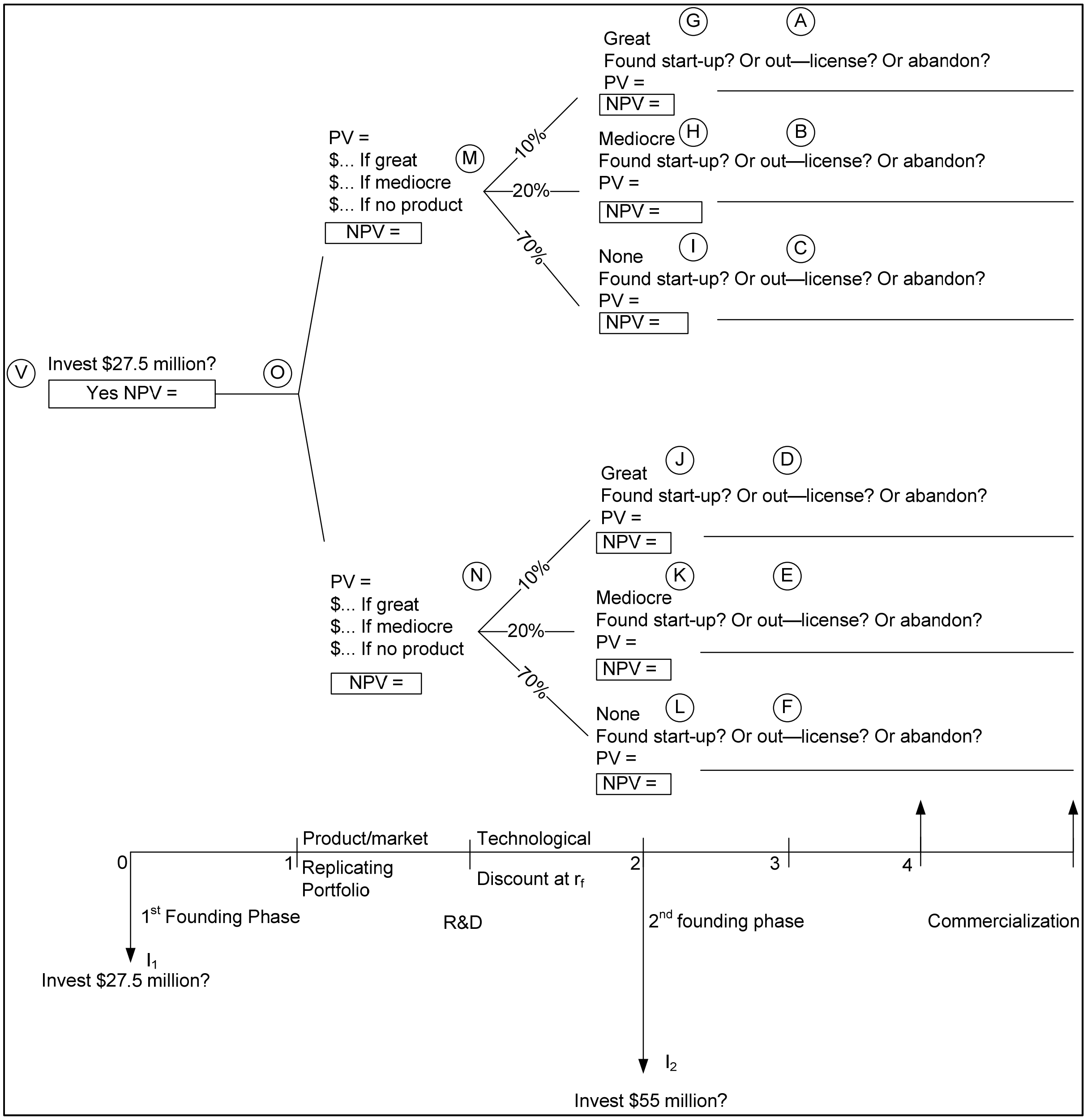

Figure 11. Biopark project as a sequential compound rainbow option

The way to calculate project value is similar to calculation in section 4.4.4, except it's in node G, H, I, J, K, L where there is mutually exclusive alternative between commercialization by start-ups or by established company. There is no exercise price in the second alternative. The calculation is illustrated in figure 12.

