# Firm technology investment and the development of technological capabilities in China's telecom sector

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## Abstract

This paper examines the impact of technological investments and technological acquisition strategies on the development of dynamic technological capabilities (DTC) at firm level in the context of the Chinese telecommunication sector. We disaggregate DTC into four types (product, process, organisation, investment) across three levels (basic, intermediate, advanced). We investigate a set of 53 firms over six years and find that all types of investments influence DTC building, although differently depending on the type and level of DTC. Our findings show the benefit of using a finer level of granularity in analysing DCT to understand their development over time.

**Keywords:** dynamic technological capability, technological investment, Chinese telecommunication sector
**Topics**: technology management

### Introduction

It has been argued that technology management is concerned with the development and exploitation of constantly changing technological capabilities (TC). This understanding of technology management emphasises the dynamic nature of TC management (Cetindamar et al., 2009a). The ability of firms to dynamically manage their TC is even more critical in contexts characterised by rapid changes in the technology, economic, social or political regimes where firms need to learn quickly and adapt fast to a changing environment through building dynamic capabilities (DC). The development of dynamic capabilities at firm level has been the focus of strategic management research that focused in identifying the mechanisms to build DC at firm level (Wang and Ahmed, 2007) as critical mechanisms to build DC. In contrast, technology management research on TC focuses on the technological effort at industry or country level, especially in the context of developing countries (see Cetindamar et al., 2009b).

Given the important role played by DTC in allowing firms to generate competitive advantage through technological change in dynamic environments, we set out investigate the mechanisms for building DTC. We focus on the role of technological investments in learning and R&D (drawing on the strategic management literature on DC development) and the role of technology acquisition strategies (drawing from technology management literature on TC).

**Dynamic Technological capabilities**

Generally, TC refers to the skill, knowledge and experience to use the existing technology or to develop new technology in order to achieve technological change (Kim, 1997), broadly in response to the demands from the competitive business environment (Jin and Zedtwitz, 2008). Two levels of TC are widely identified in the literature: static TC which refer to routine production capabilities and include the knowledge required to operate a production system; and dynamic TC which refer to the ability to change and improve existing technology, and to create new technology, and include the knowledge required to change the system (Cai and Tylecote, 2008). DTC can be further disaggregated at three levels: basic DTC which involve the ability to search for and select the most appropriate technology, and to master, utilise, adapt, and improve the selected technologies; intermediary DTC which enable the firm to make far-reaching improvements in its existing product and processes; and advanced DTC which refer to the ability of a firm to generate new technologies with little or no external help (Cai and Tylecote, 2008). Basic and intermediary DTC correspond to the absorptive capabilities identified in strategic management research. Absorptive capabilities, in a similar fashion to basic and intermediary DTC, highlight the importance of taking in external knowledge, combining it with internal knowledge and absorbing it for internal use (Cohen and Levinthal, 1990). Advanced DTC match the innovative capabilities identified in strategic management literature which in a similar fashion to advanced DCT, refers to a firm's ability to develop new products and/or markets through aligning strategic innovative orientation with innovative behaviours and processes (Wang and Ahmed, 2007).

The development of most products requires a number of distinct components, and the production of each of those components requires machinery, skills, blueprints, and licences. To develop the product, a firm must acquire all these necessary components following either a bundling or an unbundling strategy. Bundling involves the firm getting hold of all of these components together, for example in a turnkey plant in which another firm which has mastered all the components already, sets up a factory, trains all the workers, gets it running, and then hands the whole operation over, complete with licenses for each of the patented technologies. The TC that is developed following complete bundling strategy is static as the firm simply acquires routine experience required to produce a product or perform a process (Collins, 1994). The unbundling strategy requires the firm to obtain each component separately, thus requiring the firm to independently work out what the elements that are to be separately acquired, to find and negotiate with the prospective providers, and to integrate the elements once provided. Unbundling hence fosters both independence and learning, as the firm is forced to learn about the technology through independently working out, finding, negotiating, and integrating the components together. Unbundling also means that the firm can leverage this understanding of the technology for the generation of new technologies (Naughton and Segal, 2002). Moreover in

getting each component separately, the firm is free to stretch its capabilities, in one case it might be a passive recipient of blueprints and licenses, in another it might venture to imitate by reverse engineering, or in another one it might trust its own creativity. The stretching practice itself is a process of leveraging firm capabilities from basic and intermediate DTCs to advanced DTCs (Fransman, 1984). We therefore predict that:

