Andrea Rózsa:[1]

Just-in-Time system in terms of real options

Abstract

The value creation process in a company and the competitive position are critically influenced by corporate resource allocation and proper valuation of investment alternatives. After the Second World War, capital budgeting and strategic planning emerged as two complementary but different systems for resource allocation.
The real options approach developed in the ’80s may provide a useful tool for making a connection between capital budgeting and strategic management. Real options are implicit managerial and operating flexibilities embedded in many non-financial assets and liabilities. In a wider sense: “A real option is the investment in physical assets, human competence, and organisational capabilities that provide the opportunity to respond to future contingent events” (Kogut-Kulatilaka, 2001).

This paper shows that Just-in-Time (JIT) system as management philosophy can be regarded as a knowledge-based or capability-based implicit strategy rather than a simple, easy-to-imitate best practice approach. Moreover, implementation of JIT can be considered as a strategic investment.
The presentation focuses on how the relation among strategic investments, developed technological systems and corporate strategy can be expressed through the real options view.

Keywords
Real options, JIT, strategy, capability

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THE IMPORTANCE OF REAL OPTION THEORY

The value creation process in a company and its competitive position are critically influenced by corporate resource allocation and proper valuation of investment alternatives. After the Second World War, capital budgeting and strategic planning emerged as two complementary but different systems for resource allocation. Myers (1987) refers to the two systems as "two cultures looking at the same problem".

Capital budgeting

Capital budgeting developed into a decentralized process organised around individual or stand-alone projects based on DCF techniques. It focused on measurable cash flows and sought to make appropriate adjustments for the timing and riskiness of these cash flows (Trigeorgis, 1996, xi).

DCF techniques were originally developed to value passive investments in bonds and stocks. Traditional project valuation methods were predicted on the implicit assumption of **passive management** The DCF approach assumes that companies will follow a predetermined plan, regardless of how future events unfold. Conventional project evaluation ignores the upside potentials to an investment from managerial flexibility and innovations. **Active management** focuses on the strategic flexibility that gives management the option to revise decisions while a project is underway.

Strategic management

Because of these inherent limitations, DCF techniques have not gained as much acceptance in strategic planning, where competitive advantage, market leadership and industry structure remain dominant concepts.

The **'60s** can be characterised by the classical strategic theory. According to this, strategy is a result of a deliberated intellectual activity. *Porter's planning idea* (Porter, 1985) belongs to this group. Firms have to position themselves in the industrial environment, and substance of the competitive strategy is to choose and create appropriate position.

As businesses grew in the **'70s and '80s** a greater need for decentralisation of decision making and compartmentalisation into separate divisions was seen. Along with the new decentralized organisational structures (strategic business units) came decentralised resource allocation, often favouring a piecemeal approach.

Nowadays, "strategy research reflects competing ideas about how the world looks, or what the world needs. There is currently debate in strategy research between the importance for a firm to "position" itself in the market or to focus on developing unique capabilities. Bowman (1995) made the distinction between strategies that look in the mirror and those that look through the looking glass. In the parlance of contemporary strategy research, resource and knowledge theories of the firm are inward looking; whereas market positioning and industry analysis are outward looking" (Kogut – Kulatilaka, 2001).

The resource based and knowledge theories view the unique capabilities of the firm as the cornerstone of sustainable rents.

The real option approach

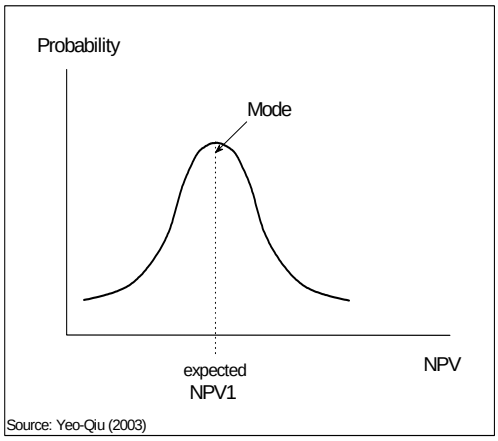
Real option theory developed in the '80s may provide a useful tool for making a connection between capital budgeting and strategic management. Through the '80s, financial option evaluation methods had been applied to evaluate flexibility associated with physical investments. This extension has been labelled ***real option***.

