Title	Real Options Analysis on Ecosystem for Agri-biotech Start-ups in Indonesia
Author(s)	Anjani, Putri; Fujiwara, Takao
Citation	年次学術大会講演要旨集, 28: 362-366
Issue Date	2013-11-02
Type	Conference Paper
Text version	publisher
URL	http://hdl.handle.net/10119/11735
Rights	本著作物は研究・技術計画学会の許可のもとに掲載するものです。This material is posted here with permission of the Japan Society for Science Policy and Research Management.
Description	一般講演要旨

2A04

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

○Anjani Putri& Fujiwara Takao
Toyohashi University of Technology

Abstract

Food security is an important issue in Indonesia. Production and consumption of beef in Indonesia is problematic because the consumption is greater than the production. To meet the gap, there are two ways that can be done, which are the import and the self-production. Imports have some vulnerability which is the dependence on price specified by importer, and the possibility of supply of imports decline. Moreover, the population of the world continues to increase and demand for food, including beef, will increase as well. In conclusion, self-sufficiency in beef production is inevitable. To increase the production of beef in Indonesia, there are two steps that must be done, which are production of calf and fattening calves. In production of calf, biotechnology has an important potential in improving the quantity and quality of calves. Investment in biotechnology R&D becomes inevitable. On the other hand, investment in recombined DNA cattle reproduction is very risky because the import still goes well, and the probability of success of the investment is still technologically, financially, and socially uncertain. Investors should determine when is the right time to invest, which is termed as real options for this case. Objective of this paper is to find when the optimal commercialization timing to invest in rDNA cattle reproduction. The expected result of this paper is improving agri-biotech R&D capability and increasing the beef production in Indonesia so Indonesia can be self-sufficient in the fulfillment of demand of domestic consumption.

Keywords: Agri-biotech R&D, Real options analysis, Cattle reproduction, Investment decision

1 Introduction

The amount of beef consumption in Indonesia is increasing due to population growth rate, improvement of living standard, and change of consumer's taste. (Priyanto, 2005). Until these days, the demand is fulfilled by three sources, which are local cow, import beef, and import cow or calf. (Kariyasa, 2004). Although there is an increase of beef local production amount from 2009 t0 2012 but still, it cannot fulfill the demand. There is also an increase in amount of import beef and import cow or calf to meet the demand. Most of imported beef in Indonesia comes from Australia (75%), New Zealand (20%), and United States of America (5%).

Value of Indonesia's gross domestic product which increased and strengthening of Indonesian currency, rupiah, from 2005 to 2011 made an influence in increase of import. The price of imported beef will decline if the exchange rate strengthened but it will push down the price of local beef and local breeder will suffered losses. Government of Indonesia launched beef self-sufficiency in 2014 through agricultural revitalization. (Pakpahan, 2012)

From background mentioned, it should be some policies to alleviate dependence on imported beef, cow, or calf. Technology to produce beef should be considered in policy, or the gap between local production and consumption will be larger and it has an impact that the amount of import will increase.

The government of Indonesia already made an effort to increase the amount of beef production in Indonesia, which includes seed quality improvement through artificial insemination program, fodder development, and disease eradication program (Kariyasa, 2004). Government also made an effort in empowerment in the citizenry farm by partnership between company and citizenry farm. However, this effort is not still succeed because there was a sharp increase in the amount of import in 1990-1999 which is 21.94% per year.

The way to improve amount of local cow in Indonesia is increase investment in insemination and fattening calves. However, investment on insemination still lower compared to investment in fattening calves and it is very risky because the import still goes well, and the probability of success of the investment is still technologically, financially, and socially uncertain. Investors should determine when is the right time to invest, which is termed as real options for this case.

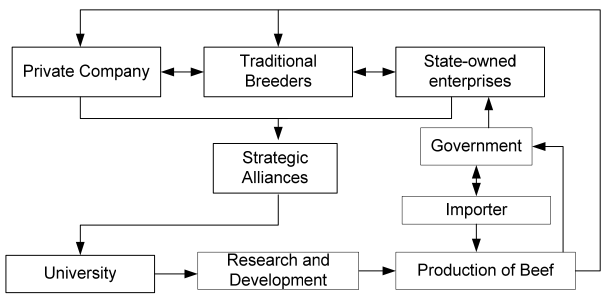

Figure 1. Symbiotic system of agri-biotech start-ups

Figure 1 explains the symbiotic system of agri-biotech start-ups. Private company and state-owned enterprises interact with traditional breeders such as commerce in beef. Private company and state-owned enterprises may make strategic alliances to give support to university to do research and development in rDNA cattle reproduction. This research and development will affect the production of beef in the future. Production of beef is also influenced by amount of imported beef. Finally, this supply of beef in market will influence private company, traditional breeders, and government in making policy.

