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The Optimal Timing of Risk Management

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This paper explores the methods of determining the optimal timing for risk management projects. It discusses the timing considerations for financial risk hedging, insurance risk hedging and investment in new risk management functions.

1. TIMING DECISION BIASES

Before discussing the approaches of formal timing decision-making, it is necessary to understand the major human biases affecting timing decisions. Being aware of these biases can help us recognize our biases and improve our understanding, opinions and future decisions accordingly.

1. **Herding.** Herding occurs when people follow the behaviors of the majority. When a decision is made because of herding, it is dangerous because the general opinion may not be suitable for a specific case. Without sufficient information and analysis, the decision could be made too early and too rashly and the appropriate timing is not fully considered.

2. **Analysis paralysis.** An over-analysis may unnecessarily defer a decision. The timing can be considered too complicated and too much information may be required before a decision can be made.

3. **Shortsighted shortcuts.** Russo and Schoemaker (1990) considered shortsighted shortcuts a decision trap. Decision-makers may rely heavily on convenient facts, easily obtained information and rules of thumb. Like herding, shortsighted shortcuts may lead to rash decisions without full consideration of appropriate timing.

4. **Shooting from the hip.** Shooting from the hip means making a quick decision without a comprehensive and systematic consideration of other alternatives. As Russo and Schoemaker (1990) described, all the information is kept in the decision-maker's head and then the decision is made. Detailed analysis of optimal timing is likely to be neglected in this decision-making style.

To reduce the negative impact of human biases on timing decision, a consistent decision-making approach is important. With a comprehensive analysis of the cost, benefits and potential value of new information, decision-makers can get a holistic view rather than judge based on limited information and experience.

2. NET PRESENT VALUE VERSUS REAL OPTION

When evaluating investment projects and making investment timing decisions, two approaches are normally used: net present value (NPV) approach and real option approach. They may also be used for optimal timing decisions.

The NPV approach measures the value of a project as the present value of future net cash flows (NCF) deducted from the initial investment costs.

$$NPV = \sum_{t=1}^{n} \frac{NCF_t}{(1+k)^t} - C_0$$

Where:

NCF_t: Net cash flow at time t; it is calculated as the difference between benefits and costs

k: Hurdle rate; it is the expected return required from an investment project

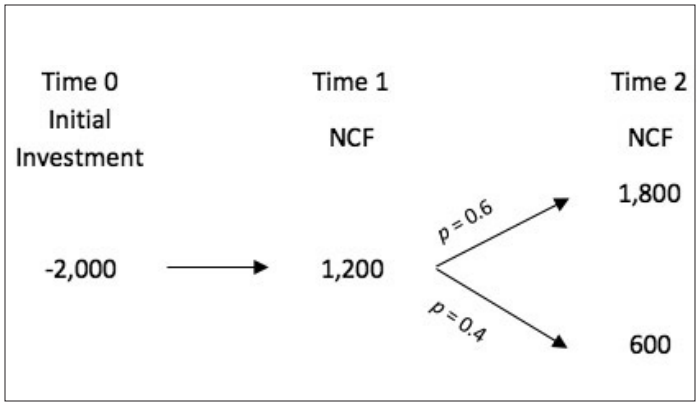
n: Time horizon

C_0: Initial investment at time 0

NPV is the expected value of the investment. An example of using the NPV approach for timing decision is shown in Section 2.1.

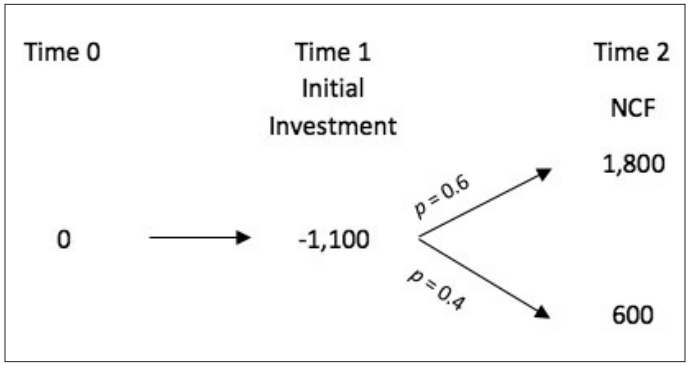
2.1. Example: Investment Timing Decision Using the NPV Approach

Option 1. Start project immediately with two-year time horizon.



The initial investment is $2,000. For the first period, the NCF is $1,200. For the second period, there is a 60 percent probability that the NCF is $1,800 and a 40 percent probability the NCF is $600.

Option 2. Start project one year later with one-year time horizon.



If the company waits one year, the investment at time 1 is $1,100. The NCF of the second time period is still uncertain, as in Option 1.

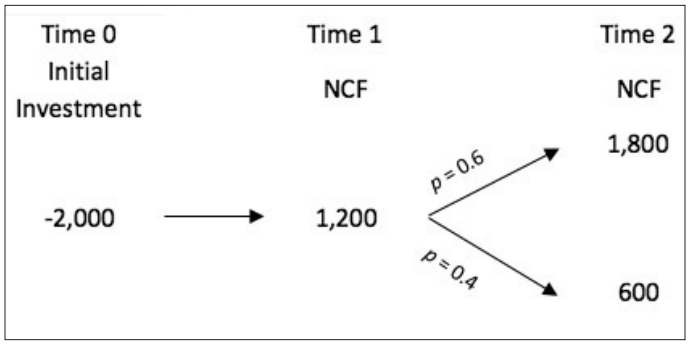
With a discount rate of 10 percent, the NPV at time 0 is $165 for the first option and $83 for the second option. By choosing the greater of the two, the investment should start immediately.