Real options are implicit managerial and operating flexibilities embedded in many non-financial assets and liabilities. Busby and Pitts (1997) described real options to their survey respondents as simply "flexibility" (in MacDougall – Pike, 2002).
In a wider sense: "A real option is the investment in physical assets, human competence, and organisational capabilities that provide the opportunity to respond to future contingent events" (Kogut-Kulatilaka, 2001).

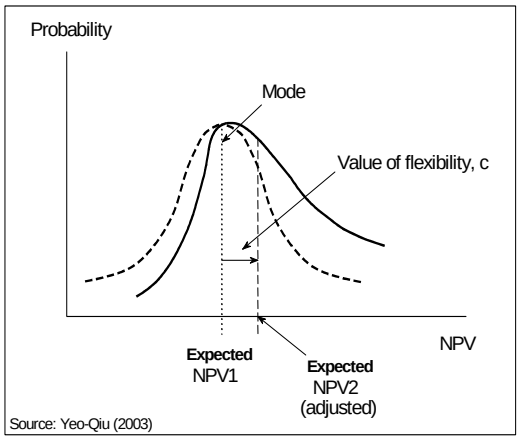
Flexibility has value under uncertainty. The concept of real options acknowledges that downside risk is limited while upward potential is maximized if management can alter the sequence of strategic actions and investment. Companies, operating in a changing and turbulent marketplace must be flexible. The belief is that these companies are agile; and by making the right moves today, they open up windows of opportunity for learning and profitability. They learn from mistakes, learn faster than competitors, and make quick adjustments to seize opportunities by exercising the options presented to them (Yeo – Qiu, 2003).
When investment is irreversible and future market conditions are uncertain, an investment decision must not be based solely on the usual net present value (NPV) rule. An investment expenditure implicitly calls for sacrifice of the option to wait-to-invest (defer), so that we must treat this lost option value as part of the investment cost[2].
Similar adjustments are necessary when there are options to abandon or temporarily shut down, options depending on the sequential nature of investment and options to choose capacity.
Management's flexibility to adapt its future actions introduces an asymmetry or skewness in the probability distribution of NPV or payoff that expands the investment opportunity's true value by improving its upside potential while limiting downside losses relative to management's initial expectations under passive management (Fig.1.).

Fig.1.

Traditional Project Evaluation



Project Evaluation with Flexibility



In the absence of such managerial flexibility, the probability distribution of NPV would be reasonably symmetric, in which case the static (or passive) expected NPV (mean value of

[2] McDonald and Siegel (1986) showed that even with moderate amounts of uncertainty, the value of the option to wait can be significant, which suggests that an investment rule ignoring the option value can be grossly in error (in Real Options in Capital Investment, Chapter 5 ed. by L. Trigeorgis (1995)).

symmetric distribution) would coincide with its mode or most likely estimate. With managerial flexibility, such as exercising of options and other innovations, it introduces enhanced upside potential so that the resulting actual distribution is skewed to the right. The true expected value of such an asymmetric distribution exceeds its mode by an option premium, reflecting the value of managerial flexibility, with the expected NPV1 being enhanced to NPV2. Hence, NPV2 (active) = NPV1 (passive) + c, where c = value of managerial flexibility afforded by embedded real options.
NPV1 is the passive NPV of an investment. Since the value of managerial flexibility is not tangible cash flow, it does not enter NPV1's computation. NPV2 is active NPV. This value shows that real options enable management to flexibly change traits of the investment in order to add value.
The mentioned option value can quite possibly turn a negative NPV1 into a positive NPV2.
Real options are not merely theoretical curiosities. In many cases, they can tip the balance between project acceptance and rejection.

THE ROLE OF ACCELERATED TECHNOLOGICAL DEVELOPMENT

Current research emphasises the fact that traditional financial measures, like NPV, do not value investment alternatives containing real options correctly. (Yeo-Qiu (2003), Trigeorgis (1996), 120.-124.p., Amram – Kulatilaka (1999)). Particularly, the following sources of strategic value are difficult to incorporate in the framework of standard capital budgeting:

- managerial operating flexibility as a collection of operating real options;
- project synergies;
- growth opportunities and interrelated dependence among projects (Trigeorgis – Kasanen (1991)).

