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Technological Innovation vs Technological Backwardness Patterns in Latecomer Firms: An Absorptive Capacity Perspective

Abstract

This study investigates the factors inhibiting latecomer firms' technological innovation and eventually their catch-up process. Accordingly, it relies on resource-based theory to advance an absorptive capacity argument and develop a multiple mediation model. This model is tested using the data collected from 166 Chinese manufacturing firms. Furthermore, this study provides theoretical arguments and empirical evidence about the role of each dimension of absorptive capacity in studying the catch-up process of latecomer firms, with particular reference to knowledge transformation. It also offers insights into the limitations of predominant latecomer firms' innovation strategies and suggests shifts in managerial practice and policymaking.

Keywords

Latecomer Firms, Technological Innovation, Secondary Innovation, Transformation, China

1. Introduction

According to Hobday (1995) and Matthews (2002), latecomer firms are 'forced' late entrants to an industry. These firms suffer the competitive disadvantage of initially lacking technology and market access. According to Amsden (1989), they have to rely on a combination of other initial advantages such as low wages, government support and borrowed technology to generate incremental productivity and quality improvements to existing products and enhance their price and quality competitiveness to eventually catch-up. Furthermore, the catch-up hypothesis implies that latecomer firms, which have lower initial levels of productivity, might be able to increase efficiency at a faster rate (Abramovitz, 1986). Therefore, along with Gershenkron (1962), latecomers' technological backlog and backwardness carries an inherent advantage for technological catch-up.

However, the catch-up process is challenging. First, it is self-limiting. The productivity improvement opportunities acquired from the replacement of obsolete technologies with new ones diminish with an advancement of the catch-up process (Abramovitz, 1986). Second, this replacement process may be quicker than the creation of the technological skills required to fully exploit advanced technologies. Third, with the rapid shift in global technological frontiers, best-practice technologies and capabilities can become outdated quickly (Westphal, 2002).

This study focuses on the factors that hamper or derail a latecomer firm’s catch-up process.

Accordingly, the study considers the concept of secondary innovation. In other words, it stresses on the specific firm-level innovation process that begins with technology acquisition from developed countries and develops further along the acquired technologies’ existing trajectories within the established technological paradigm (Wu et al., 2009). The literature argues this process to be the main means by which latecomer firms address their technology disadvantage. This study contends that secondary innovation also contributes to these firms’ difficulties in catching up.

In fact, although secondary innovation has continued to be a rational strategy for latecomer firms to overcome the initial liabilities incurred, it poses inherent challenges in the catch-up process. Existing studies have recognised the transitory nature of secondary innovation; however, they have failed to consider the unsuccessful achievement of catch-up as another possible outcome. Accordingly, this literature does not focus on the limitations of secondary innovation, namely, the possibility that it may lead to technological backwardness and the factors that may be responsible for it.

To bridge this gap, this study considers the observations of Abramovitz (1986), Amsden (1989), Wade (1990) and Westphal (2002) concerning the relevance of social capabilities, learning and apprenticeship in the catch-up process. This study also relies on the early accounts of the relationships between absorptive capacity (Cohen and Levinthal, 1989, 1990) and the catch-up process on innovation outcomes in studies on latecomer firms (i.e. Guan et al., 2006; Li and Kozhikode, 2008; Wu et al., 2009). Through this, it advances a resource-based argument concerning the determinant role of absorptive capacity. Accordingly, the study adopts a multi-dimensional perspective about the role of each dimension of absorptive capacity as well as theirs functional diversity and relevance. More specifically, we adopt the decomposition in knowledge acquisition, assimilation, transformation and exploitation detailed in the study by Zahra and George (2002). Further, we argue and prove that transformation is the weak link in latecomer firms' absorption and processing of external knowledge with respect to technological innovation.

We investigate our theses using a survey undertaken on a sample of 166 Chinese manufacturing firms in Guangdong Province (China). Chinese studies pioneered the concept of secondary innovation, and the country provided fertile ground to more recent studies on latecomer firms. Guangdong Province plays a crucial role in innovation within China (Di Tommaso et al., 2012). Therefore, although the subject matter of this study may be applicable to other contexts as well, this study focuses on Chinese firms.

2. Theoretical Development and Hypotheses

2.1 Latecomer Firms and Secondary Innovation

From the resource-based perspective, asymmetry in the resources needed to access the target markets lead to the competitive disadvantages faced by latecomer firms in terms of technology and market access (Hobday, 1995; Matthews, 2002). More specifically, latecomer firms cannot deploy the same set of valuable, rare, inimitable and non-substitutable internal resources developed by established competitors (Li and Kozhikode, 2008). Considering this asymmetry, latecomer firms seek to obtain critical resources externally while trying to catch-up with internal development. They rely on a combined set of some initial advantages such as low wages and government support (Amsden, 1989). Moreover, they target under-served market niches overlooked by incumbents (Li and Kozhikode, 2008; Wu et al., 2010). In this regard, buying or emulating technology from abroad tends to be the best option. In addition to allowing latecomer firms to enhance price and quality competitiveness through incremental improvements (Amsden, 1989), secondary innovation allows them to learn how to produce at cutting-edge levels of efficiency. This advances their competitiveness beyond their technological development capabilities (Westphal, 2002).