**Hypothesis 1a**: Investment in bundled technologies is negatively associated with the development of firms' DTC at all three levels.

**Hypothesis 1b**: Investment in unbundled technologies is positively associated with the development of firms' DTC at all three levels.

Five distinct learning mechanisms are identified in existing literature: learning by doing, learning by using, learning by training, learning by searching and learning by interacting. Learning by doing increases productivity through a string of incremental innovations in product or production processes (Arrow, 1962) which highlight the user's effort and its need for learning and capability accumulation (Attewell, 1992) through problem-solving and experimentation (Koberg et al., 2003). According to Rosenberg (1976), learning by using is based on past experience and is derived from using new technology which cannot be acquired without any effort made to absorb it (Fransman, 1984). Given its idiosyncratic and tacit aspects, newly acquired technology may require a firm to learn how to use it through a distinctive form of learning by 'struggling to get it to work' (e.g. trouble-shooting, problem resolving and various experiments at the shop-floor level), which cultivate firms' absorptive capabilities. Learning by training involves both internal mechanisms (e.g. on-the-job-training, blending different in-house knowledge) which enhance firms' ability to assimilate and apply new knowledge across the organization, and external mechanisms (e.g. inviting experts and outside engineers) which constitute important sources for obtaining new technologies. These three learning mechanisms facilitate a firm's knowledge assimilation and utilisation for conducting product or process improvement based on existing understanding, which is conducive to the advancement of absorptive capability. We hypothesize that:

**Hypothesis 2a**: Investment in learning by doing, using and training is conducive to basic and intermediate DTC;

Innovative capability assumes the firm is capable of generating emerging technologies with little external help. To generate new innovation opportunities, firms need to engage in searching for a wider range of information (Schilling and Phelps, 2007). Searching for and exploring new opportunities also allows a firm to keep abreast of related technological advancements (Amara et al., 2004). Learning through interactions with different stakeholders can also elevate advanced DTC. For example, supplier interaction in the design of radically new products can help a firm acquire new capabilities (Wynstra and Wggemann, 2001), while interaction with lead users is valuable to the idea-generation processes for radically new concepts and in the marketing of new products, and nurtures a stream of new skills and abilities that enhance the value of lead user (Schreier and Prügl, 2008). Learning by training through circulation of good project management practices across internal organisation and on-going effort to learn from external best practices in relevant industries accentuates a firm's ability to manage project successfully as well as to shape its culture and structure that drive innovation. We argue that:

**Hypothesis 2b**: Investment in learning by searching, interacting and training is conducive to innovative DTC.

R&D in conventional technologies is generally driven by the need to make incremental improvements to current products or processes, whilst R&D in emerging technologies is generally driven by the need for radical technological improvements or the generation of new technologies (Helfat, 1997). Both forms of R&D are associated with the development of DTC. Systematic R&D effort to deepen the understanding of existing knowledge (i.e. R&D in conventional technologies) improves the ability to define problems and to generate, assess, and choose alternative technologies (Marsh and Stock, 2006). This ability is a critical factor influencing the ability to absorb knowledge (Cohen and Levinthal, 1990). R&D in emerging technologies provides firms with access and exposure to a variety of new and alternative knowledge streams (Subramaniam and Youndt, 2005). As emerging technologies often have vastly differing logics for their inner workings, the more a firm gets exposed to the new premises behind new knowledge, the more likely the firm begins to challenge its existing problem-solving approaches, and begins to deploy new technologies to develop new products and markets (Hill and Rothaermel, 2003). We hypothesize that:

**Hypothesis 3**: Investment in R&D is positively associated with the development of dynamic technological capability in terms all three DTC levels.