Asymmetry coming from the managerial capacity for adaption claims an ***extended or strategic investment criteria*** which represent both value components:
1. traditional (static or passive) NPV of direct cash flows,
2. option value of operating flexibility and strategic interactions.

Strategy and manufacturing capabilities

The dynamic and rapidly changing markets and technologies have called into question the sustainability of a competitive advantage. Increasingly, companies were looking to advanced manufacturing technologies (AMT) to acquire or sustain compatitive advantage. AMT is typically more expensive and complex than conventional technology and much of the value needed to justify its adoption is derived from benefits that are intangible, contingent and hard to quantify.

Dramatic operational improvements were realised, but they have rarely resulted in sustainable profitability. Firms introduced more or less well applicable best practice; however, it seemed that they were not able to overtake each other. This phenomenon is called as 'hypercompetition' by Porter (1996).

Along the new production dogma a new idea has emerged, i.e. operations' role is not just implementing of strategy; on the contrary, operations can be determinant of corporate strategy through developing unique organisational capabilities. It is widely accepted that Penrose (1959) was the first who suggested determinant role of manufacturing resources of firms. From the 80's several authors have emphasised advantages generated by manufacturing knowledge, e.g. Nelson and Winter (1982), Wheelwright and Hayes (1985), Hayes,

Wheelwright and Clark (1988), Wheelwright and Clark (1992), Hamel and Prahalad (1990, 1991, 1994), Hayes and Pisano (1994), Teece, Pisano and Shuen (1997), Hayes and Upton (1998).

According to Hayes and Pisano (1994) a company should think of itself as a collection of evolving capabilities (Hayes and Pisano, 1994)[3]. The key to long term success is being able to do certain things better than rivals can. Hayes' ideas indicated changes concerning not only manufacturing but substance of the competitive strategy. This change integrates manufacturing strategy with the notions of both core competences and learning organisations, and suggests that competitive advantages can be gained by a strategy using manufacturing processes (Wheelwright and Hayes, 1985; Hayes, Wheelwright and Clark, 1988; Hayes and Pisano, 1994).

Operations' role is not just implementing of strategy. *'Superior operations effectiveness not only serves to buttress a company's existing competitive position, but when based on capabilities, that are embedded in the company's people and operating processes, is inherently difficult to imitate'*. Consequently, the sustainability of a competitive advantage that is based on superior operating skills is enhanced, because it is difficult to duplicate and because competitors may not perceive its potential effectiveness, or even its existence (Hayes and Upton, 1998).

According to Hayes and Upton (1998) the cause of that the operational effectiveness based on organisational capabilities is so valuable is that the source of innovations in operations are inherently difficult to imitate and slow diffusion. The reason for it is that the superior operating capabilities are organisationally specific, thus competitive advantages provided by them are more sustainable. On the other hand, operations-based strategies have a dynamic quality. Continuous improvement is the essence of today's most effective operations organisations. *The most difficult task is to learn, obtain or develop the ability of improving new and valuable capabilities. Organisations that are able to solve it will be able to push out the frontiers of their operating performance faster than competitors can; and they are possessed of the ability of organisational learning and quick adaptability.*

STRATEGIC VALUE OF JIT

JIT AS IMPLICIT STRATEGY

JIT system is equivalent to Toyota Production System (TPS). This paper considers JIT in the largest sense, i.e., regarded as a philosophy of management concerning all aspects of a firm's productive activities with the main purpose of the elimination of waste.

Sakakibara et al (1997) refers to JIT as an overall organisational phenomenon, and it is accordance with the wider sense of JIT. Regarding this paper, the most important conclusions of the article are the following: there is a statistically significant relationship between the combined set of JIT and infrastructure practices and the set of manufacturing performance measures; and there is a strong relationship between manufacturing performance and achieving a competitive advantage. The authors did not explain in detail how can be the

[3] Compare with the concept of 'routine' in Nelson-Winter (1982).

combination of JIT and infrastructures practices realised. However, the study of Spear and Bowen (1999) shows a possible version of this combination called 'scientific method'.