Secondary innovation starts with technology acquisition and relies on the adaptation and/or localisation of the technologies acquired (Wu et al., 2009). It helps produce products that are 'good enough' and helps develop business models tailored to the characteristics and preferences of the firm's home market (Wu et al., 2010). This study refers to secondary innovation as embracing all those concepts and practices that relate to the limited originality, significance and the new technology content of products (Drucker, 1985; Chen et al., 2011; Guan et al., 2006; Liu, 2008; Maksimov et al., 2014).

The basic tenets of secondary innovation can be traced back to the study by Gershenkron (1962), in the seminal works by Abramovitz (1986) and Amsden (1989) as well as to Drucker's (1985) conceptualisation of creative imitation, at the corporate level. However, the topic has reached more widespread popularity over the past 20 years because of the East Asian context. This includes Kim's works (1997, 1998) on Korea and China, where the term 'secondary innovation' first appeared during the mid-1990s (Wu et al., 2009). These studies have comprehensively focused on why and how firms adopt secondary innovation as well as how this leads to the development of technological capabilities through interaction with mature, emerging or disruptive technologies. Yet, none of these studies have discussed its potential limitations, which arise from decline in productivity and potential shortages of advanced technological skills coupled with the rapid technological obsolescence (Abramovitz, 1986; Westphal, 2002) inherent in the catch-up process. Due to such obstacles, latecomers may fail to compete with incumbents because they cannot generate the technological change required to build on their initial low-cost, localisation and productivity advantages. In fact, at the mature stages of a technology's lifecycle, the pace of technological change will inevitably slowdown due to a reduction in technological opportunities.

Figueiredo (2014) argued that there are other outcomes beyond technological catch-up. Accordingly, technological backwardness is another possible outcome of catch-up, eventually leading a firm to choose the acquisition and adaptation of existing technologies over internal technological development (Guan et al., 2006) or to exit the market (Li and Kozhikode, 2008). In fact, in accordance with the resource-based perspective, the few initial advantages latecomers can deploy or the resources they can acquire initially are not particularly valuable, rare, inimitable or non-substitutable because of the asymmetry in knowledge levels with the providers of these resources. Accordingly, a better strategy for latecomers would be low costs coupled with readily available, less advanced technologies.

Since the study by Gershenkron (1962), researchers have believed that industrialisation happens by imitating pioneering incumbents. The main facets of this process involved the importation of technologies and know-how from abroad in the form of turnkey modern machinery, technical assistance, skilled labour and the use of training facilities in more advanced countries. Nonetheless, this has never been a purely imitative process since it has always occurred in combination with different, indigenously determined elements (Gershenkron, 1962). Abramovitz's (1986) social capability concept, strictly related to years of education (but not only), is one of those key elements that make a country able to absorb and exploit advanced technologies.

In this regard, learning has played a fundamental role, especially in more recent industrialisation. Learning, with particular reference to imitation and apprenticeship using technologies developed elsewhere, was the new and prominent policy adopted by East Asian late-industrialising countries to develop these capabilities; firms were the catalyst in this process (Amsden, 1989) through their specialisation in learning using technologies transferred from abroad (Westphal, 2002). Scientific progress has made operations far easier to transfer and exploit technology to narrow competitive gaps. However, the exhaustion of acquired technological opportunities has also raised the need to harness scientific content to pioneer new technologies through the development of in-house technological capability (Amsden, 1989; Westphal, 2002). Therefore, the adaptive learning focus on mastering the acquired technology and its localisation needs at the imitation and apprenticeship stages needs to evolve into the development of capabilities. This would help transform acquired technologies into new combinations and applications and generate new ones (Wu et al., 2009).

This implies the role of organisational characteristics in the effectiveness of technology transfer. The key role in this regard has been attributed to absorptive capacity. Kedia and Baghat (1988) argued that with absorptive capacity, a firm can make better use of transferred technologies and obtain better technologies to undertake its own technological developments.

2.2 The Role of Absorptive Capacity

Absorptive capacity, defined as receptivity to technological change of a recipient organisation, appeared in the international technology transfer domain for the first time in the study of Kedia and Baghat (1988). According to the authors, the lack of a sophisticated technical core and an appropriate strategic orientation makes it harder for innovation to occur. More recent works (Guan et al., 2006; Li and Kozhikode, 2008) rely on the same argument to sustain the proposition that the weaker the absorptive capacity, the more likely the latecomer firm will adopt imitative forms of learning that generate limited technological innovation. This relation among secondary innovation, weak absorptive capacity, and limited technological innovation mirrors the content in existing studies on latecomer firms. These studies relate secondary innovation to limited originality, significance and new technology content of products (Drucker, 1985; Chen et al., 2011; Maksimov et al., 2014; Liu, 2008; Wu et al., 2009; Wu et al., 2010). However, evidence regarding the role of absorptive capacity in the catch-up process is only anecdotal. In addition, the few works that emphasise the issue of absorptive capacity specifically adopt a quantitative perspective regarding the appraisal of its endowment (Guan et al., 2006; Li and Kozhikode, 2008) or strength (Chen et al., 2006; Wu et al., 2009). This provides neither a new nor a satisfactory theoretical explanation. Rather, the cumulative nature of absorptive capacity, self-reinforcing behaviours (Cohen and Levinthal, 1990) as well as Nelson and Winter's (1982) pattern of inertia may bind firms to a particular technological paradigm, regardless of how high their absorptive capacity is. Thus, it is neither uncommon nor theoretically puzzling to find firms with high levels of absorptive capacity associated with limited technological innovation. Therefore, we believe that this paradox is better solved by opening the black box of absorptive capacity and looking at the functional diversity and relevance of the different absorptive capacity dimensions.