2. Timing Options

Basically, most investment decisions share three important characteristics. First, the investment is irreversible. The initial cost of investment cannot recover it all. Second, there is uncertainty of future rewards from the investment. Third, you have a chance about the timing of your investment. You can delay action to get more information about the future. (Dixit & Pindyck, 1994). This paper uses real options analysis. Real options analysis applies concept and technique used for financial derivatives to real assets. (Fujiwara, 2011). The term real option captures the fact that many investment decisions provide the right, but not the obligation to proceed with a certain course of action. Real options are methodological approach to analyze investment which has uncertainty and flexibility. (Harmantzis & Tanguturi, 2007). To evaluate the economic validity of the innovative, promising, but high-risk project, real options analysis can be used. Real options analyses have proved to be useful in guiding corporate decisions regarding investments in R&D and other capital investments that may not have a positive discounted cash flow. (Zee & Spinler, 2013).

Unlike real options, net present value assumes that either the investment is reversible, that is, it can somehow be undone and the expenditures recovered should market conditions turn out to be worse than anticipated, or, if the investment is irreversible, it is a now or never proposition, that is, if the firm doesn't undertake the investment now, it will never be able to in the future. Some investment meets these conditions, but most do not. In reality, irreversibility and the possibility of delay are very important characteristics of most investments. This ability to delay an investment can affect the decision to invest. (Dixit & Pyndick, 1994)

Timing option is one of example of real options.It defined as a deferrable right – like call option – to start any given project as a real option. In other words, timing option is an option to defer or delay an investment decision for a certain period of time until uncertainty levels fall. It can be applied to an investment with irreversible and sunk cost. (Fujiwara, 2011).However, firms do not always has the opportunity to delay their investment. For example, there can be occasions in which strategic considerations make it important for a firm to invest quickly and preempt investment by existing or potential competitors. But still, in most cases, delay is at least feasible. A cost of delay may exist – the risk of entry by other firms, or simply foregone cash flows- but this cost must be weighed against the benefits of waiting for new information that often large. (Dixit & Pindyck, 1994).

The value of waiting can be considered as a call option on the project, with an exercise price equal to the investment cost. There are two characteristics that investment expenditures should have so that timing option can be applied. First, the sunk cost can't be covered. Second, these investments can be deferred, so that the firm has the opportunity to wait for new information to arrive about prices, costs, and other market conditions before it commits resources.(Dixit & Pyndick, 1994).

3 R&D Agri-biotech Investment Model

3.1 Deterministic Model

The basic model used in this paper is developed by McDonald and Siegel (2006). The problem is when is the optimal time to pay a sunk cost I in return to a project whose value is V. (Dixit & Pyndick, 1994). The value of investment opportunity is F(V). The payoff of investing in at time t is Vt-I. We want to maximize the expected present value of

$$F(V) = \max\{E(V_T - I)e^{-pT}, 0\} \quad (1)$$

Where E denotes expectation, T is unknown future time that the investment is made, and ρis a discount rate.

The deterministic case will be used in this case. Deterministic case means σ=0. Hence, V(t)= $V_0 e^{\alpha t}$. Value of investment than will be

$$F(V) = (Ve^{\alpha T} - I)e^{-pT} \quad (2)$$

If α≤0, then it is better to invest now because value of project will decline all over the time, and never invest otherwise.