However, the NPV approach does not reflect the impact of risk. It also assumes there will be no additional information in the future that can affect the decision and the NPV of future investment.

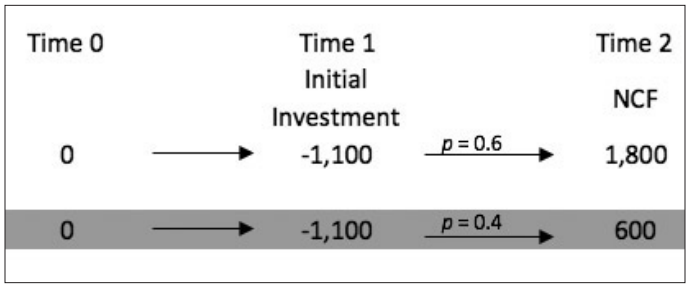
On the other hand, the real option approach incorporates the value of future information in the decision-making process. Continuing with the NPV example and assuming that the NCF at time 2 will be known exactly at time 1, a better decision could be made given the new information. If the NCF of the second period is known to be $1,800 at time 1, the investment will be made. If the NCF is known to be $600, no investment will be made.

2.2. Example: Investment Timing Decision Using the Real Option Approach

Option 1. Start project immediately with two-year time horizon.



Option 2. Start project one year later with one-year time horizon.



For both options, the NCF at time 2 is uncertain at time 0, but certain at time 1. If the investment decision is deferred to time 1, the investment will be made only if the NCF at time 2 is $1,800.

With a discount rate of 10 percent, the NPV at time 0 is $165 for the first option. Unlike the NPV approach, the NPV of the second option is calculated as $\left(\frac{1800}{1.1^2}-\frac{1100}{1.1}\right)\times 0.6 = \$266$. By choosing the greater of the two, the investment decision should be deferred to time 1.

Therefore, when future information has immaterial impact on future decision-making, the NPV approach can be used. Otherwise, the real option approach should be adopted.

3. TIMING OF RISK MANAGEMENT DECISION-MAKING

Given that the real option approach incorporates the value of new information in the analysis, it is more appropriate than the NPV approach for determining the appropriate timing of a risk management project. However, some adjustments are needed to reflect the differences between risk management projects and investment projects.

- The main purpose of risk management projects is to reduce risk rather than maximize investment gains. NCF in the traditional NPV calculation is the expected value and cannot reflect the benefit of loss reduction because of a risk management project. Measures based on expected values are not appropriate for assessing risk management projects. Instead, NCF at a more extreme confidence level can be used. The chosen confidence level should be consistent with the company's risk appetite.

- The costs and benefits of risk management projects are complicated and may be different from investment projects. Some types of cost and benefit follow.

Costs:

- **Project investment.** This is similar to the cost in normal investment projects.

- **Hedging cost.** This may include the cost of buying hedging instruments such as equity index options.

- **Transaction cost.** Some risk management projects require dynamic trading such as in a dynamic hedging program. The transaction cost measured by bid-ask spread could be a significant part of the total cost.

- **Counterparty risk.** A risk management project may involve transferring risk to a counterparty. At the same time, the exposure to the counterparty risk increases.

- **Loss of upside gains.** A risk management project can reduce the risk but at the same time limit the upside potential. The loss of gains needs to be considered in project assessment.

Benefits:

- **Loss reduction.** At a given confidence level or in an extreme event, a risk management project such as an interest rate risk hedging program can reduce the amount of loss.

- **Potential benefit of a lower borrowing cost because of a higher credit rating.** A risk management project may increase the rating on enterprise risk management, which is a key component of credit risk assessment by rating agencies. The benefit can be quantified as the product of three factors: the probability of getting a higher credit rating, the contribution of the project and the magnitude of borrowing cost reduction.

- **Potential benefit of lower cost of capital.** If a risk management project can improve the capital adequacy and liquidity position of a company, the cost of raising additional capital in a normal economic environment will be lower. The benefit is the expected reduction in the financing cost.

- **Potential benefit of better decisions.** For example, an investment in building a more advanced risk assessment platform such as an economic capital framework could help senior management make informed decisions. The benefit of the investment is the product of the decreased probability of making a wrong decision and the cost of a wrong decision.

Most of the cost and benefit items listed require complex predicting using either historical experience or experts' opinions.

- The value of future information is necessary but difficult to quantify. To determine the optimal timing, the key is to evaluate how future information may improve future decisions. For example, to hedge the equity risk in a future financial crisis, equity index put options can be bought either immediately or later. Assuming that the economy is in the expansion phase, the key value of future information is a better understanding of the time the economy will go into a recession period. If future economic data indicate a prolonged economic expansion phase, it may be better to defer equity risk hedging.

- Some risk management projects are divisible across time. For example, a hedging program can be implemented at several stages gradually till it is fully completed. Staged risk management decisions include not only the timing but also the amount of investment at each stage. The decision-making process is even more complicated and may require dynamic programming.

With these adjustments, different timing options can be compared based on the NPV after considering the value of future information. In sections 4 to 6, specific considerations are discussed regarding these adjustments for different decision problems.

4. TIMING OF HEDGING FINANCIAL RISKS

For companies with significant free capital, adopting the contrarian approach in financial risk hedging may be a good idea. If the economy has stayed in the expansion cycle for a long period and the market has started worrying about market bubbles, it is a good time to mitigate the risk being taken before the hedging cost rises. If the economy stagnates for a continued period and financial stimulus plans start to have some beneficial outcomes, it may not be a good time to reduce the risk exposure due to the high cost. On the other hand, taking risk is more profitable as most market participants are looking for counterparties to transfer the risk.