In this study, we depart from this dominant explicit or implicit 'monolithic' view of absorptive capacity. We use extended multi-dimensional conceptualisations that separate absorptive capacity into its different components and dimensions (e.g., Jansen et al., 2005; Un, 2017). We do so by adopting Zahra and George's (2002) decomposition of absorptive capacity in knowledge acquisition, assimilation, transformation and exploitation.

Zahra and George (2002) recognised knowledge transformation and exploitation as essential steps that must occur between the acquisition and assimilation of external knowledge after realising the benefits. Knowledge transformation and exploitation have been recognised as having a more straightforward link to technological innovation in achieving superior performance. We refer to this sequence as Path 1: the conventional path that goes from acquisition to technological innovation through assimilation, transformation and exploitation.

Nemanich (2005) emphasised the relevance of exploitation. While she did not consider the transformation dimension in her model, she suggested the existence of an alternative path, which we refer to as Path 2. This path goes from acquisition to assimilation and then directly to exploitation and technological innovation. However, by adopting a resource-based perspective, transformation is of utmost importance in absorbing and integrating new rare, non-imitable and non-transferable knowledge to generate new competencies and foster radical strategic changes (Zahra and George, 2002). Resource barriers will lead latecomer firms to those technologies that are least rare (e.g. mature technologies), easily imitable (e.g. through reverse engineering), and easily transferrable in the form of explicit knowledge (e.g. through technology consultancy) or readily usable, embodied knowledge embedded in equipment or components (Mathews, 2002). Such technologies need less intensive effort and shorter periods to be assimilated and converted for internal use. Therefore, secondary innovation may not require transformation since the acquired technology is often directly applied for new processes or new products without significant change and conversion (Wu et al., 2010). This is referred to as Path 2.

However, transformation is the key process for creating new knowledge. Consistent with Todorova's and Durisin's (2007) arguments, assimilation and transformation may be conceived as alternative rather than subsequent processes in the knowledge absorption process towards exploitation. In this case, we have another path (Path 3) that goes from acquisition to technological innovation through transformation and exploitation.

Theoretically, other paths can be identified, e.g. a path that goes directly from acquisition to technological innovation through exploitation. However, we consider this option to be purely speculative since even assembling existing chunks of external knowledge requires some level of assimilation and/or transformation; otherwise, it can be considered to be a mere intermediation rather than a production model.

In light of the above discussion, there are multiple internal paths of absorptive capacity, beginning with acquisition via assimilation, transformation, exploitation, leading to technological innovation; however, not all entail transformation. This is because of latecomer firms' inclination towards less rare, more imitable and transferable technologies, which need less reliance on transformation for implementation. This diminishes the relevance of transformation, and the relevant knowledge-absorbing paths may have lower effects on technological innovation. Therefore, the contribution of transformation to latecomer firms' innovation may be relatively small, and the knowledge-absorbing paths passing through it will have weaker effects. This leads to our first hypothesis:

> **Hypothesis 1.** Transformation marginally contributes to latecomer firms' technological innovation compared with the other dimensions of absorptive capacity, i.e. the total effect of the paths passing through transformation is weaker than that of paths bypassing transformation.

Figure 1 below summarises the paths discussed and this research's conceptual framework.

Figure 1. about here

The central premise of our model is that, because of the reasons above, secondary innovation leads to a lesser focus on transformation. In fact, by focusing on easily imitable and transferable technologies, while bypassing transformation and leveraging their limited initial advantages, a latecomer firm can quickly become a follower through secondary innovation (Wu et al., 2010). However, such initial success may encourage the firm to under-invest in transformation and continue or increase its reliance on the direct exploitation of acquired technologies for peripheral modifications without internal conversion, transformation and further development. Guan et al. (2006) referred to this as 'innovation indolence'. Thus, instead of progressively developing its own core technology and competence, the latecomer firm will remain heavily dependent on external technology suppliers to stay abreast of technological trends. This will leave the latecomer firm at a serious disadvantage when competing with the technology leaders. This may be particularly detrimental under frequent technological changes, especially in the case of technological paradigm shifts (Westphal, 2002; Wu et al., 2010). Previous studies have documented failures of latecomer firms due to a reliance on external technology supply and a lack of internal transformative and development capabilities (See for example Lee and Lim, 2001 and Lee et al., 2009). Based on these previous theoretical insights and empirical findings, we argue that latecomer firms must substantially invest in acquisition, assimilation and exploitation of external technology, in addition to a certain level of transformation, to be able to produce technological innovations. This is the case because transformation is central to the creation of new knowledge and fosters further technological innovation in latecomer firms. However, their investment in transformation will be significantly lower compared with that in the other dimensions of absorptive capacity due to their bias towards direct exploitation of acquired and assimilated external technology coupled with little transformation. Thus, we posit the following:

Hypothesis 2. Innovative latecomer firms exhibit higher levels of transformation than non-innovative latecomer firms, but the difference in transformation between the innovative and non-innovative groups is smaller compared with those in acquisition, assimilation and exploitation.

3. Methods

3.1 Data Collection and Sample

We conducted a survey in Guangdong Province, the world's biggest manufacturing hub and leading innovation region in China, from December 2015 to January 2016. We developed the questionnaire in English and translated it into Chinese following Chapman and Carter (1979). Finally, we translated it back into English and cross-checked it with the original version to ensure congruence between the two versions. We used a list of 293 manufacturing firms located in Qingxi Town, a well-known manufacturing centre for photoelectric and communication products in the City of Dongguan, at the heart of the Pearl River Delta. The contemporary presence of high-tech and traditional manufacturing is of particular relevance for this study's objectives.

