

# The Impact of R&D Expenditure upon the Efficiency of M&A Deals with Hi-Tech Companies

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## Abstract

The motives behind merger and acquisitions (M&A) are often linked to the opportunities to obtain knowledge and technologies in order to enhance the competitive advantages of companies. In particular, the acquisition of digital technologies through mergers and acquisitions with ICT companies is especially relevant. However, the efficiency of such deals is often low and calls

into question the implementation of digitalization strategies of companies. In this study we employ an approach for assessing the efficiency of M&A deals with ICT companies by using the DEA method. Applying regression analysis, it was found that the high level of research and development expenses of the acquirers can negatively impact the efficiency of the M&A deals with ICT companies.

**Keywords:** mergers and acquisitions (M&A); ICT sector; research and development (R&D); gross domestic expenditure on R&D; DEA; digital technologies

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Investing in research and development (R&D) can accelerate economic growth and improve business performance [Griliches, 1958, 1979; Mansfield, 1988; Hall, 1996; Koellinger, 2008]. A 10% increase in relevant domestic expenditures on average leads to a 1.6% increase in economic productivity [Bravo-Ortega, Marin, 2011]. One of the ways to accelerate companies' R&D and innovation development is through mergers and acquisitions (M&A) intended to acquire necessary competencies to create and apply technological or other innovations [Hitt et al., 1991]. This strategy is seen as a long-term growth tool. Its choice is determined by the need to strengthen the research base and build up technological potential [Capron, Hulland, 1999; Halebian et al., 2009; Sirmon et al., 2011].

Various aspects of the effect of "technological" mergers and acquisitions became the subject of empirical research. A number of studies (e.g. [Ahuja, Katila, 2001]) assess the impact of such deals upon the innovation or technological performance of buyer companies. Contrary to theoretical assumptions, empirical analysis not infrequently reveals the neutral [Prabhu et al., 2005] or negative [Ravenscraft, Scherer, 1987; Hitt et al., 1991, 1996] effect of M&A deals on companies' innovative development. Possible factors include the following:

- the negative impact of companies' merger on the processes associated with R&D [Jemison, Haspeslagh, 1991; Ranft, Lord, 2002];
- loss of key employees during the transition period [Ernst, Vitt, 2000; Ranft, Lord, 2000];
- organizational imbalances and low technological compatibility between the involved parties [Chakrabarti et al., 1994; Hagedoorn, Duysters, 2002; Cloodt et al., 2006].

Technological consistency between the parties contributes to M&A effectiveness [Cloodt et al., 2006]. The closer the parties' technological arsenals match one other, the easier it is for the buyer company to adapt and use the acquired assets [Cohen, Levinthal, 1990; Lane, Lubatkin, 1998]. In high-tech sectors including information and communication technologies (ICT), the development, creation, and application of new solutions involve a high level of uncertainty [Wagner, 2011]. M&A strategies aimed at leveling the associated risks for the company are typically based on finding necessary technologies and knowledge externally [Desyllas, Hughes, 2008; Ortega-Argilés et al., 2010]. Acquiring a player with unique technological competencies helps to accelerate development by integrating new knowledge [Hitt et al., 1996]. In the age of digitization such strategies may be more effective than buying assets from other sectors of the economy.

The existing empirical studies on the effectiveness of "technological" M&A deals mostly involve applying

regression analysis to assess buyers' financial performance after the transaction has been completed [DeYoung et al., 2009]. Assessing how the company's technological indicators affect M&A results requires eliminating the impact of various specific factors, which, given the limited functionality of regression techniques and a lack of data, is fraught with certain difficulties.

In our study the effects of M&A are measured based on the basis input parameters of such deals with ICT companies using Data Envelopment Analysis (DEA).

The DEA technique, first presented in [Charnes et al., 1978], is widely applied as a way to measure the relative effectiveness of M&A deals [Worthington, 2001; Bogetoft, Wang, 2005; Liu et al., 2007; Lozano, Villa, 2010; Peyrache, 2013; Wanke et al., 2017]. Compared to traditional performance metrics, it can take into account several input and output parameters to analyze non-linear functional dependencies between the data and is suitable for various sectors of the economy [Emrouznejad, Yang, 2018]. DEA allows one to proactively assess the impact of potential acquisition targets' various characteristics upon the buyer's capacities in the event the deal actually going through.