To get the maximum value to invest, we will differentiate the equation 2 with respect to T.

$$\frac{dF(V)}{dT} = -(\rho - \alpha)Ve^{-(\rho-\alpha)T} + \rho I e^{-pT} = 0 \quad (3)$$

Which implies

$$T^* = \max\left\{\frac{1}{\alpha} ln\left[\frac{\rho I}{(\rho-\alpha)V}\right], 0\right\} \quad (4)$$

If it is better to invest in project immediately, then $T^* = 0$. One should invest immediately if $V \geq V^*$, where

$$V^* = \frac{\rho}{\rho-\alpha} I > I \quad (5)$$

By substituting expression (4) into equation (3), then the solution for F(V) is

$$F(V) = \begin{cases} \left[\frac{\alpha I}{\rho-\alpha}\right]\left[\frac{(p-\alpha)V}{\rho I}\right]^{\rho/\alpha} & \text{for } V \leq V^* \\ \text{V} - \text{I} & \text{for } V > V^* \end{cases} \quad (6)$$

3.2 Stochastic Model

Not like deterministic model, stochastic model considers σ>0. Stochastic model will determine the point at which is optimal to invest I in return of asset worth V. However, we can't determine a time T as deterministic model since V evolves stochastically. Critical value of V^* will be determined so it is optimum time to invest when $V \geq V^*$

There are two ways to get the value of deferring the investment or F(V), which are solution by dynamic programming and by contingent claim analysis. These two ways will give the same solution.

In the case of solution by dynamic programming, investment opportunity will not have cash flow up to the time T when investment is undertaken. Hence, the only return from holding it is its capital appreciation.

$$\rho F dt = E(dF) \quad (7)$$

The meaning of Equation 7 is that over time interval dt, the total expected return on the investment opportunity, ρFdt is equal to its expected rate of capital appreciation.

If we expand dF using Ito's lemma, and note that α=ρ-δ, then the equation 7 becomes

$$\frac{1}{2}\sigma^2 V^2 F''(V) + (\rho - \delta)VF'(V) - \rho F = 0 \quad (8)$$

F(V) must satisfying this three conditions

$$F(0) = 0 \quad (9)$$

$$F(V^*) = V^* - I \quad (10)$$

$$F'(V^*) = 1 \quad (11)$$

With this three boundary condition, the value of F(V) will take the form

$$F(V) = AV^{\beta_1} \quad (12)$$

$$V^* = \frac{\beta_1}{\beta_1 - 1} I \quad (13)$$

$$A = \frac{(V^* - I)}{(V^*)^{\beta_1}} = \frac{(\beta_1 - 1)^{\beta_1 - 1}}{(\beta_1 - 1)^{\beta_1} I^{\beta_1 - 1}} \quad (14)$$

$$\beta_1 = \frac{1}{2} - \frac{\rho - \delta}{\sigma^2} + \sqrt{\left[\frac{\rho-\delta}{\sigma^2} - \frac{1}{2}\right]^2 + \frac{2\rho}{\sigma^2}} \quad (15)$$

In the case of solution by contingent claim analysis, the total return from holding the portfolio over a short time interval dt is

$$dF - F'(V)dV - \delta V F'(V)dt \quad (16)$$

If we expand dF using ito lemma, F(V) must satisfy

$$\frac{1}{2}\sigma^2 V^2 F''(V) + (r - \delta)VF'(V) - rF = 0 \quad (17)$$

Hence, the contingent claim solution and dynamic programming solution is equivalent to investment problem, under the assumption of risk neutrality.

4 Numerical Example

4.1 Deterministic model

In this calculation, we assume investment value I=Rp3 (in trillion, equal to $260million), project value V=Rp3 (in trillion), and ρ = 5%. Using equation (2), value of timing option with growth rate ranging from 4% until 6% is indicated in figure 2.

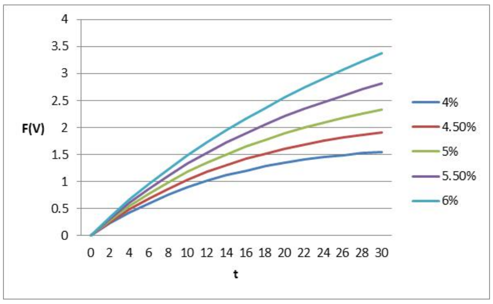

Figure 2. Sensitivity analysis using different growth rate α

Figure 3 is option value with fixed value of growth rate α = 5% and discount rate ranging from 5% until 7%.