These investment and strategic decisions in developing technologies has a lagged effect on firm's capability building and performance (Jefferson et al., 2006). For instance research on R&D investment found that estimated duration of the benefits from R&D investment is seven years and most profit benefits are generated after 3 years (Aboody and Lev, 2001). Considering this time lagged effect, we propose that:

**Proposition 1a**: Those firms which followed an unbundled technology acquisition strategy in 2004 would achieve better innovation performance in 2009 than those firms who followed a bundling strategy in 2004;

**Proposition 1b**: Those firms which invested heavily in learning and R&D in 2004 would achieve a stronger innovation performance in 2009 than those firms which invested less in learning and R&D in 2004.

## Methods

We use the DTC framework developed by Cai and Tylecote (2008) which differentiates DTC across three dimensions: type, level, and degree of DTC. Four types of DCT are identified: product, production, investment and organisational; across three levels: basic, intermediate and advanced, and at five levels: from not advanced by regional standards up to advanced by world standards. Product TC refers to the skills required to improve an existing product specification or to design a new product. Production TC is linked to the productivity of labour and capital, and the efficiency in using material and energy. Investment TC includes skills needed to identify, assess and acquire new technology. Organisational TC refers to the ability to make changes to the firm's organizational structure and to mitigate hierarchical and bureaucratic attitudes to embrace technological change. Basic DTCs involve fundamental technology assimilation and adaptation skills and refer to firms' capabilities of making incremental changes based on newly acquired technologies. They relate not only to how well give technologies are improved, but also

to how in-house effort is made to absorb and integrate technologies to existing systems. Intermediate DTCs indicate firms' abilities to make far-reaching technological improvement on current technologies. Innovative DTC refer to the ability to generate emerging technologies that cannot be acquired (completely) from either local or foreign sources. Activates at this levels are mostly R&D-oriented, since technologies cannot usually be obtained from the market. In order to assess how far a certain level of technological capability has been achieved by firms, elements under all four types of DTC are evaluated by degree from 1 to 6. In the statistical analysis we consider that only when firms have reached degrees 5 or 6 have they built that level of capability.

This research focuses on the Chinese telecom equipment sector. We used two sources of data: Cai's (2005) doctoral thesis for the 2004 data and a survey conducted in 2009. Full description of the methods to develop the questionnaire and to collect the data in the first time period can be found in Cai and Tylecote's (2008). The same questionnaire and target population was used to collect the data in 2009. In 2004, there were around 739 equipment manufacturers in our targeted sub-sector which produce base stations, switches and handsets within which 163 were fully Chinese local firms. 89 firms participated in the 2004 survey, representing a response rate of 54.6%. In 2009 the same questionnaire was sent to these 163 firms with 62 firms completing the survey (response rate of 38%). We address the potential non-response bias by comparing the firm size and the four types of DTC to a group of 23 non-respondents. T-test revealed no significant difference between respondents and non-respondents.

We chose multiple regressions to test our hypotheses. Considering a time lagged effect, we use 2004 data for information on technology acquisition strategies and investments in R&D and learning, and the 2009 data for assessing the level of DTC and the firm's innovation performance. We then tested if technology strategies and investments made in 2004 correlate to the levels of DTC and the innovation performance achieved in 2009.