According to the authors the activities of the firm can be regarded as the set of controlled experiments. Whenever Toyota defines a specification, it is establishing sets of hypotheses that can be tested. This approach is not imposed on workers, it is ingrained in them. The article says that the key is to understand that the TPS creates a community of scientists.
The tacit knowledge that underlies the Toyota Production System can be captured in four basic rules. These rules guide the design, operation, improvement of every activity, connection, and pathway for every product and service. *Problem-solving and learning take place at all levels of the company.*

Connections, relations, and production flows are coordinated by collective knowledge of the organisation through scientific method. This knowledge is embedded in the organisation, distributed and tacit[4] It can be considered as an outstanding organisation-based operating capability following Hayes and Upton (1998). According to Lam (1998) there is a close connection between the dominant knowledge type and structural configuration of organisation. Toyota's knowledge is embedded which is generated by JIT. The organisational structure adequate for embedded knowledge is J-form organisation, i. e., Japanese type of organisation The tacit (implicit) knowledge is inherent in routines (Nelson and Winter, 1982), and it is accumulated by 'learning by doing' J-form organisation, consequently Toyota is a 'knowledge creating company' (Hayes-Clark-Wheelwright (1988), Nonaka-Takeuchi (1995) in Lam (1998)). The scientific method provides consideration and continuous improvement of all aspects of the firm. Through the continuous improvement, it makes the ability of developing new capabilities possible; hence, the company becomes to be able to shift productivity frontiers faster than its rivals do.

Consequently, JIT can be considered a knowledge-based implicit strategy following Mintzberg's idea, because it is difficult to understand and imitate. Difficulty of imitation also results from a strong fit of activities. Managing this fit enhances both competitive advantage and sustainability. Using scientific method, however, the organisation of Toyota is learning continuously; hence, this fit becomes a unique organisational capability (Rózsa, 2002).

EMBEDDED OPTIONS IN IMPLEMENTATION OF JIT[5]

Most Japanese firms do not rely on the seemingly more scientific DCF techniques[6], although they do perceive some significant value in managing real options over time.

According to the previous section, implementation of JIT system is a strategic investment in infrastructure. Infrastructure investments consist of both tangible and intangible assets on which individual operating flexibility are based. Flexible manufacturing systems such as JIT

[4] *Tacit knowledge* refers to knowledge that is intuitive, unarticulated, and that cannot be easily codified and transferred. It is based on experience and bodily action, it can only be acquired through 'learning-by-doing' *Collective knowledge* refers to the ways in which knowledge is distributed and shared among members of the organisation. It is the accumulated knowledge of the organisation stored in its rules, procedures, routines and shared norms, which guide the behaviour, problem-solving activities and pattern of interaction among its members. A combination of individual implicit knowledge and collective knowledge may create embedded knowledge. *Embedded knowledge* is relation-specific, contextual, path dependent and dispersed (Lam, 1998).
[5] Trigeorgis (1995), Real options in Japan by Takato Hiraki, 151-163 p.
[6] Japanese firms typically use very restrictive payback standards for incremental investments. For example, a three year payback for product model changes is not unusual for durable consumer goods.

are evidential. In addition to accumulated technology through R&D, some aspects of Japanese management provide the intangible infrastructure required for certain real options. For example, the Japanese labor force is well trained and specialises in more than one area of operation. In Japan, there usually exist regular (lifetime) employees and part-time workers. Regular employees are generally treated better, but they are subject to bonus cuts and are expected to be cooperative in various cost-cutting programs implemented during less profitable periods. These systems unique to Japanese companies such as Toyota, also provide the infrastructure in order to more effectively build and manage real options.

Japanese manufacturing firms have aggressively invested in flexible manufacturing systems (Jaikumar, 1989). The resulting operating flexibility is well treated within a real options framework.
Many operating flexibilities derive from infrastructure investments in a core asset, system, or information and manufacturing technology. Such an infrastructure investment is valuable since it increases contingency opportunities and the value of real options. Those firms equipped with such basic infrastructure are better able to increase potential gains or reduce losses through appropriate timely operational adjustments. The contingent plans of such firms typically include various standard operating flexibility options.
These are the following:

1. Options to switch

Output switch

It refers to product line producing one or several kinds of product. As the demand for a product changes adversely, a new product is quickly introduced with manufacturing flexibility. The Japanese manufacturers in automobile and high-technology industries have focused on this flexibility due to sophisticated domestic consumers and high quality standards. This flexibility has, in turn, helped them become more competitive in foreign markets.