For companies in a distressed situation that still have a pretty big chance of recovery, it may be better to only hedge short-term earnings volatility to ease the panic of investors. Long-term arrangement of risk transfer in difficult times may not be a wise decision. However, these companies may not have a choice due to pressure from regulators, rating agencies, customers and the public.

A key consideration in determining the appropriate timing of hedging financial risks is the future changes in economic conditions. In a situation where the future economic situation is unclear, deferring the decision on financial risk hedging may buy decision-makers some time to get a better view of economic development and then make a more informed decision. In the following example, the company wants to hedge its exposure to equity risk but is also considering different timing options.

4.1. Example: Equity Risk Hedging

Insurance company ABC sells variable annuity products with a guaranteed minimum account value equal to 100 percent of paid premium. It has a large exposure to equity downside risk. The

existing exposure is below the company's risk tolerance. However, the company has a business expansion plan that needs extra capital. By hedging the equity risk, some capital can be freed to support the expansion plan.

The economy has been recovering from the 2008 financial crisis for six years. It is difficult to predict whether the economy will continue expanding or move slowly into another recession. To evaluate the timing options of hedging, the company needs to predict the change in market volatility, which has a significant impact on the cost of hedging. The company plans to buy stock index put options so it can hedge the minimum guarantee but not give up the potential upside. The higher the market volatility, the higher the cost of buying put options. Figure 1 shows the Standard & Poor's 500 daily index and its volatility index from Jan. 2, 1990, to Nov. 11, 2015. Spikes of the VIX[1] are normally accompanied with material downward market movements. The correlation coefficient between the daily change in the index value and the daily change in the VIX is –71 percent over the study period.

For the timing decision, an important question to answer is that given the current level of VIX, what will the value of VIX be in one month, three months and so on. If the VIX is likely to go down, the company may want to defer the hedging for a lower cost of put options. If the VIX is likely to go up, the company may want to buy the put options immediately.

For simplicity, the only cost of the hedging program to be considered is the cost of put options. For the same reason, the price of put options is assumed to change only with the volatility parameter across time. In practice, when considering timing options, other assumptions such as interest rate can also be predicted to be time variant.

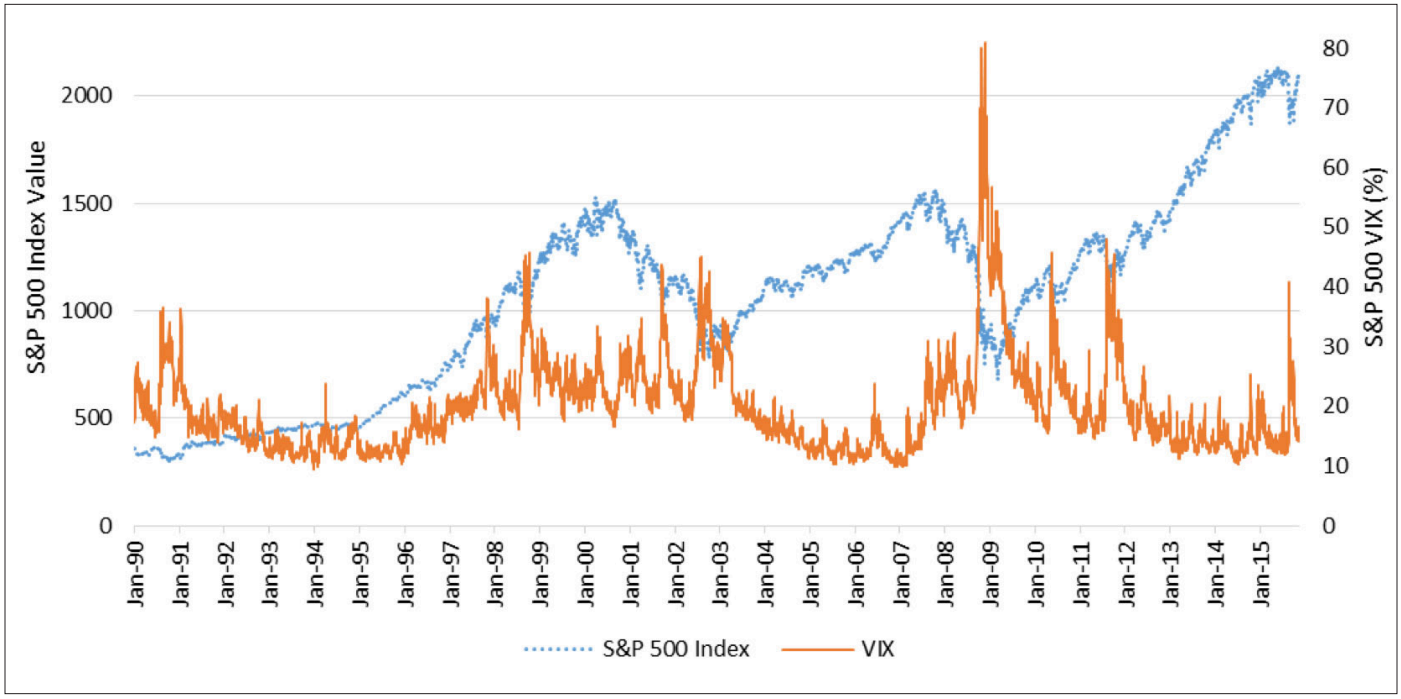
The benefits of the hedging program include

- the loss reduction if the stock index value falls below the exercise price and
- the saving of the cost of raising capital for the business expansion plan.