Node G and node H

$PV\ licensing\ G = PV_A \times 70\% = 472.45$ ($PV\ licensing\ G$ is less than PV_A, so invest in start-up)

$PV\ licensing\ H = PV_B \times 70\%$ ($PV\ licensing\ H$ is greater than PV_B, so out-license to established company)

Node J and K

$PV\ licensing\ J = PV_D \times 70\% = 259.2$ ($PV\ licensing\ J$ is less than PV_D, so invest in start-up)

$PV\ licensing\ K = PV_E \times 70\%$ ($PV\ licensing\ K$ is greater than PV_E, so out-license to established company)

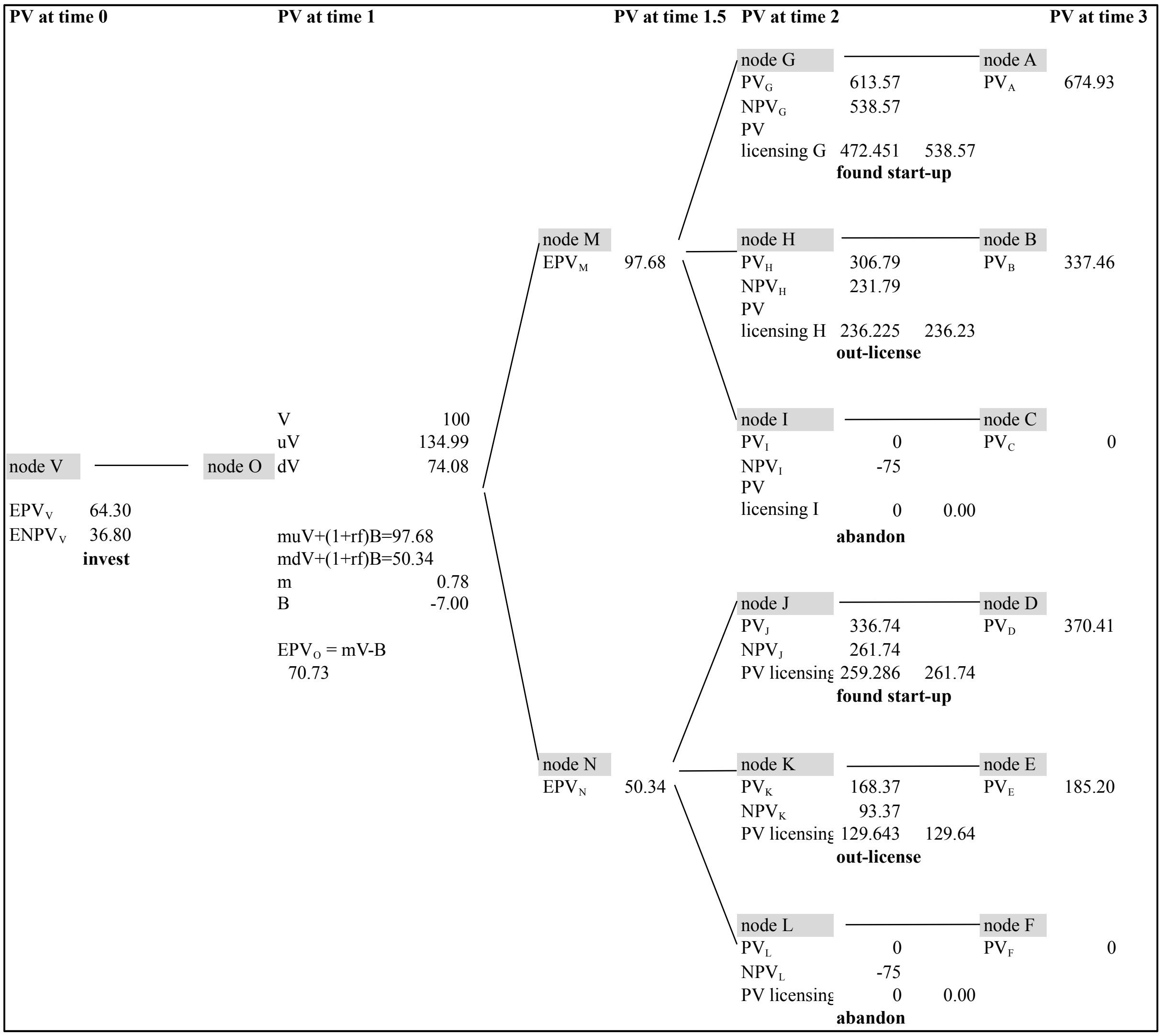

Figure 12. Valuation of project with option to found start-up, or out-license, or abandon the project

TABLE 3. PROJECT VALUE BY EACH WAY OF VALUATION

No	Scenario	Project value
1	NPV when it is just at R&D stage	-19.00
2	NPV assuming that investors pre-commit to found start-up	11.87
3	NPV assuming that investors pre-commit to out-license to established company	30.29
4	ENPV with option to found start-up or abandon the project	33.26
5	ENPV with option to found start-up, out-license, or abandon the project	36.80

6) Overview of five scenarios

Table 3 illustrates the differences of project value between each scenario and each way of valuing the project.