The level of DTC in 2009 is assessed following our framework, i.e. if the firms have achieved degree 5 or 6 at each of the three levels across the four types. Innovation performance in 2009 is calculated as the ratio of the sales revenue generated by products launched in the last 4 years to that of the total sales revenue to average firm performance from 2005 to 2009. To test the influence of technology acquisition strategies on innovation performance we separate the firms into two groups depending on their level of investment in unbundled technology (above or below the average) in 2004 and examine their innovation performance results in 2009. We also conduct similar T-test to compare group differences in technology investments in learning and R&D in 2004, and the differences in innovation performance in 2009. To track these relationships over time, we identified the 53 firms that responded to both surveys in 2004 and 2009 and use them as our sample size to test hypothesis analyses. We included firm size and age as our control variables, with employee numbers are used as an indicator of firm size.

**Findings**

**H1a** predicts a negative association between investment in bundled technology purchase and development of DTC. This is largely supported by our results. Apart from organizational capability, the other three types of capabilities are all negatively correlated to bundled technology investment across three levels of DTC. **H1b** predicts a positive relationship between investment in unbundled technology and DTC development and is supported by our results

across all three levels of DTC. The correlation is stronger for basic DTC and weaker for innovative DTC. **H2a** posits investment in learning by doing, using and training is conducive to basic and intermediate absorptive DTC. All these three learning mechanisms have statistically significant positive correlations with the basic and intermediate DTC for all types of DCT. Learning by training has the weakest relationship, while generally learning by using has the strongest association with the development of DTC. **H2b** proposes that investment in learning by searching, interacting and training is conducive to innovative DTC. Our results show that all searching and interacting are positively correlated to DTC at innovative and intermediate levels, while training has been found to be beneficial to all three level of DTC although at a very weak level. **H3** predicts investment in R&D is positively associated with the development of dynamic technological capability in terms all three levels. This is partially supported by our results. Apart from basic DTCs, intermediate and advanced DTCs are both positively influenced by R&D investment (See Table 1).

*Table 1 Relationship between technology investments and DTC development*

| | **Basic Absorptive DTC** | | | | **Intermediate Absorptive DTC** | | | | **Innovative DTC** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PRD | PRN | INV | ORG | PRD | PRN | INV | ORG | PRD | PRN | INV | ORG |
| *Age* | .134 | .152 | .097 | .068 | .183+ | .171+ | .156 | .114 | .259+ | .271+ | .203 | .198+ |
| *Size* | .224+ | .216+ | .162+ | .159 | .195+ | .203+ | .187+ | .159 | .283+ | .241+ | .196+ | .162+ |
| *Bnd* | -.461** | -.441** | -.290* | -.156 | -.356* | -.350* | -.191+ | -.147 | -.164+ | -.178+ | -.182+ | -.124 |
| *unBnd* | .408** | .457** | .264* | .171+ | .351* | .398* | .231+ | .229+ | .261+ | .293+ | .182+ | .174+ |
| *LbD* | .367* | .394* | .235+ | .163+ | .283+ | .297+ | .170+ | .168+ | .089 | .106 | .067 | .126 |
| *LbU* | .563** | .679** | .255+ | .181+ | .318* | .441** | .194+ | .163+ | .126 | .114 | .047 | .065 |
| *LbT* | .206+ | .198+ | .213+ | .166+ | .211+ | .174+ | .155+ | .192+ | .213+ | .207+ | .215+ | .168+ |
| *LbS* | .132 | .101 | .093 | .075 | .216+ | .253+ | .195+ | .181+ | .534** | .492** | .386* | .325* |
| *LbI* | .146 | .157 | .112 | .152 | .255+ | .278+ | .262+ | .196+ | .583** | .417** | .320* | .316* |
| *R&D* | .151 | .132 | .106 | .103 | .243+ | .239+ | .217+ | .203+ | .621** | .563** | .367* | .298+ |
| *Model summary* | | | | | | | | | | | | |
| $R^2$ | .371 | .356 | .381 | .384 | .359 | .335 | .319 | ..366 | .390 | .373 | .398 | .311 |
| Adjusted $R^2$ | .316 | .350 | .374 | .356 | .339 | .328 | .311 | .323 | .372 | .357 | .346 | .295 |
| F | 6.811* | 6.508*** | 7.145*** | 7.322*** | 6.538*** | 6.427*** | 6.006*** | 6.745*** | 7.631*** | 6.960*** | 7.640*** | 5.872*** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ** | | | | | | | | | | | |