Both benefits vary with the future economic environment. In an economic expansion, the benefit of loss reduction is small but the saving of capital cost is large. In an economic recession, the benefit of loss reduction is large but the saving of capital cost is zero because the company is unlikely to have enough financial resources for the expansion.

Generally speaking, the current level of market volatility has a big impact on the timing decision.

Figure 1. S&P 500 Index Value and VIX (January 1990 to November 2015)



Data from Yahoo! Finance

Table 1. Three-Month Transition Matrix of VIX (January 1990 to November 2015)

VIX	<10%	[10%, 20%)	[20%, 30%)	[30%, 40%)	[40%, 50%)	≥50%
<10%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
[10%, 20%)	0.3%	84.0%	12.6%	2.6%	0.5%	0.1%
[20%, 30%)	0.0%	29.5%	57.6%	9.7%	1.1%	2.1%
[30%, 40%)	0.0%	10.7%	68.5%	16.6%	3.4%	0.7%
[40%, 50%)	0.0%	0.0%	47.3%	39.3%	13.4%	0.0%
≥50%	0.0%	0.0%	1.8%	16.1%	71.4%	10.7%

- In a low volatility situation (low VIX), the cost of hedging is relatively low. It is likely the hedging program should be implemented immediately.
- In a high volatility situation (high VIX), the cost of hedging is high and the loss due to the bear market has already happened. Also, the business expansion plan may need to be deferred due to stressed financial conditions. Therefore, it is likely the hedging program should be deferred.
- In a medium volatility situation (medium VIX), the timing decision becomes complicated. If the economy is heading into recession, the cost of hedging is lower now than later. The benefit of hedging is likely to be realized in the near future. In this case, it is better to implement the hedging strategy immediately. If the economy continues expanding, the cost of hedging is higher now than later and the benefit of hedging may not be realized in the near future. Because it is difficult to predict future economic conditions, it may be worth waiting for a certain period to get a clearer idea of the direction of the economy.

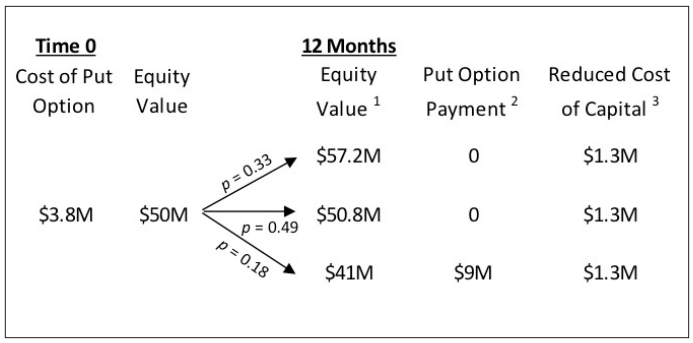
Table 1 lists the transition matrix of S&P 500 VIX with a period of three months based on the data from Jan. 2, 1990, to Nov. 11, 2015. In the low volatility range (VIX <20 percent), the VIX has a very high probability of staying in the low range. In the high volatility range (VIX >30 percent), there is a high probability the VIX will go down in the next three months. In the middle volatility range (VIX $\in$ [20 percent, 30 percent]), VIX has a high chance to stay in the middle range or go down. But the chance of going up is not negligible.

Assuming that the current VIX is 25 percent, which is the average value in the middle range based on the experience data, the company is considering whether to implement the hedging program immediately or three months later. The company wants to hedge an equity risk exposure of $50 million for one year.

Option 1. Hedge immediately.

The cost of hedging is estimated to be $3.8 million with an interest rate of 4.5 percent, an implied volatility of 25 percent[2] and a term of one year using the Black-Scholes formula for a European put option.

Based on the experience data, three real world scenarios are assumed at the end of one year:



Notes:

1. Three scenarios are assumed for the equity value at the end of one year. In the up scenario, the equity value is $57.2 million with a probability of 33 percent. In the middle scenario, the equity value is $50.8 million with a probability of 49 percent. In the down scenario, the equity value is $41 million with a probability of 18 percent. The scenarios represent the average equity values for the low, medium and high VIX scenarios, respectively. Both the equity values and the probabilities are derived from the historical data of S&P 500 index and VIX from January 1990 to November 2015.

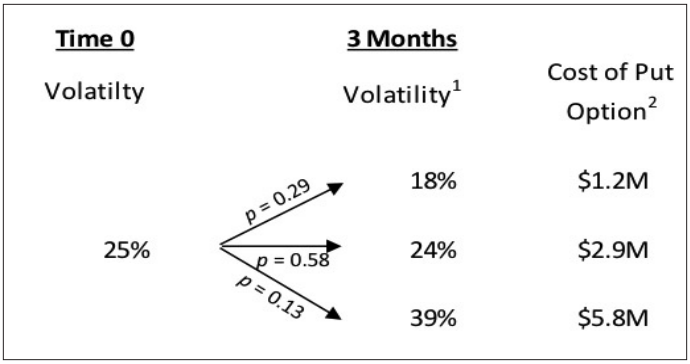
2. Only in the down scenario will the at-the-money equity put option be exercised. The payment is $9 million ($50 million – $41 million).