Input switch

Input switch means that production facility allows the use of alternative process or technology depending on the price of inputs. To produce the same product, process flexibility can contribute to maintaining low production costs and profitability when the cost of alternative product inputs fluctuates. A major production facility is designed and maintained so as to quickly adjust to these changes through the use of different technologies depending on the relative cost of the inputs.

2. Options to alter

This flexibility makes it possible for a manufacturer to expand or contract the scale of operations by changing the utilization of production facilities or resources. Since Japanese manufacturers are more vertically integrated or related to suppliers and customers, this production scale adjustment for them is easier than for their competitors; in the U.S., for example. The scale expansion is supported by industrial group companies and financial institutions while the downward adjustment sometimes involves industry-wide coordination.

3. Option to defer

A project with negative NPV may become profitable if it can be deferred over a certain time period. For example, output prices can increase or borrowing rates decrease unexpectedly. This flexibility is more beneficial to Japanese manufacturers because of their stable and reciprocal relations with contractors and financial institutions than to their U. S. competitors. JIT system can be characterized by presented real options concerning production/operating flexibility.

Strategic versus operating options

Regarding strategic technology or infrastructure investments firms usually invest in two types of real options (Yeo-Qiu, 2003): strategic (or growth) options and operating (flexibility) options.

As discussed earlier, operational flexibility options are common in technology investments that yield direct measurable payoffs. However, these operational options must be planned[7] and designed to fit each investment differently. The flexibility strategy allows a firm to more easily and quickly switch product features or service offerings to meet changing market conditions. In the literature investment in flexible manufacturing systems are classic examples. JIT system is more than a collection of flexibility options.

Strategic options are usually spawned by investments that aim at developing core technologies and/or building experience with promising technologies that could become the drivers of future organisational capabilities.

Following Kyläheiko, et. al. (2002) we can complete previous real option system with

4. Implementation option

Implementation options represent the decision on how the company configures its value chain by choosing among alternative resources, routines and capabilities. The choices the firm can make about how it will organise its value chain can greatly affect both the speed with which the value chain can be assembled and the flexibility of the chain to change tasks once it is in place. The choice set consisting of routines and capabilities is of course highly dependent on former cumulative decisions and learning processes realised throughout the company.

Moreover, according to Yeo – Qiu (2003) we can examine

5. Learning option

Investing in operating options can be used to create a window for education and learning, and lead to enhanced organisational capabilities and consequential reduction of risk. R&D investments for exploring and learning about different technologies is an example. Sub-options may be created due to learning and for becoming more knowledgeable.

[7] Options to switch and options to alter are the typical examples.

Implementation of JIT system includes complex/compound options since it contains naturally emerging options and designed-in options as well; but also strategic options like implementation and learning options are embedded in JIT.

CONCLUSIONS

Real options create a relationship between capital budgeting and strategic management.
Real options thinking compels managers to go beyond a single point estimate of the likely future but to recognise a broader domain of possible opportunities. Many investment scenarios can be considered as sets of options. An options approach to capital budgeting has the potential to conceptualise and quantify the value of options from active management and strategic interactions. This value is typically manifest as a collection of "real options" embedded in capital-investment opportunities.

By systematically developing these options, companies achieve continuous improvement in operating flexibility and strategic adaptability, thus gaining a substantial competitive advantage over their rivals.

This article dealt with strategic aspects of JIT in terms of real options. It can be stated that JIT is more than a simple production management system. Following Mintzberg's idea, it can be considered a knowledge-based implicit strategy because it is difficult to understand and imitate. Consequently, JIT is more than a simple collection of flexibility options because of its strong strategic relevance. If a company during the implementation of flexible manufacturing system considers only the technological side, it can lose value-creating aspects. Adaption of JIT results in flexible production system. And in addition to this, it allows dvelopment of difficult-to-imitate strategic capabilities as well, and thus contributes to achieving and sustaining a competitive advantage.

This study examined qualitatively the benefits of adaption of JIT system. Concrete applications and quantitative tests can induce further research in this area.

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