*Age = firm age; Size = firm size; Bdl = bundled technology; unBdl = unbundled technology; LbD = learning by doing; LbU = learning by using' LbT = learning by training; LbS = learning by searching; LbI = learning by interacting; R&D = investments in R&D; PRD = product; PRN = production; INV = investment; ORG = organization*

**P1a** assumes that unbundling strategy in 2004 will support a stronger innovation performance in 2009. T-test results support this proposition (see Table 2a).

*Table 2a): t-test: differences in technology acquisition strategies*

| | Group | N | Mean | Mean Difference | Std. Deviation | t value | Sig. |
|---|---|---|---|---|---|---|---|
| Technology acquisition strategy (2004) | | | | | | | |
| Investment in unbundled technologies as % of total revenue | 1 | 39 | 13.57% | 10.32% | 0.023 | 2.872 | .002 |
| | 2 | 14 | 3.26% | | 0.015 | | |
| Innovation performance (2005-9) | | | | | | | |
| Sales revenue from products launched in the last 4 years / Total sales revenue | 1 | 39 | 5.4% | 31.6% | 0.13 | 4.973 | .000 |
| | 2 | 14 | 37% | | 0.17 | | |

*Group 1: 14 firms in 2004 that invested considerably heavy in unbundled technologies*
*Group 2: 39 firms in 2004 that invested less in unbundled technologies*

**P1b** proposes that heavier investment in learning and R&D in 2004 will lead to a better innovation performance in 2009. T-test results also support this proposition (see Table 2b).

*Table 2b) : t-test: differences in technology investment*

| | Group | N | Mean | Mean Difference | Std. Deviation | t value | Sig. |
|---|---|---|---|---|---|---|---|
| Technology investment (2004) | | | | | | | |
| Investment in technological learning and R&D as % of total revenue (2004) | 1 | 18 | 1.56% | -11.13% | 0.003 | -3.131 | .000 |
| | 2 | 35 | 12.69% | | 0.026 | | |
| Innovation performance (2005-9) | | | | | | | |
| Sales revenue from products launched in the last 4 years / Total sales revenue | 1 | 18 | 10.2% | -31.4% | 0.038 | -5.275 | .000 |
| | 2 | 35 | 42% | | 0.12 | | |

*Group 1: 18 firms that invested less significantly in technological learning and R&D in 2004*
*Group 2: 35 firms that invested significantly in technological learning and R&D in 2004*

**Discussions**

Our analysis of the evolution of DTC at 53 Chinese firms from 2004 to 2009 demonstrate the benefits of decomposing DTC and technology strategies/investments to provide a fuller understanding of DTC development in the context of a fast moving developing country.

We find that bundling technology acquisition strategy hinders the development of all three levels of DTC. We also find that the 26.4% of firms following a bundling strategy in 2004 achieved a lower average ratio of new product sales to total sales by 2009, and that by 2009, more than half of these firms changed their technology acquisition strategy to unbundling. As expected, we find that unbundling supports the development of DTC at all three levels, with the effect stronger at absorptive level. One explanation is that unbundling enhances the ability of the firm to decompose complex technology into elements, to identify and value the most important element(s) that need to be acquired from external sources, to assimilate, master and improve the acquired element(s), and to integrate new element(s) into its current systems for technology improvement. These activities relate to the absorptive capability. In contrast, innovative capability requires a firm to mostly generate technology by itself through indigenous R&D effort, rather than digesting and improving existing technologies from the market.