3. The hedging will release the required capital used to support equity risk. It is assumed the company sets the required capital at a confidence level of 99.5 percent. Assuming the equity value follows a lognormal distribution with $\mu = 7$ percent and $\sigma = 25$ percent, the required capital is calculated as the cost of capital rate × initial exposure × (1 – 0.5th percentile of lognormal (μ, σ)). The cost of capital rate is assumed to be 6 percent. Initial exposure is $50 million. The 0.5th percentile of lognormal (0.07, 0.25) is the left-tail 0.5 percent value at risk (VaR). (1 – 0.5th percentile) is the smallest loss in the worst 0.5 percent scenarios and is used to calculate the required capital to be freed. The reduced cost of capital is estimated to be $1.3 million.

The cost of Option 1 is $3.8 million at time 0. The benefit is $2.9 million at the end of one year, which is the sum of the put option payment ($9M × 0.18 = $1.6M) and the reduced cost of capital ($1.3M). The return on investment (ROI)3 is –23 percent and the NPV with a hurdle rate of 10 percent is –$1.1 million. From the perspective of maximizing the investment gain, Option 1 is not a good option because of negative ROI and NPV. In practice, other benefits of the hedging may exist that could improve the NPV and ROI significantly. For example, a reduction in required capital could lead to an improved capital position and a credit rating upgrade, which can reduce the borrowing cost. For simplicity, these potential benefits are not included in the example. The focus here is the comparison of the NPVs between different timing options.

Option 2. Defer hedging decision for three months.

The company also wants to consider delaying the hedging decision for three months. It has the following assumption of changes in the VIX in three months based on experience data.



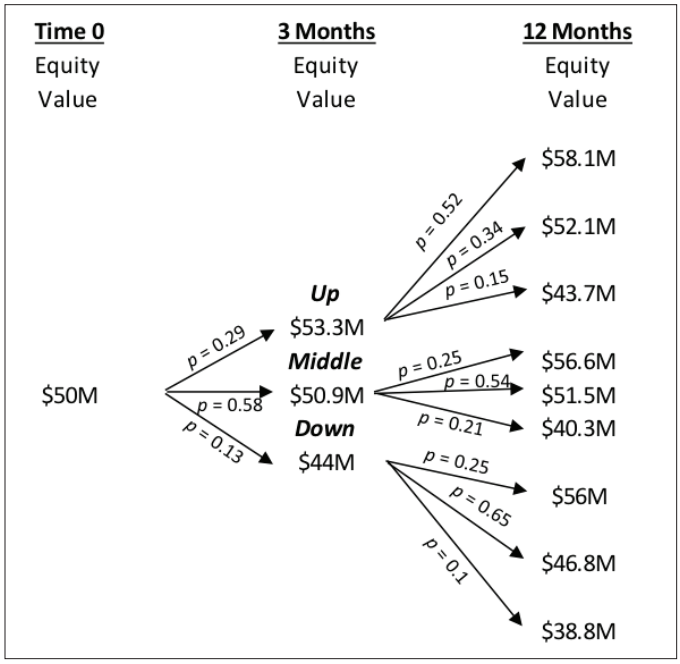
Notes:

1. The VIX may drop to 18 percent with a probability of 29 percent, change to 24 percent with a probability of 58 percent, and go up to 39 percent with a probability of 13 percent. Both the VIX and probability are derived from the historical data of VIX from January 1990 to November 2015.

2. The cost of buying put options at the end of three months for each scenario is calculated with an interest rate of 4.5 percent and a term of nine months. The exercise price is equal to the minimum of the equity index price at time 0 and the equity index price at the end of three months. In the low VIX scenario (up scenario for equity price), the equity value is expected to be $53.3 million. The put option to be bought at the end of three months will have an exercise value of $50 million. In the medium VIX scenario (medium scenario for equity price), the equity value is expected to be $50.9 million and the exercise value of the put option will be $50 million. In the high VIX scenario (down scenario for equity price), the equity value is expected to be $44 million. The exercise value of the put option will be $44 million

instead of $50 million. The cost of the in-the-money put option with an exercise value of $50 million is too high in the high VIX scenario.

The following scenarios of equity values at the end of one year, given the value at the end of three months are assumed.

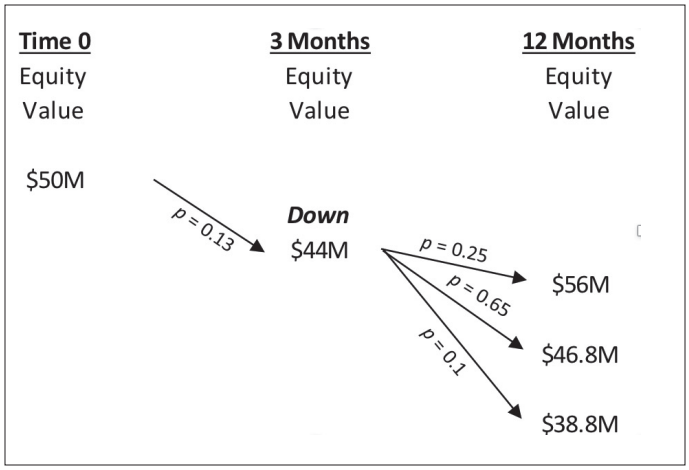


Using the same method as in Option 1, the benefit of hedging in each scenario (up, middle or down) at the end of three months can be calculated. The results are listed in Table 2.

Table 2. NPV Result by Scenario

Scenario	Up	Middle	Down
NPV@10%	0.45	0.04	−5.20
ROI	70%	12%	−96%
Probability	29%	58%	13%
Time	Cash Flows		
0	0	0	0
0.25	−1.20	−2.90	−5.80
1	1.78	3.16	0.51
Decision	Hedge	Hedge	No

Both the up scenario and middle scenario have a positive NPV. In these scenarios, hedging is likely to be implemented at the end of three months. In the down scenario, negative NPV indicates the hedging strategy will not be implemented. The cost of the unhedged position in the down scenario is the loss caused by the equity value dropping below $50 million. It is calculated as shown.