The local Science, Technology & Innovation Service Centre (STISC) supported data collection. The STISC provided a list of all the manufacturing firms above the designated size (annual sales equal to or greater than RMB 20 million) and helped us submit the questionnaire via e-mail to key personnel (i.e. the general manager or the CEO, or the CTO or director of the R&D department). By the end of January 2016, we received 219 questionnaires. Among these, we excluded 40 questionnaires because of missing data and another 13 because they had been returned from firms established after 2012 and so were likely to have been able to provide only partial information over the three-year reference period. Eventually, the final sample comprised 166 manufacturing companies, as detailed in Table 1.

Table 1 about here

Potential non-response bias was tested using ANOVA and two-way contingency tables analysis, which did not highlight any concerns. To control and alleviate for potential common method bias, we followed Podsakoff et al. (2003) and conducted Harman's one-factor test after data collection (Podsakoff and Organ, 1986). The exploratory factor analysis with an unrotated principle component method on all 15 of the measured items of our main constructs resulted in four factors with eigenvalues greater than 1, constituting 80.4% of the total variance. This indicates that there is neither a single nor general factor that can explain the majority of the covariance among the measures, providing evidence that our analysis is not subject to an inherent common method bias.

3.2 Measures

To maximise reliability and validity, we relied on existing literature to measure most of the constructs. We adapted a measure for technological innovation to reduce potential ambiguities about the meaning of new products inherent in the accepted measures of innovation (see OECD, 2005) and technological innovation (see Hagedoorn and Cloodt, 2003) in the Chinese context (see Xu et al., 2012).

Following Zahra and George's (2002) four-dimensional conceptualisation, we used the 14-item scale developed by Flatten et al. (2011) to measure knowledge acquisition (3 items), knowledge assimilation (4 items), knowledge transformation (4 items) and knowledge exploitation (3 items). All items were measured using a seven-point Likert scale, with 1 indicating 'To no extent' through to 7 indicating 'To a great extent'. After an exploratory factor analysis for each of the four groups of items, we measured each dimension with the average score of the respective items. Examples of the statements included were as follows: 'Our management expects that employees deal with information beyond our industry' and 'Our management emphasises cross-departmental support to solve problems'.

For measuring technological innovation, we referred to the EUROSTAT/OECD (1997, 2005) definition of implemented technological product and process innovation and to product innovation in particular as ‘the introduction of goods or services whose technological characteristics or intended uses differ significantly from those of previously produced products, or whose performance has been significantly enhanced or upgraded’. This definition allowed us to focus on the elements of ‘originality’ and ‘significance’, which are the final aims of the learning process that most latecomer firms undertake to catch-up with secondary innovation. Accordingly, we measured technological innovation as a ratio of two items: (1) the number of radical/truly innovative new or significantly improved products introduced to the market and (2) the entire number of new or significantly improved products introduced.

As research identified significant effects of size and longevity on a firm’s innovation levels (Damanpour, 1992; Hansen, 1992) and because the latter varies across sectors and industries (Malerba, 2002; Pavitt, 1984), we used the firm’s size, age and industry as controls. We measured size as the average number of employees in the period under scrutiny (2012–2014), with age as the time span from establishment to the end of 2014 and a firm’s industry using four-digit sectoral classification code (GB/T 4754-2011) gathered from secondary sources.

4. Results

4.1 Reliability and Validity

To test for reliability and validity, we conducted confirmatory factor analyses and calculated Cronbach’s alpha coefficient, individual item reliability, composite reliability and the average variance extracted (AVE) for all the four absorptive capacity components.

We used structural equation modelling to assess the dimensionality, reliability and validity of the absorptive capacity measures. The overall model fit was $\chi^2 = 463.81$, d.f. = 215, $p < 0.0001$, RMSEA = 0.083, CFI = 0.953, TLI = 0.945 and SRMR = 0.028. Following Hu and Bentler (1999), when the sample size is $N \leq 250$, as in our case, the combinational rules based on RMSEA (or TLI) and SRMR reject simpler and more complex true-population models under the non-robustness condition. Thus, although the model is not perfect, with RMSEA exceeding the cut-off point of 0.06, the other measures could still be considered to support sufficient goodness-of-fit based on the two-index combination rules suggested by the authors.

All Cronbach's alphas were above the 0.7 threshold, indicating high internal consistency. The reliability values of all individual items ranged from 0.74 to 0.94, and the composite reliability values were all above 0.9, exceeding the thresholds of 0.5 for the former and 0.7 for the latter, as suggested by Bagozzi and Yi (2012). The AVE values were all higher than 0.8, above the lower limit of 0.5 (Fornell and Larcker, 1981). Thus, our model achieved satisfactory reliability. In addition, all factor loadings relating items to the hypothesised latent variables ranging from 0.86 to 0.97 were significant at the 0.0001 level, indicating satisfactory convergent validity (Bagozzi et al., 1991).

We further analysed discriminant validity as suggested by Fornell and Larcker (1981). The results (available upon request) indicate that the AVE value of each construct is significantly higher than the shared variance between them, satisfying the criteria for discriminant validity at the construct level. In addition, a test of item-level discriminant validity also generated satisfactory results, as all items shared more variance with their intended constructs than with any other constructs. Further inspection of the absolute standardised correlation between the constructs revealed that the hypothesis of perfectly correlated factors (Bagozzi et al. 1991) could be rejected.