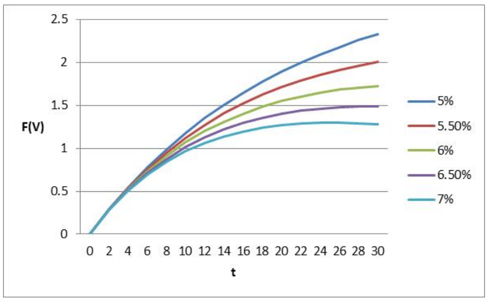

Figure 3. Sensitivity analysis using different discount rate ρ

Figure 2 shows that in the same time point, the greater value of growth rate give the greater option value. Conversely, the greater discount rate value gives the lower option value. For all value of growth rate and discount rate, the increment of option value over time was significant at first few years, then the increment gradually declined, and finally decreased. This means it is useless to delay the project for too long.

Using equation (4), the relationship between optimal time with both growth rate and project value is demonstrated in Figure 4. At (sigma) equal to zero which is a characteristic for deterministic approach and T equal to zero we can see that growth rate and project value shows a proportional relation. The smaller of the growth rate gave the smaller the project value.

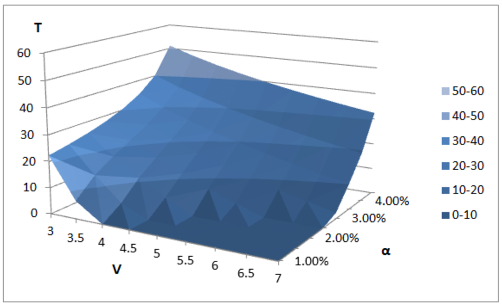

Figure 4. Optimal time with both profit index and dividend rate

It can be seen in figure 5 and 6, at any given growth rate, the higher the value of the project the shorter optimum time was observed. And at any given value of project, the higher the value of the growth rate, the longer optimum time to defer was observed. The higher the value of project means the lower the value of dividend rate. Dividend rate means opportunity cost of delaying the project or keeping the option to invest alive. If δ were zero, there would be no opportunity cost to keeping the option alive, and one would never invest. If δ were is very large, the value of the option will be very small, because the opportunity cost of waiting is large.

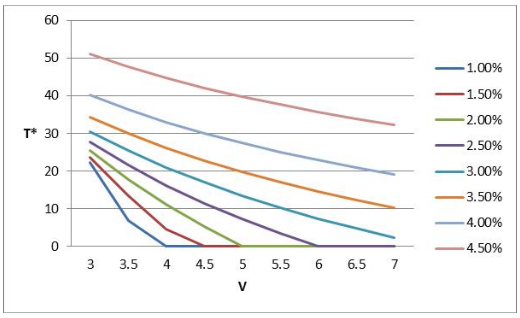

Figure 5. Optimal time with both specific project value V and growth rate α (1)

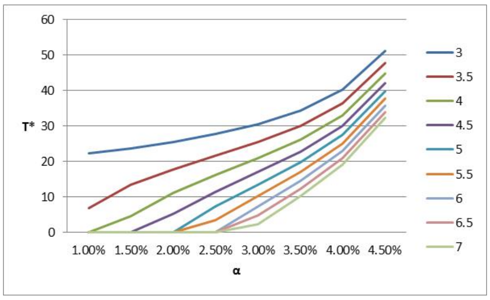

Figure 6. Optimal time with both specific project value V and growth rate α (2)

4.2 Stochastic model

Based on equation (12), value of the project demonstrated proportional relationship with options value. Option value increased if the value of the project was bigger. And at any given volume of the project, the higher the risk, the option value will be higher.

Relationship among critical value, risk, and dividend rate under stochastic model was showed in Figure 7. The critical value was relatively higher in conditions where opportunity cost was low and risk was high

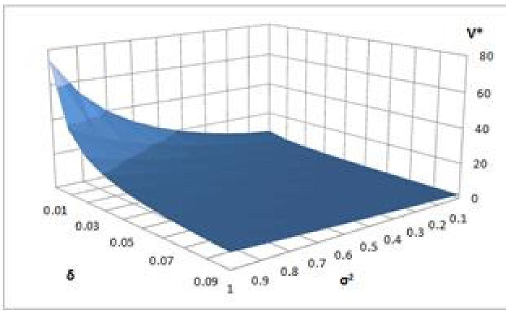

Figure 7. Critical value of risk and opportunity cost

It was also proven from Figure 8 that critical value under stochastic model was increase by the increase of the risk. In addition, the figure 8 also indicated that at any given risk, the critical value increased with the decrease of the opportunity cost.