From the table 3, we can derive some conclusions:

1. NPV in first scenario is negative so the stakeholders seem to be reluctant to start project. It is reasonable because it neglect the possibility of growth of the project, which means the commercialization by start-ups or by out-licensing to established company.
2. When we value the project assuming investors pre-commit to found start-up, the NPV is greater than the first scenario. Investor would be more motivated to invest in this project.
3. When we value the project assuming investors pre-commit to out-license the R&D result to established companies, the NPV is greater than the second scenario. This allows that there is no exercise price (investment) in second alternative of commercialization.
4. When we value the project assuming there is flexibility to found start-up if condition is favorable or abandon the project if condition is unfavorable, the project value is greater than its in second scenario. We will derive conclusion that the option value is \$33.26-\$11.87=\$21.39 (in million).
5. When we value the project assuming there are mutually exclusive alternatives at decision point but the flexibility of deferral to decide before that point to commercialize R&D result between by start-up or by out-licensing to established companies, the project value is greater than it's in forth scenario by such switching option. This is reasonable for stakeholders to choose the best strategies at each node.

V. SENSITIVITY ANALYSIS

Sensitivity analysis is done to check the robustness of the model and to understand the relationship between variable and parameter. We will focus on node G where condition of market is favorable and the result of R&D is great. We will see the influence of royalty and amount of second investment to found start-up to the optimal strategy (table 4) and the value of NPV at node G (figure 13).

From table 4 we can derive conclusion that the higher the value of royalty, the probability to out-license the R&D result to established company is more likely. The higher the value of second investment, the probability to out-license the R&D result to established company is also more likely. This is reasonable since in out-license, there is not any exercise price. Moreover, at the same value of second investment, there is some point which out-license is better than founding start-up. NPV in out-license must be greater in that kind of position. We can see how this strategy has really strong connection with NPV in figure 13.

In area where the value of royalty is start from 80% to 90%, there are sudden jump of value of NPV. This is happened when strategy is shifting from found-start-up to out-license to established company. The 2-dimension map can be useful to be base to select best alternative in each situation, while 3-dimension map can be useful for a reasonable guideline to NPV We should remember that node G is when the market condition is favorable and the R&D result is great. Table 4 and figure 13 make implication to policy maker, which is government. If government wants to make the possibility of founding start-up or out-license more likely, then the R&D result should be great or medium at least initial starting stage. If it is failed, then the Biopark project will be abandoned. Moreover, if government wants to encourage entrepreneurship in Indonesia by founding start-up since founding can provide opportunities for entrepreneurs to learn practical development experiences, government should provide enough capitalization against risk for entrepreneur.

TABLE 4. OPTIMAL STRATEGY WHEN PARAMETER VALUES OF ROYALTY RATE (λ) AND SECOND INVESTMENT (I_2) CHANGE

I_2 \ λ	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
20	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O
25	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O
30	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O
35	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O
40	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O
45	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O
50	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O
55	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O
60	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O
65	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O
70	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O
75	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O	O
80	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O	O
85	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O	O
90	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O	O
95	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O	O
100	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	O	O	O