Cost of unhedged position in the down scenario = ($50M – $46.8M) × 0.65 + ($50M – $38.8M) × 0.1 = $3.2M.

The NPV of Option 2 at time 0 is –$0.2 million, calculated as the weighted average of the values in three scenarios based on the chosen strategy. The weight is the probability of each scenario. The value is the NPV of the hedging strategy for the up and middle scenarios and the cost of the unhedged position in the down scenario. It is much higher than the NPV of Option 1, which is –$1.1 million. Therefore, the company is better waiting three months before making decisions on hedging implementation.

In this example, a transition matrix based on experience data is used as one of many possible approaches. History may not be a good indicator of the future because of the persisting low interest rate environment, which has never happened before. Advanced predictive models adapted for the new economic regime can be used in practice. The trinomial tree can also be replaced by a stochastic model that considers thousands of scenarios.

In practice, threshold-based decision mechanism can be designed for easy monitoring. For example, the middle scenario has a near-zero NPV. A possible simplified decision-making mechanism could be that if the VIX is no greater than 24 percent, which is the volatility in the middle scenario, the hedging strategy will be implemented immediately. Otherwise, the decision will be deferred.

4.2. Other Applications

The approach used in the example in Section 4.1 can be used for other projects such as deciding the optimal timing of raising capital. The cost of financing changes with the economic environment as well. Raising additional capital during an economic

expansion is less costly than during an economic recession. Incorporating economic cycles in the analysis can provide valuable information for decision-making regarding capital management.

5. TIMING OF HEDGING INSURANCE RISKS

Similar to the timing decision on hedging financial risks, the optimal timing of hedging insurance risks needs to consider the possible changes in costs and benefits in the future caused by changes in the market condition. In addition to the economic cycle, the insurance cycle is an important consideration for hedging insurance risks.

The insurance cycle, aka the underwriting cycle, is the cyclical pattern of insurance prices and profits for the property and casualty insurance industry. A full cycle consists of two phases: soft market and hard market. A soft market is featured with increasing competition, relaxing underwriting rules, lower insurance price and profit. With a capacity constraint or a major catastrophic event, the market moves into a hard market. A hard market is featured with stringent underwriting, higher insurance price and improved profit. Meier and Outreville (2003) showed that the return on equity (ROE) of the U.S. P&C insurance industry has a material impact on the reinsurance price. A lower ROE indicates a higher reinsurance price. A higher reinsurance price could also indicate a higher level of hedging cost for insurance risk.

If the hedging is not immediately needed, the company can decide the most appropriate time to implement the hedging. The cost of hedging is a major component in the timing decision. For example, a company wants to hedge its exposure to catastrophe risk by issuing catastrophe bonds. The market changed into a hard market one year ago. The company's capital position is strong and it does not need to reduce its risk exposure immediately. In this case, the company may consider the following factors for its timing decision.

- When will the market move to a soft market? In a soft market, the cost of issuing catastrophe bonds will be lower. It might be worth waiting if the hedging is a long-term plan. Some models are available to predict insurance cycles such as the regime-switching model proposed by Wang et al. (2011).
- The company could also take a staged approach by issuing a small portion of the total amount in a hard market and gradually increasing the amount of hedging as the market moves into a soft market.
- When evaluating different timing options, the company needs to consider the potential loss caused by catastrophes during the period before hedging is in place.

The real option approach can be used in a similar way to the analysis of financial risk hedging. The value of new information is estimated using the insurance cycle modeling rather than the economic cycle modeling.

6. TIMING OF RISK MANAGEMENT INVESTMENT

Building new risk management functions is important but also expensive. Other important projects may compete for limited resources. Unless the risk management investment is required immediately by regulators, it is helpful to study its optimal timing from an economic perspective.

The benefit of building new risk management functions are difficult to quantify. For example, building an economic capital (EC) framework can improve a company's risk analysis capability, improve future risk decisions and, in the long term, may contribute to a credit rating upgrade. Unlike the examples of hedging programs in the previous sections, most of the assessments could be quite subjective and few company-specific experience can be relied on. The timing consideration is even more ambiguous. In practice, the timing is determined after the board or senior management have made the decision to build the EC framework. The actual timing depends heavily on the availability of resources. Therefore, the optimization of timing for investment in the EC framework is not a scientific task. An example of a high-level assessment of an EC project and its timing is given in Section 6.1.

6.1. Example: Investment in Building an EC Framework

Insurance company ABC is considering building an EC framework and its applications to enhance the company's risk management. The company has been using a factor-based

approach to assess risk exposure and calculate risk charges. The EC framework will be a major enhancement of the risk analysis in the company. The company will also use EC as an additional measure for capital management and performance measurement. The project is expected to require an initial investment of $20 million. Annual cost is expected to be $2 million inflated by 3 percent each year. Company ABC is considering whether and when to make the investment.

The benefits company ABC are looking for include:

- **A contribution to the company's enterprise risk management rating.** The company plans to boost its credit rating in the medium term (three to five years) from A+ to AA–. ERM rating is an important component of risk assessment by rating agencies. By using the EC framework in business decision-making, the company wants to improve its risk management practices.

- **Improving business decision-making such as capital management, new business planning, risk optimization and performance measurement.** Risk-adjusted return on economic capital will be used as a new measure. The benefit is measured by comparing the decision without the support of EC results and the decision with the support of EC results. In the past, the company had some successful and some unsuccessful capital management decisions. If the EC framework had been in place, some wrong decisions may have been corrected; however, correct decisions may have been changed as well. The net impact is seen as a benefit of the new project.