Table 2 provides the descriptive statistics and the correlations among the variables. As seen from the mean, less than one out of five new products introduced represents a truly original and significant technological innovation. Transformation exhibits a lower mean against the other processes, except acquisition, and it has the weakest correlation with technological innovation. In sum, this reflects earlier findings.

4.2. Tests of Hypotheses

To test the hypotheses, we used a mediation modelling framework (Baron and Kenny, 1986). We used Hayes's (2013) multiple mediation analysis techniques, PROCESS tool on SPSS© and conducted a one-way MANOVA test.

In our model, transformation is supposed to provide a marginal contribution in the causal mediation chain from knowledge acquisition to technological innovation since it is considered to be weak. Therefore, before running the tests, we needed to check whether this assumption held true. Descriptive analysis revealed that transformation exhibited a lower mean against the other dimensions, with the exception of acquisition. An explanation for this can be found in the average age of the sample, which suggests that most of the firms may have been engaged in significant prior technological acquisition beforehand. The lower value of this dimension, against assimilation and exploitation, points in this direction. However, in such a case, we should expect the transformation value to be higher than it is, especially when compared with assimilation, which is not the case. This reflects the fact that these firms are less reliant on internal transformation and knowledge creation in their innovation processes—as the correlations with technological innovation suggest—supporting our assumption about a lower focus on transformation in these firms. We can therefore proceed to test our hypotheses.

Table 2 about here

For Hypothesis 1, we developed a serial multiple mediation model and used the bootstrapping procedure to undertake the analysis. Specifically, we postulated multiple mediators (M_1, M_2, M_3) to be causally associated among them such that the independent variable causes the first mediator, which in turn causes the second mediator and so forth, concluding with the independent variable as the final consequent. To appraise the fitness of this model to the hypothesis, we examined the partial correlation of all the mediators after controlling for the independent variable (acquisition). Since they remained significantly correlated, this suggests that they share an additional common cause other than the independent variable, that is, they affect one another. We chose bootstrapping to test the mediation effects, as simulation studies (Fritz and Mackinnon, 2007) have shown it to be more powerful and more flexible than other popular approaches (Hayes, 2009). Besides being useful when the sample size is an issue, the main advantage of this method is that it provides an explicit quantification of the indirect effect itself, which is the difference between the total and the direct effect. Therefore, there is no need to think about the statistical significance of each path in the causal sequence that defines the mediating effect or even about the existence of an association between the independent and dependent variables (Hayes 2009). The only consideration is whether the confidence intervals generated by the bootstrapping procedure would not contain zeros. To do so, we had to examine the significance and the strength of the indirect effects (i.e. paths in Table 3) running from acquisition to technological innovation through assimilation, transformation and exploitation. Here, the strength or effect of a path is measured as the indirect effect of an independent variable (IV) on the dependent variable through multiple mediators. It is calculated as the coefficient product of IV and the mediators. The bigger the size of this product, the stronger the indirect effect will be.

Table 3 illustrates the results of the analysis by reporting the indirect effects of acquisition. The results indicate that multiple paths towards technological innovation, but not all pass through transformation (i.e. paths 2, 4, and 5). In fact, the effects of those passing by transformation are either not significant (i.e. paths 6 and 7) or weak (i.e. paths 1 and 3). The strongest path is Path 2, which does not pass through transformation. With a point estimate of .1160 within a 95% bias corrected confidence interval from .0125 to .2621, the indirect effect of acquisition on technological innovation through assimilation and exploitation is the strongest, i.e. the specific indirect effect that weighs most in the ensemble of the paths that external knowledge may take to technological innovation through absorptive capacity components. This effect is almost three times that of the conventional Path 1, which travels linearly through all the four dimensions of absorptive capacity (point estimate of .0467 within a 95% bias corrected confidence interval from .0037 to .1101). Concerning the non-significant paths 6 and 7, these are in line with the significant role of exploitation attributed in studies related to the innovation outcomes of absorptive capacity.

Table 3 about here

None of the control variables were shown to have significant effects. Therefore, Hypothesis 1 is supported.

For Hypothesis 2, we conducted a one-way MANOVA to test if the four-dimensional mean vectors of absorptive capacity differed between the innovative and non-innovative groups. This multivariate test considered the correlations among acquisition, assimilation, transformation and exploitation. A binary variable was constructed to indicate whether a firm belonged to the innovative or non-innovative group. The variable took a value of 1 if the firm's total number of new product innovations was greater than 0; otherwise, the value was set to 0. The results showed that the F-statistics for all of the four multivariate statistics, including Wilks's lambda, Pillai's trace, Lawley–Hotelling trace and Roy's largest root were all significant at the $p < 0.0001$ level. This indicated significant difference in the four-dimensional mean vectors of absorptive capacity between the innovative and non-innovative groups (see table 4a). A closer look at the underlying MANOVA multivariate regression results reveals that the coefficients of the innovative group for transformation (0.89), acquisition (1.04), assimilation (1.16) and exploitation (1.34) were all positive and highly significant at $p < 0.001$. This demonstrates that the levels of the four absorptive dimensions of the innovative group are all significantly higher than those of the non-innovative group. Moreover, the coefficient of the innovative group for transformation is lower than those for acquisition, assimilation and exploitation. Although further Wald tests indicated that the coefficient difference was only significant between transformation and exploitation ($p < 0.05$), these results still convey that the difference in transformation between the innovative and non-innovative groups is smaller compared to those in acquisition, assimilation and exploitation. To ensure the robustness of our findings, we ran another MANOVA test to determine if the firm had any radical/truly innovative product as the grouping variable to distinguish the radical innovative firms from the non-radical innovative firms (see table 4b). The results were even stronger than those of the previous test. The coefficients of the radical innovative group for transformation (1.22), acquisition (1.37), assimilation (1.62) and exploitation (1.96) were all positive and highly significant at $p < 0.0001$, and the coefficients for assimilation ($p < 0.05$) and exploitation ($p < 0.0001$) were both significantly higher than that for transformation, with the only exception being that the coefficient difference between transformation and acquisition is not significant. In sum, Hypothesis 2 is largely supported by the above tests: radical innovative firms exhibit higher levels of transformation than non-radical innovative firms, but the difference in transformation between radical innovative and non-radical innovative groups is smaller than the differences in acquisition, assimilation and exploitation.