We find that learning by doing and by using are conducive to absorptive DTC, but not to innovative DTC. Using new technology or improving current technology implies that the technology gap between what firms already known and what they wish to absorb or improve upon is small and thus easier to manage. Therefore, these two learning mechanisms are relevant to basic (using through absorption) and intermediate (major improvement). They are less relevant to innovative DTC because the technological gap required by a breakthrough innovation is too large to be filled through relying on existing technology. We also find that learning by interacting and searching is conducive to innovative DTC. Our results indicate that these two mechanisms also facilitate intermediate DTC, although to a lesser degree. We explain this based on the nature of intermediate DTC which involve a much fuller understanding of underlying working principle than at the basic level. Thus, while the assimilation of new technology required by the basic level of DTC is met largely through internal effort based on what is already been known by the firm, the improvements conducted at the intermediate level may require new learning from suppliers/customers or the search for new supplementary skills. We also find evidence only of moderate influence of learning by training for DTC development, less significant than for the other learning mechanisms. This result could be explained by inappropriate training practices or programme. We also find that the strength of the effect of learning on DCT varies across the types of DTC. Learning by doing and by using have the highest effect on production capabilities, suggesting that such mechanisms are more effective at improving the ability of firms to exploit labour and capital, rather than to develop new products, identify new technology or change organisational structure. In contrast, learning by searching and by interacting have the strongest effect on product DTC, suggesting that they are most effective at improving the ability of firms to develop new products.

We also find that investment in R&D is strongly correlated to innovative DTC and only moderately to intermediate DTC. We find no statistically significant relationship between investment in R&D and the development of DTC at basic level. In contrast to existing literature which suggests that investing in R&D at the very beginning of firms' technological effort contribute to firms' strong technological performance later (Fan, 2006), our study finds that investment in R&D during the early stages of a firm DTC development does not bring any significant improvements in its DTC at basic level and the positive effect of R&D investment

begins to manifest only moderately at intermediate stage. Thus investing too early in R&D before the firm can exploit this investment might be of limited value.

We find that product and production capabilities respond more intensely to different technology strategies and investments in comparison to investment capability and organizational capability. Further research is required to investigate why these mechanisms are less influential on these two types of DTC. Finally we find that for firms that followed an unbundling strategy or made substantial investment in technology learning and R&D in 2004 achieved strong innovation performance in 2009. Hence over time, all three types of technology mechanisms not only enable firms to achieve higher levels of DTC, but also improve their financial performance.

**Relevance and imitations**

The contribution of this study is twofold. First, to our knowledge this is the first study that examines the impact of technology strategies and investments on firm DTC development from such a subtle standpoint. This level of granularity enables a more in depth understanding of the detailed technological effort through which firms build distinct type or level of DTC through making (or following) particular type of investment or strategy. Second, our quantitative approach allows generalisation beyond the confines of individual case study which has tended to dominate existing research on DC (Wang and Ahmed, 2007).

A major limitation of this research is its samples size. The sizes of two samples which are small if benchmarking against the rule of thumb that a minimum 5:1 ratio of sample size to number of free parameters, however smaller samples are often seen as appropriate if the variables are reliable and the effects are strong (Iacobucci, 2009).

**References**


Aboody, D. and Lev, B. (2001), "R&D productivity in chemical industry", working paper, New York University, New York.

Arrow, K.J. (1962), "The economic implications of learning by doing", Review of Economic Studies, Vol. 29, No. 3, pp. 155-173

Amara, N., Landry, R., Becheikh, N. and Ouimet, M. (2004), "Radical innovations in traditional manufacturing industries", DRUID Summer Conference on Industrial Dynamics, Innovation and Development, Denmark, June 14-1,

Attewell, P. (1992), "Technology diffusion and organizational learning: The case of business computing", Organization Science, Vol. 3, No. 1, pp. 1-19.

Cai, J. (2005), The development of technological capability in the Chinese mobile telecommunication sector, unpublished PhD thesis, University of Sheffield

Cai, J. and Tylecote, A., (2008), "Corporate governance and technological dynamism of Chinese firms in mobile telecommunications: A quantitative study", Research Policy, Vol. 37, No. 10, pp. 1790-1811.