- **Reducing the significant financing cost of a five-year business expansion plan.** The company plans to issue bonds and shares at the same time. If the credit rating is upgraded, the company could save about 10 basis points in terms of the cost of capital rate. The EC model can also help the company understand the amount of capital it needs to raise to remain at the same level of capital adequacy. The additional information generated from the EC model may lead to a reduced level of required capital and therefore less capital cost. It may also lead to an increased level of capital needed. In this case, the future cost of capital raising or risk mitigation will be less after gaining a stronger capital position as indicated by the EC result.

As this is not a regulatory requirement, company ABC does not have to build the EC framework immediately. Several considerations on the timing are under review.

- The company wants to raise capital for the business expansion during an economic expansion to control the cost. Therefore, it is ideal that the EC framework building be finished before the capital raising and a future economic downturn. The economy has been recovering from the last financial crisis for six years and may keep expanding or move into a recession. If the company starts the EC project now, it runs into the risk that the economy goes into a recession in the near future. The company will not implement the business expansion plan then and the benefit of the EC framework will be limited. In that case, the initial investment may be better used to improve the capital position rather than build the EC framework. On the other hand, if the company waits for six months or a year, the direction of the economy could be clearer and the company may be able to make a more informed decision. For example, the Federal Reserve has implemented the near-zero interest rate (0 to 25 basis points) policy for nearly seven years. A series of increases in the Fed rate would indicate an expanding economy ahead. Keeping the rate unchanged or reducing it further would indicate a higher risk of economic recession. The Fed actively monitors the unemployment rate, inflation rate and economic activities to decide the rate level. There have been many discussions on rate hiking in 2015. In six months or a year, we may see a rate increase that raises the probability of a continuing economic expansion in the medium term. The company may decide to start the project immediately at that time. On the other hand, the average period of an economic cycle since World War II is seven years. An economic recession is also a possible scenario. If we experience a level rate or a rate decrease in the next six months or a year, the probability of an economic recession will be higher. In that case, the company may decide to postpone the project.

- The company does not have any experience with economic capital modeling and application. Without back testing and proper model validation, the EC result could be very sensitive to assumptions and misleading. In the 2008 financial crisis, some global insurance companies needed government bailout to survive although the economic capital result had showed these companies had strong capital positions and abundant free capital to deploy. Before the investment, the company may want to gain additional knowledge and experience to better assess the benefits of the EC framework.

- If the company wait for another six or 12 months for the EC project and then decide to build the EC framework, it may end up with an additional $10 million cost to achieve the target timeline of capital raising and business expansion. If interest rates are raised during that period, the financing cost will be higher as well.

With a 10-year time horizon, the following high level estimates of the costs and benefits are used for the timing decision.

To determine the optimal timing, the key is to evaluate how future information may improve future decisions.

Option 1. Start project immediately.

Table 3. Option 1 Cash Flow Projection

		Inflation Rate	3%		NPV	$0.03
Unit: $M		Discount Rate	10%		ROI	10%
Time	Investment[1]	Benefit of Improved Decisions[2]		Benefit of Reduced Cost of Capital[3]		Expected NCF[4]
		p = 0.5 (2a)	q = 0.5 (2b)	p = 0.5 (3a)	q = 0.5 (3b)	
0	20.0					−20.0
1	2.0	4.0	1.0	0.0	0.0	0.5
2	2.1	4.1	1.0	0.0	0.0	0.5
3	2.1	4.2	1.1	15.0	0.0	8.0
4	2.2	4.4	1.1	15.0	0.0	8.0
5	2.3	4.5	1.1	15.0	0.0	8.1
6	2.3	4.6	1.2	1.0	0.0	1.1
7	2.4	4.8	1.2	1.0	0.0	1.1
8	2.5	4.9	1.2	1.0	0.0	1.1
9	2.5	5.1	1.3	1.0	0.0	1.1
10	2.6	5.2	1.3	1.0	0.0	1.2

Notes:

1. **Investment.** $20 million initial investment with an annual cost of $2 million growing by an inflation rate of 3 percent.
2. **Benefit of improved decisions.** Based on the company's current knowledge, the benefit of improved decisions has an even chance to be $4 million or $1 million in the first year, growing by the inflation rate annually.
3. **Benefit of reduced cost of capital.** Because the direction of economic development is unclear now, the company expects two economic scenarios with equal chances. In the economic expansion scenario, the company will raise additional capital to implement the business expansion plan. The benefit of reduced cost will be realized from the third year, with $15 million for thee years, followed by $1 million till the end of the time horizon. In the economic recession scenario, the business expansion plan will be cancelled and no benefit will be gained.
4. **Expected NCF.** The NCF is calculated as (2a) × 0.5 + (2b) × 0.5 + (3a) × 0.5 + (3b) × 0.5 – (1). The ROI is 10 percent. With a hurdle rate of 10 percent, the NPV is $0.03 million.

Option 2. Wait one year and then decide whether to make investment or not.