## Methodology of the Study

We define ICT companies in line with the Bloomberg Industry Classification (BICS) which attributes companies to particular sectors on the basis of their main revenue-generating business segments [Phillips, Ormsby, 2016]. Our study covers segments such as semiconductors and semiconductor equipment; software and related services; communication services; and technological equipment. A number of parameters which describe the technological development of ICT companies whose activities depend on intangible assets (enabling them to develop, produce, and apply innovations) were considered. The motivation for M&A is often assessed using models in which one of the objectives of merging businesses is to acquire intangible assets [Cassiman et al., 2005; Phillips, Zhdanov, 2013; Jovanovic, Rousseau, 2008]. Sectoral differences allow one to identify the effect of using such assets [Brown et al., 2009], in particular to measure their role in promoting companies' internal R&D investments [Eisfeldt, Papanikolaou, 2014; Peters, Taylor, 2017].

Risk-avoiding firms in countries with low gross domestic expenditures on R&D (GERD) tend to have a conservative attitude toward investing in R&D, preferring more reliable strategies. In countries with a relatively low level of technological development, companies have to look for competencies they lack abroad [Belderbos et al., 2014]. Jurisdictions with a high level of GERD promote companies' innovation

activities by offering knowledge flows, skilled labor, and opportunities to conduct R&D jointly with other organizations [Iwasa, Odagiri, 2004; Griffith *et al.*, 2006; Audretsch, Belitski, 2020]. At the same time companies in countries with a low level of GERD face information asymmetry combined with limited access to capital markets [Alam *et al.*, 2019]. Thus, the level of GERD in a country becomes a factor determining the effectiveness of M&A deals [Xie *et al.*, 2017]. M&A deals with ICT companies in jurisdictions with a relatively high value for this indicator are more likely to provide access to advanced technological knowledge and have a positive impact upon the buyer company. It should also be borne in mind that, as already noted, the level of technological development and innovation is industry-specific [Hagedoorn, Cloudt, 2003]. In high-tech sectors, R&D expenditures are a key development driver [Duysters, Hagedoorn, 2001], so buyer companies are primarily interested in strengthening their own research potential with the acquired players' R&D results [Benou, Madura, 2005]. The resulting synergy increases the overall cost-effectiveness of R&D and helps the buyer company to grow. However, it is not at all easy to ensure that M&A motivated by target companies' high R&D expenditures are feasible, since such investments are associated with a high degree of uncertainty. Furthermore, empirical research does not confirm that R&D expenditures always positively affect firms' overall performance [Chan *et al.*, 2001; Hung *et al.*, 2006]; sometimes a substitution effect is noted, when the R&D carried out by the acquired company do not bring the expected benefits to the buyer [Hitt *et al.*, 1991; Blonigen, Taylor, 2000; Cassiman *et al.*, 2005].

Capital expenditures (CAPEX) serve as an indirect measure of companies' technological development [Healy *et al.*, 1992], strengthening their performance and competitiveness by upgrading their technological assets [Andrade, Stafford, 2004]. Investment intensity is an indirect indicator of innovation activity [Stoneman, Kwon, 1996].

In our study the effects of “technological” M&A are assessed using the DEA method taking into account input parameters describing the technological activities of target companies. Table 1 presents the variables used in our calculations: technological characteristics of the acquired firms in the year before the transaction, including R&D cost intensity, intangible assets, and capital investments. The ratio of companies' market and book values (which reflects their growth potential and attractiveness to investors) was also considered as an input variable. Two characteristics of buyer companies associated with changes in their value were used as output parameters, namely revenue growth and return on assets a year after the deal was completed [Kohers, Kohers, 2000].

The DEA model solves the maximization problem:

$$Output_i / Input_i \rightarrow \max = DEA_i \quad (1),$$

with

$$Output_i < Input_i \text{ and } Output_n < Input_n \quad (2),$$

where:

$Output_i$  and  $Input_i$  are input and output variables for company  $i$ ;

$n$  is the number of input and output variables.