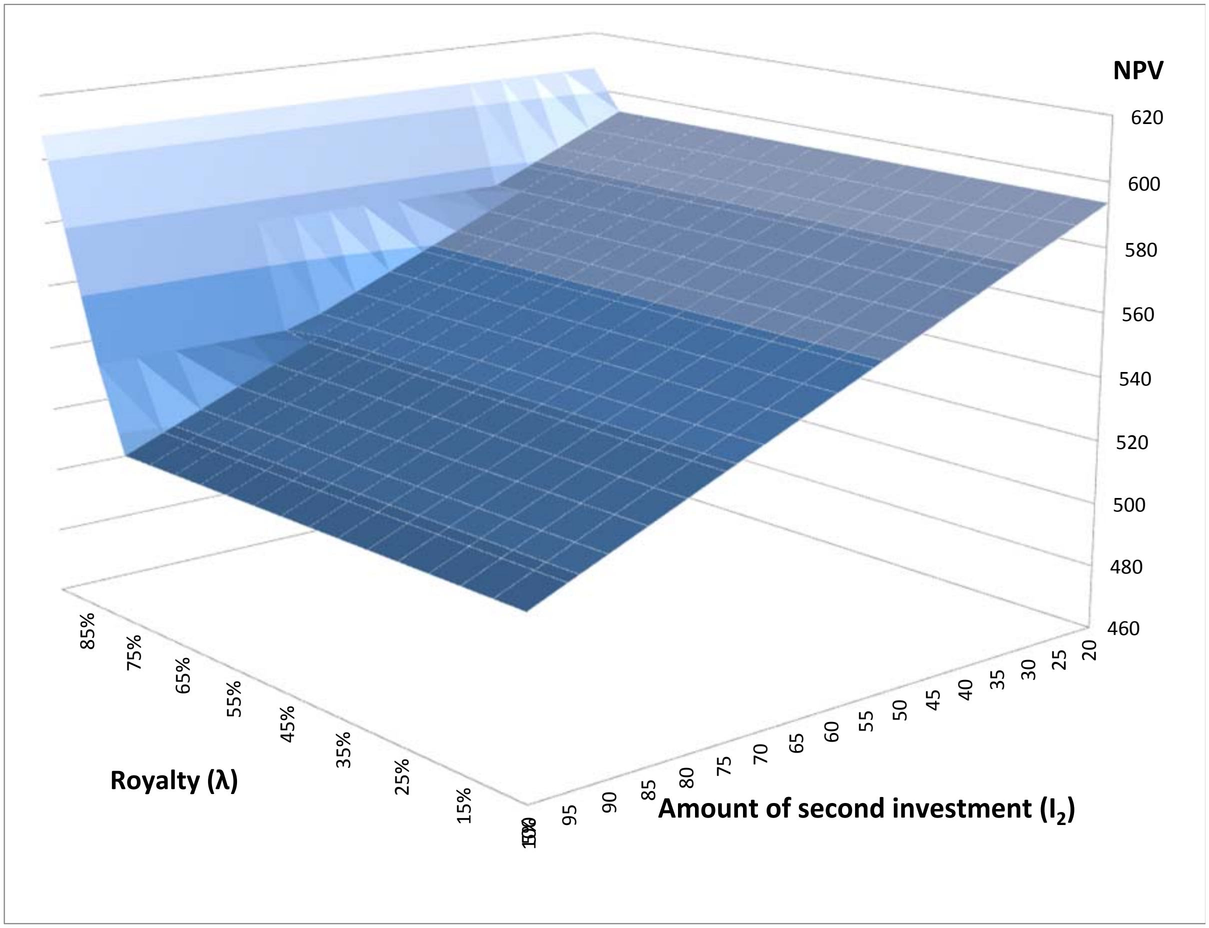

Figure13. NPV at node G when both parameter values of royalty and investment change

VI. CONCLUSION

Real option analysis can capture value of investment in Biopark Indonesia considering potential growth in the future, more than one uncertainty, and alternatives in commercialization. This research has a role in valuing potential unique project, Biopark, especially in condition of Indonesia. The project value can encourage the stakeholders to start Biopark project as soon as possible. From the sensitivity analysis, we can derive conclusion that flexibility is important to minimize risk for loss and utilize favorable chance conditions. If the government of Indonesia wants to encourage the development of start-ups, it is better to provide capitalization for entrepreneur. Entrepreneur should realize that to explore high-tech companies, a specific learning strategy and the dimension of the fuzziness (uncertainty, equivocality, and complexity) involved is a condition possibly leading to successful developments [12].

This paper clarify that it is worth it to start Biopark project. Research and development is a key point to make a future growth, for example in commercialization. Real option valuation is clearly better way to value this kind of project that need irreversible investment in long term, also considering uncertainty in technology and market and flexibility of strategic decision, that NPV could not handle. The project will be rejected for sure if we were wrong to choose the method of assessment. However, in fact, the way of commercialization is so many. This paper considered two ways commercialization, which are founding start-up or out-license to established company, with each way to calculate return. The limitation of this paper could be the scenario to conduct research and development and commercialization is too simple. In reality, research and development could be done by joint research with another party, and many other possibilities.

The future expected progress from this paper is to study switching option to accommodate alternatives between commercialization ways by start-up or out-licensing to established companies, more sophisticatedly. Besides, real-option framework in this case assumed monopolistic access to the investment opportunity and the impact on the market structure is minimal. Actually, if there are potential competitors, not investing may lead some other producer to seize the opportunity [10]. The second future expected progress is to study an option-games model by considering global competition. Global competition is considering strategic position and it will have an impact on the market value of the firm [11]. Similarities in countries' research strength support the empirical evidence and theoretical argument of connections being prefer-ably established between similar actors. The mechanism may lead to increasing connectivity within network and it will encourage knowledge transfer [14]

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