Table 4
Option 2 Cash Flow Projection

		Inflation Rate		3%		NPV	−$3.15	$20.37	$4.07	−$9.80	−$26.09
Unit: $M		Discount Rate		10%		ROI	5.4%	36%	17%	−3%	N/A
Time	Invest-ment[1]	Benefit of Improved Decisions[2]		Benefit of Reduced Cost of Capital[3]		Expected NCF[4]	NCF[5a]	NCF[5b]	NCF[5c]	NCF[5d]
		p = 0.5 (2a)	q = 0.5 (2b)	p h= 0.5 (3a)	q = 0.5 (3b)	Average	p = 0.25 (2a)&(3a)	p = 0.25 (2b)&(3a)	p = 0.25 (2a)&(3b)	p = 0.25 (2b)&(3b)
		High	Low	High	Low					
						Decision @ Time 1	Yes	Yes	No	No
0	0.0						0.0	0.0	0.0	0.0
1	25.0	0.0	0.0	0.0	0.0	−25.0	−25.0	−25.0	−25.0	−25.0
2	2.1	4.1	1.0	0.0	0.0	0.5	2.1	−1.0	2.1	−1.0
3	2.1	4.2	1.1	15.0	0.0	8.0	17.1	13.9	2.1	−1.1
4	2.2	4.4	1.1	15.0	0.0	8.0	17.2	13.9	2.2	−1.1
5	2.3	4.5	1.1	15.0	0.0	8.1	17.3	13.9	2.3	−1.1
6	2.3	4.6	1.2	1.0	0.0	1.1	3.3	−0.2	2.3	−1.2
7	2.4	4.8	1.2	1.0	0.0	1.1	3.4	−0.2	2.4	−1.2
8	2.5	4.9	1.2	1.0	0.0	1.1	3.5	−0.2	2.5	−1.2
9	2.5	5.1	1.3	1.0	0.0	1.1	3.5	−0.3	2.5	−1.3
10	2.6	5.2	1.3	1.0	0.0	1.2	3.6	−0.3	2.6	−1.3

Notes:

1. **Investment.** $25 million initial investment at time 1 with an annual cost of $2 million growing by the inflation rate, which is 3 percent.

2. **Benefit of improved decisions.** The benefit of improved decisions has an even chance to be $4.1 million or $1 million in the second year, growing by the inflation rate annually. At time 1, with the accumulation of knowledge and experience, the company will know exactly which benefit amount it will get.

3. **Benefit of reduced cost of capital.** Because the direction of economic development is unclear now, the company expected two economic scenarios with equal chances. In the economic expansion scenario, the company will raise additional capital to implement the business expansion plan. The benefit of reduced cost will be realized from the third year, with $15 million for three years, followed by $1 million till the end of the time horizon. In the economic recession scenario, the business expansion plan will be cancelled and no benefit will be gained. At time 1, the company will know exactly the scenario of the economy.

4. **Expected NCF.** The expected net cash flow is calculated as (2a) × 0.5 + (2b) × 0.5 + (3a) × 0.5 + (3b) × 0.5 – (1). It assumes that no matter what additional information the company will get in one year, it will still make the investment. The ROI is 5.4 percent. With a hurdle rate of 10 percent, the net present value is –$3.15 million. It is the NPV approach without considering the value of new information. If this approach is used, Option 1 will be chosen as it has a higher NPV and ROI.

5. **NCF.** Using the real option approach, at time 1, the company gets to choose whether to make the investment or not. As shown in tables 4 and 5, items 5a to 5d are four scenarios and the company will know exactly which scenario will play out. The NCF of each scenario is the sum of corresponding benefits deducted by the investment. For example, the NCF of 5a = (2a) + (3a) – (1). Scenarios 5a and 5b will lead to a positive NPV. The investment will be made if 5a or 5b is expected at time 1. No investment will be made if 5c and 5d is realized. The aggregate NPV of Option 2 is $6.1 million (20.4 × 0.25 + 4.1 × 0.25). Compared to the NPV of Option 1, the company should wait one year before making the investment decision.

Table 5 Investment Decision by Scenario

Scenario	Benefit of Improved Decisions	Benefit of Reduced Cost of Capital	Probability	Decision	ROI	NPV ($M)
5a	High	High	0.25	Yes	36%	20.4
5b	Low	High	0.25	Yes	17%	4.1
5c	High	Low	0.25	No	−3%	−9.8
5d	Low	Low	0.25	No	N/A	−26.1
Aggregate [(5a) and (5b) Only]						**$6.1**

For simplicity, it is assumed that the company will know exactly the actual scenario at time 1 in this example. In reality, it is not realistic but the company may have a much better idea which scenario is the most likely one. It can be reflected by assigning a different probability than 25 percent for each scenario.

The costs, benefits and the value of new information vary from one risk management investment to another. They may not always be quantifiable and the uncertainty could be very high. Experts' opinions are useful for choosing the best timing as well. For example, the company may not need one year extra time to better understand the benefit of improved decisions. Seeking the opinions of experts with relevant experience may shorten the knowledge gap.

7. CONCLUSION

The timing of a risk management project could have a material impact on the cost, such as for a hedging program or the capital in a financing plan. Choosing the right timing to implement a risk management strategy or start an investment in new risk management functions is important.

Traditional approaches such as the NPV and real option approach used for investment decisions can be adjusted and used for timing decisions on risk management projects. The cost and benefit of a risk management project are different from a traditional investment. Risk management projects focus on more extreme scenarios than the expected cases.

Assessing the value of new information and its impact on future decisions is the key to timing decisions for risk management projects. The assessment usually requires comprehensive and complex analysis.

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ENDNOTE

1 VIX is a volatility index developed by the Chicago Board Options Exchange that tracks the implied volatility based on the prices of options on the S&P 500 index.

2 The VIX is used as the implied volatility for simplicity. In reality, the implied volatility varies by option type (call or put), term of the option contract and the level of exercise price (in-the-money/at-the-money/out-of-the-money option).

3 Here ROI is the internal rate of return (IRR). It is the discount rate that makes the NPV equals to 0.