5. Discussion

Our findings demonstrate that latecomer firms rely less on transformation than the other absorptive capacity dimensions in their innovation because they place too much emphasis on exploitation and too little on transformation. Further, given the likely shortages in resources and capabilities among latecomer firms, they focus most of their innovation efforts on exploitation because this is less resource consuming and will produce quicker returns initially compared with transformation. However, because of the relevance of the latter for adapting and integrating more advanced and strategic technologies into the firm's existing technology base to foster bespoke technological development, this may hinder further development and innovation among latecomer firms. MANOVA analysis results support this, providing a coefficient of exploitation that is significantly higher than those of the other dimensions. Accordingly, transformation contributes marginally to latecomer firms' technological innovation and instead becomes a bottleneck within the knowledge absorption process. This is a kind of a 'transformation gap' in the causal chain between the acquisition of external knowledge and technological innovation, which further qualifies and explains 'innovation indolence' in Chinese firms, i.e. their tendency to prioritise the acquisition and adaptation of existing technologies over internal technological development. More specifically, drawing on the resource-based asymmetry argument, this study shows that a latecomer firm's limitations in technological innovation should be examined through the functional diversity of absorptive capacity dimensions. More specifically, it should look at the weak focus and contribution of knowledge transformation compared with other dimensions and the over-reliance on exploitation. We will now discuss the contributions to research and practice, as well as the limitations of the research and future research directions.

5.1. Contribution to research

This paper contributes to existing theories on latecomer firms' innovation and catch-up processes and outcomes by highlighting the hindrances that may incline these firms towards technological backwardness. In this regard, our findings provide evidence that the nature and extent of technology innovation in (Chinese) latecomer firms can be better explained by gaps within the knowledge absorption process, rather than as a mere quantification of the firm's entire absorptive capacity. In particular, we refer to knowledge transformation, which proved weak and insignificant along the path of external knowledge from acquisition to technological innovation (see Table 3). This extends and confirms empirical evidence in previous studies that identified and assumed that absorptive capacity (Li and Kozhikode, 2008) and transformative capacity in particular (Guan et al., 2006; Wu et al., 2009) contribute to limited technological innovation among latecomer firms in China. Data reveal a marked concentration in assimilating and exploiting acquired knowledge rather than in structuring, adapting, combining and modifying that knowledge, which eventually leads to the creation of new knowledge. In fact, less than a fifth of surveyed firms reported technological innovation in the preceding three years. Secondary innovation is a rational choice for latecomer firms' intent on catching-up with established incumbents; however, the methods undertaken to implement it differ and the various approaches have long-term consequences for the evolution (or not) of innovation capabilities. Our findings indicate that the different emphases given to each dimension of absorptive capacity, particularly transformation and exploitation, determine this approach. Therefore, our work extends theories on the role of absorptive capacity in filling the resource's asymmetries and competitive advantages of latecomer firms by adopting a more updated and specific multi-dimensional and qualitative perspective. In doing so, it also contributes by providing arguments to the body of literature that questions the assumption of absorptive capacity as a reflective higher order construct (e.g. Jansen et al., 2005). Moreover, it supports the perspectives of those scholars that argue for a process-based conceptualisation of absorptive capacity (e.g. Volberda et al., 2010). It uses theoretical separation of the different dimensions of absorptive capacity (e.g. Un, 2017) within the Chinese context.

Within this context, it also demonstrates the limitations of secondary innovation practices among Chinese firms. The second contribution of our research warns latecomer firms not to focus solely on secondary innovation as an alternative model for innovation development.

Although this may provide an explanation for the limited technology innovation in latecomer firms and supports the reliance on secondary innovation well beyond a stage in the catch-up process, there are several arguments against it. The most convincing fact is that it is the result of internal and external contingencies. This point to, for example, the nature of the technologies used in the catch-up process and the weak transformation focus illustrated in this paper or, for instance, the dysfunctional nature of financial markets, which may affect the industrial specialisation model in traditional industries (Giunta and Sarno, 2009).

Removing these and other contingencies may eventually bring back 'innovation as usual', which would highlight the anomaly of extensive and prolonged secondary innovation as well as the role of the external environment and other attributes to explain latecomer firms' catch-up process (van der Heiden et al., 2016)

5.2. Contribution to practitioners

This work of research should serve as a warning to practitioners regarding the dangers of indulging in secondary innovation because we classify it only as a phase, although necessary, in the innovation catch-up process. Innovation catch-up cannot be taken for granted and should be nurtured so as to achieve desired outcomes.