Cetindamar, D., Phaal, R. and Probert, D. (2009a), "Understanding technology management as a dynamic capability: a framework for technology management activities", Technovation, Vol. 29, No. 4, pp. 237-246

Cetindamar, D., Wasti, S.N., Ansal. H. and Beyhan, B. (2009b), "Does technology management research diverge or converge in developing and developed countries?", Technovation, Vol. 29, No. 1, pp. 45-58.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: A new perspective on learning and innovation", Administrative Science Quarterly, Vol. 35, No. 1, pp. 128-152.

Collins, D.J. (1994), "Research note: How valuable are organizational capabilities", Strategic Management Journal, Vol. 15, No. S1, pp. 143-152.
Fan, R. (2006), "Catching up through developing innovation capability: evidence from China's telecom-equipment industry", Technovation, Vol. 26, No. 3, pp. 359-368
Fransman, M. and King, K. (1984), Technological Capability in the Third World, Macmillan Press, London.
Helfat, C. (1997), "Know-how and asset complementarity and dynamic capability accumulation: the case of R&D", Strategic Management Journal, Vol. 18, No. 5, pp. 339–360.
Hill, C.W.L. and Rothaermel, F.T. (2003), "The performance of incumbent firms in the face of radical technological innovation", Academy of Management Review, Vol. 28, No. 2, pp. 257-274.
Iacobucci, D. (2010), "Structural equations modeling: Fit Indices, sample size, and advanced topics", Journal of Consumer Psychology, Vol. 20, No. 1, pp. 90–98.
Jefferson, G.H., Huamano, B., Xiaojing, G. and Xiaoyun, Y. (2006), "R&D performance in Chinese industry", Economics of Innovation and New Technology, Vol. 15, No. 4-5, pp. 345-366.
Jin, J. and von Zedtwitz, M. (2008), "Technological capability development in China's mobile phone industry", Technovation, Vol. 28, No. 6, pp. 327-334.
Kim, L. (1997), Imitation to Innovation: The Dynamics of Korea's Technological Learning, Harvard Business Press, Harvard.
Koberg, C.S., Detienne, D.R. and Heppard, K.A. (2003), "An empirical test of environmental, organizational, and process factors affecting incremental and radical innovation", The Journal of High Technology Management Research, Vol. 14, No. 1, pp. 21-45.
Kusunoki, K., Nonaka, J., and Nagata, A. (1998), "Organizational Capabilities in Product Development of Japanese Firms: A Conceptual Framework and Empirical Findings", Organization Science, Vol. 9, No. 6, pp. 699-718
Marsh, S.J. and Stock, G.N. (2006), "Creating Dynamic Capability: The Role of Intertemporal Integration, Knowledge Retention, and Interpretation", Journal of Product Innovation Management, Vol. 23, No. 5, pp. 422–436.
Rosenberg, N. (1976), Perspectives on Technology, Cambridge University Press, Cambridge.
Schilling, M.A. and Phelps, C.C. (2007), "Interfirm collaboration networks: the impact of large-scale network structure on firm innovation", Management Science, Vol. 53, No. 7, pp. 1113-1126
Schreier, M. and Prugl, R. (2008), "Extending lead-user theory: antecedents and consequences of consumers' lead userness", Journal of Product Innovation Management, Vol. 25, No. 4, pp. 331-346.
Subramaniam, M. and Youndt, M.A. (2005), "The influence of intellectual capital on the types of innovative capabilities", Academy of Management Journal, Vol. 48, No. 3, pp. 450-463.
Wang, C.L. and Ahmed, P.K. (2007), "Dynamic capabilities: A review and research agenda", International Journal of Management Reviews, Vol. 9, No. 1, pp. 31-521.
Wynstra, F., van Weele, A. and Wggemann, M. (2001), "Managing supplier involvement in product development: Three critical issues", European Management Journal, Vol. 19, No. 2, pp. 157-167.