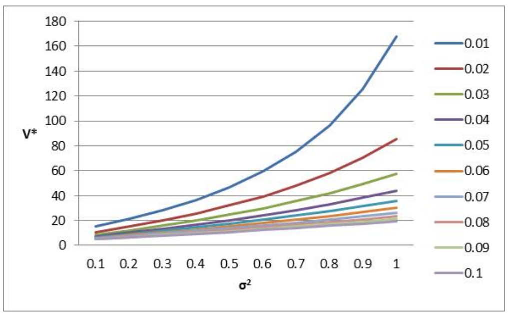

Figure 8. Critical value with risk and opportunity cost

We assume the value of the project evolves according to the geometric Brownian motion (GBM).

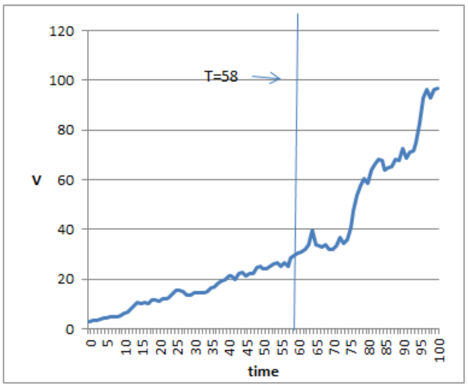

Figure 9. Value of project by GBM simulation (Base case : V0=3, σ=0.07, α=0.04, I=3, ρ=0.05)

The measurement of the optimal timing of investment is examined using GBM distribution. The base case parameter used in this paper are the following. Using this method, the optimal timing is identified in day 58.

5 Conclusions

The two models in real option that is deterministic and stochastic can help in forecasting the optimal timing of investment. In the former model, when the risk is not calculated then the time of investment could be calculated. However in the latter model, the time of investment could not be calculated as it involves many other aspects, which are represented by the value of the risk. In Indonesian case, where R&D of biotech including agri-biotech is still very limited many aspect must be considered before investment can be made. Risk factors includes the failure of harvest caused by the climate as well as by the poor quality of the seed due to lack of research and development in (for example rDNA development of cattle reproduction) cattle reproduction. Thus delaying the investment would be a wiser option. However looking at the model we know that critical value of investment would be higher when the risk is high. Looking at this point, nevertheless, agri-biotech business in Indonesia still promising with one important note that is the R&D on this topic should also be focused. Better quality of R&D could provide more useful information for staring investment. It is assured by the model that by the support from the R&D the delay of investment can be shortened.

References

Campbell, J. A. (2002). Real options analysis of the timing of IS investment decisions. Information and Management 39 (pp. 337-344)

Dixit, A.K. and Pindyck, R.S. (1994) : Investment under Uncertainty. Princeton University Press, Princeton, NJ.

Fujiwara, T. (2011). Application of timing option to founding investment decision of biotech start-ups. Available from http://www.businesschemistry.org/article/?article=145. Accessed April 11, 2012.

Harmantzis, F. C., Tanguturi, V. P. (2007). Investment decisions in the wireless industry applying real options. Telecommunications Policy 31 (pp. 107-203)

Kariyasa, K. (2004). Analysis of beef supply and demand in Indonesia before and after economic crisis : analysis of beef self-supporting projection 2005. Available from http://library.unud.ac.id/index.php/soca/article/download/4060/3049. Accessed July 31, 2013. (in Indonesian)

Pakpahan, A. R. S.. (2012). Analysis of factors that affect import of beef in Indonesia.Economics Development Analysis Journal. (in Indonesian)
Priyanto, Dwi. (2005). The evaluation of beef importation policy through supply and demand analysis. Available from http://peternakan.litbang.deptan.go.id/fullteks/semnas/pro05-39.pdf. Accessed August 26, 2013. (in Indonesian)

Soim, A. (2013).Beef breeding opportunities. Available from http://tabloidsinartani.com/content/read/peluang-usaha-pembibitan-sapi/. Accessed August 27,2013. (in Indonesian)

Zee, R. D., Spinler S. (2013). Real option valuation of public sector R&D investments with a down-and-out barrier option. Technovation.