We have shown that secondary innovation, with its focus on technology acquisition and exploitation, may lead latecomer firms to underinvest in knowledge transformation. However, we do not contend that this is the mere result of some form of 'managerial myopia' or worse. The kinds of technologies that latecomer firms can afford are limited, but underinvestment in transformation may also be a consequence of the peculiar and hypercompetitive business environment in which the firms we surveyed operate. The short catch-up times of imitators and the short payback times frequently demanded by private investors often lead to innovation 'shortcuts'. Therefore, leveraging 'ready-to-use' acquired knowledge for pursuing 'secondary' innovation advantages rather than investing in more advanced, expensive and long-term knowledge development activities, that is, transformation, is also a conscious decision made by rational actors. We believe that this is a better explanation of the widespread diffusion of market-oriented (Liu, 2008) and business model (Wu et al., 2010) innovations in latecomer firms, particularly within Chinese firms.

Therefore, we contend that dealing with this issue requires concerted and systematic efforts by managers in the firms themselves and by public policymakers. In the case of firms, it puts a threshold on their capacity to serve high-end international markets, both at home and overseas. For policymakers, unless these impediments are addressed, they could threaten the country's ambitions to upscale at an aggregate level. Both parties can and must contribute to steer innovation catch-up towards the desired outcomes. Managers could promote an emphasis on the 'intangible' aspects of technology and start looking outside R&D departments. For example, if the status of human resources function was increased, it could become the main determinant of knowledge transformation by implementing recruitment, training, incentives and compensation policies to ensure that the best and the brightest are attracted, leveraged and retained. In this regard, the role of a conducive organisational culture promoting experimentation and challenge as well as valuing diversity, imagination and out-of-the-box thinking should be considered.

Policymakers may support these efforts by promoting a shift from technological upgrading, which is often interpreted as promoting technology acquisition, to competence upgrading. This would be possible by promoting policies that encourage firms to invest in people rather than in machinery and technologies, changing programmes, projects and related funding schemes and incentives accordingly, all of which are currently still biased towards spending on equipment.

5.3. Limitations and future research

This study has its limitations. First, the scope of our survey was confined to a single respondent in each firm. Although we have attempted to rule out possible biases, future researchers might wish to collect data from multiple sources.

Second, our analysis is cross-sectional. A better understanding of the phenomenon would definitely benefit from carrying out a longitudinal study to further prove the causal linkages detected and investigate the persistence of secondary innovation over time and the mechanisms at work.

Third, the catch-up literature has traditionally emphasised the relevance of foreign technologies. However, recent studies—with particular reference to Chinese firms—have indicated that these firms draw from a wider range of foreign and domestic knowledge external sources than previous latecomer firms in newly industrialised economies (e.g. Chen and Qu, 2003). Our study is focused more on the behaviour of firms related to the acquisition, assimilation, transformation and exploitation of external knowledge rather than on the sources of this knowledge. This pertains not only to foreign technological leaders but also to domestic users, suppliers, competitors, universities and research institutes. Therefore, future studies must consider the role of external knowledge more explicitly.

Finally, in the same vein as our treatment of external knowledge and its sources, we have only mentioned the effects of environmental variables. Further research may introduce these kinds of variables as moderators to test and enrich the arguments illustrated here.

6. Conclusions

This study has advanced a resource-based argument about the discriminant role of absorptive capacity as well as the factors leading to a limited technological innovation and an unsuccessful catch-up. We developed a multiple mediation model that was tested using data collected from 166 Chinese manufacturing firms in Guangdong Province (China). The findings indicate the determinant role of weak knowledge transformation and the relevance of each dimension of absorptive capacity in studying and determining innovation and the catch-up processes of latecomer firms. This study offers practical insights into the limitations of predominant innovation and catch-up strategies of latecomer firms and suggests the necessary shifts in managerial practice and policymaking.

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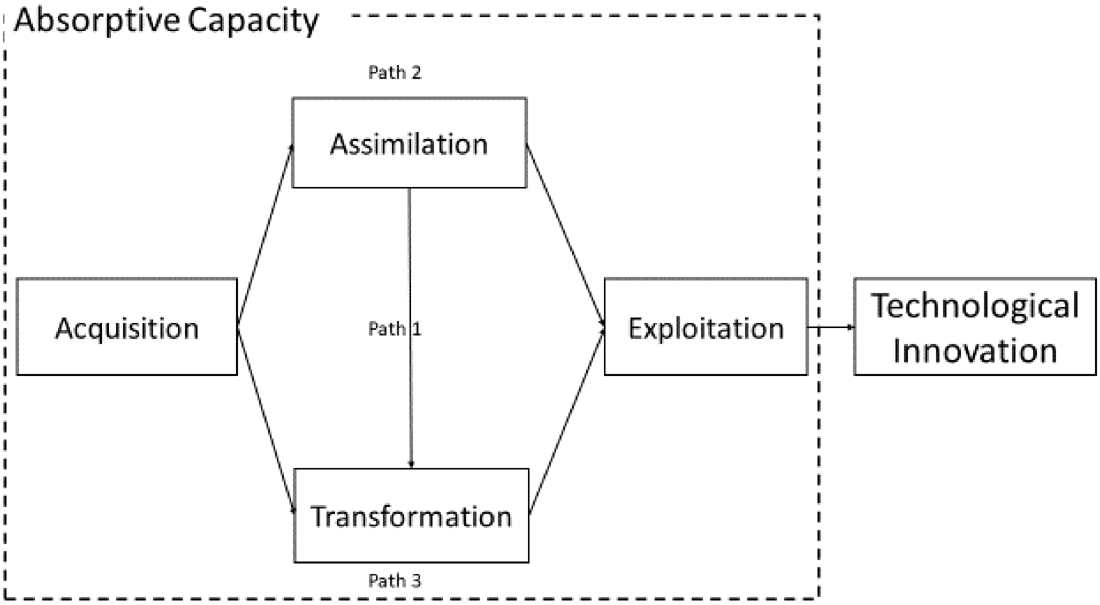

Figure 1. Conceptual framework

Table 1 Study Sample.

1. Number of employees	%
<50	1.2
51-300	51.2
301-500	21.1
501-2000	23.5
2000+	3.0
2. Sales Revenue (in million RMB)	
20-50	30.1
51-200	52.4
201-1000	14.5
1000+	3.0
3. Firm age (years)	
3-5	27.7
6-10	27.1
11-15	25.3
16 +	19.9
4. Industry affiliation	
Computers, communication & other electronics equipment	32.7
Electrical machinery & equipment	13.3
General and special purpose equipment	12.7
Metal products	9.6
Chemical products	9.0
Others Manufacturing	22.7
5. Share of R&D employees	
0	29.5
0-10%	49.4
11-20%	13.9
21-30%	2.4
31%+	4.8

Table 2. Descriptive Statistics and Correlations

Constructs	Mean	Standard Deviation	1	2	3	4	5	6	7
1. Knowledge acquisition	3.61	1.61	1.000						
2. Knowledge assimilation	4.03	1.74	.797**	1.000					
3. Knowledge transformation	3.74	1.63	.771**	.813**	1.000				
4. Knowledge exploitation	4.10	1.93	.673**	.843**	.812**	1.000			
5. Technology innovation	.1757	.2898	.373**	.400**	.362**	.403**	1.000		
6. Firm size	520	791	.134	.166*	.091	.135	.018	1.000	
7. Firm age	11.96	5.54	.066	–.028	.056	–.021	.063	.139	1.000

N = 166. ** Correlation is significant at 0.01 level (2-tailed). * Correlation is significant at 0.05 (2-tailed).

Table 3. Analysis of Results

	Path Coefficients				Indirect Effects			
	to Assimilation (ASS)	to Transformation (TRA)	to Exploitation (EXP)	to Technological Innovation (TI)	Point estimate (effect)	s.e.	Lower 95% C.I.	Upper 95% C.I.
from Acquisition (ACQ)	.7394*** (.0475)	.3240*** (.0715)	–.1374** (.0684)	.1491 (.1272)				
from Assimilation (ASS)		.5641*** (.0718)	.6009*** (.0761)	.1421 (.1649)				
from Transformation (TRA)			.4287*** (.0712)	–.0746 (.1449)				
from Exploitation (EXP)				.2434* (.1456)				
Path 1: ACQ→ASS→TRA→EXP→TI					**.0467**	**.0267**	**.0037**	**.1101**
Path 2: ACQ→ASS→EXP→TI					**.1160**	**.0619**	**.0126**	**.2621**
Path 3: ACQ→TRA→EXP→TI					**.0338**	**.0196**	**.0059**	**.0879**
Path 4: ACQ→EXP→TI					–.0335	.0241	–.1059	–.0014
Path 5: ACQ→ASS→TI					.1128	.1384	–.1530	.3852
Path 6: ACQ→ASS→TRA→TI					–.0334	.0704	–.1745	.1118
Path 7: ACQ→TRA→TI					–.0242	.0531	–.1542	–.0639

Total Effect = .3674**** (.0729), Direct Effect .1491$^{n.s}$ (.1272) $^{n.s.}$ not significant *Sig. p<0.10; **Sig. p<0.05; ***Sig. <0.01

Table 4. One-Way MANOVA Test

Table 4a Test for innovative/non-innovative firms

	(1) Acquisition	(2) Assimilation	(3) Transformation	(4) Exploitation
Innovative firm	1.0403***	1.1558***	0.8857***	1.3406***
	(0.2459)	(0.2647)	(0.2525)	(0.2918)
_cons	2.9630***	3.3175***	3.1944***	3.2646***
	(0.1937)	(0.2085)	(0.1989)	(0.2298)
R^2	0.0984	0.1042	0.0698	0.1141
Wilks' lambda	0.8674***			
Pillai's trace	0.1363***			
Lawley-Hotelling trace	0.1579***			
Roy's largest root	0.1579***			
N	166			

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4b Test for radical-innovative/non-radical-innovative firms

	(1) Acquisition	(2) Assimilation	(3) Transformation	(4) Exploitation
Radical-innovative firm	1.3733***	1.6192***	1.2165***	1.9563***
	(0.2303)	(0.2434)	(0.2385)	(0.2629)
_cons	3.0211***	3.3421***	3.2237***	3.2596***
	(0.1506)	(0.1592)	(0.1560)	(0.1719)
R^2	0.1782	0.2125	0.1369	0.2524
Wilks' lambda	0.7127***			
Pillai's trace	0.2873***			
Lawley-Hotelling trace	0.4030***			
Roy's largest root	0.4030***			
N	166			

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.