To assess how the buyer company's R&D and other indicators affect the deal results using the DEA method, a beta regression model was applied [Ferrari, Cribari-Neto, 2010]:

$$g(\mu_i) = \beta_0 + \beta_1 R\&Dint_{i,a} + \beta_2 Ln(Intangibles_{i,a}) + \beta_3 CAPEXint_{i,a} + \beta_4 GERD_{i,a} + \varepsilon_i \quad (3)$$

where:

$R\&Dint_{i,a}$ , is R&D expenditures-to-revenue ratio of the buyer company  $i$  one year after the deal;

$Ln(Intangibles_{i,a})$  is logarithm of intangible assets of the buyer company  $i$  one year after the deal;

$CAPEXint_{i,a}$ , is capital investments-to-revenue ratio of the buyer company  $i$  one year after the deal;

Table 1. Input and Output Parameters

Variable	Variable description
<b>Input parameters (estimated values for target companies a year before the deal)</b>	
$Ln(Intangibles_{i,t})$	Logarithm of the $i$ -th company's intangible assets
$R\&Dint_{i,t}$	R&D costs-to-revenue ratio of the $i$ -th company
$CAPEXint_{i,t}$	Capital expenditures-to-revenue ratio of the $i$ -th company
$MtB_{i,t}$	Market and book value ratio of the $i$ -th company
<b>Output parameters (estimated values for buyer companies a year after the deal)</b>	
$Ln(RevGrowth)_{i,a}$	Logarithm of the $i$ -th company revenue growth
$ROA_{i,a}$	Return on $i$ -th company's assets
Source: composed by the authors.	

Table 2. Examples of M&A Deals in the Technology Sector

Buyer company	Buyer company's home country	Target company	Target company's home country	Deal date
Nokia Oyj	Finland	Alcatel Lucent SAS	France	15.04.2015
Diodes Inc	US	BCD Semiconductor Manufacturing Ltd	China	26.12.2012
Delta Electronics Inc	Taiwan	Eltek AS	Norway	15.12.2014
Informatica LLC	US	Heiler Software GmbH	Germany	01.10.2012
AT&T Inc	US	Superclick Inc	Canada	26.09.2011
Schneider Electric SE	France	Telvent GIT SA	US	01.06.2011
Nuri Telecom Co Ltd	South Korea	Apivio Systems Inc	Canada	17.01.2017
Everbridge Inc	US	Unified Messaging Systems AS	Norway	14.02.2018

Source: composed by the authors.

$GERD_{i,a}$ , is GERD as share of GDP of the home country of the buyer company  $i$  one year after the deal.

### Sample Description

The sample of M&A deals in the technology sector was based on the BICS index, meeting the following criteria:

- Date of the deal announcement: between January 1, 2010 to January 1, 2019.
- Deal status: completed, announced, pending completion.
- Target company belongs to at least one of the BICS technology sectors: Communication Services (10) (except the first-level micro-sector “Media and Entertainment”) or Technology (18).
- Both companies (buyer and target) are public joint stock companies quoted on a stock exchange.

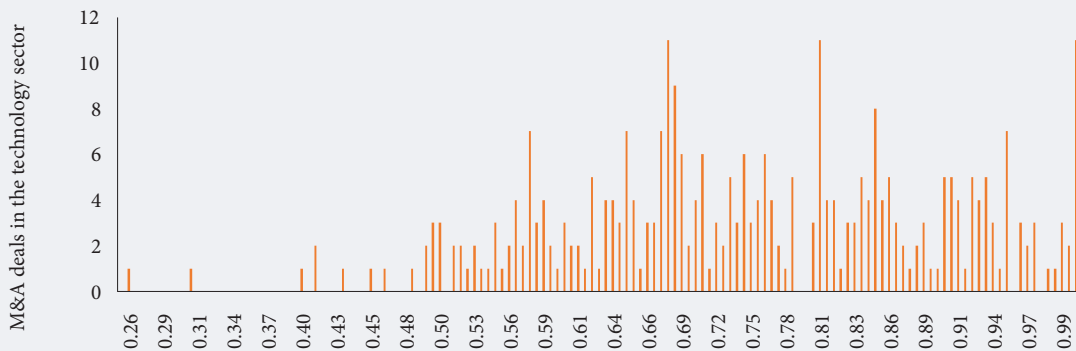
After applying these criteria, 322 deals were included in the sample (examples and descriptions are presented in Table 2).

Table 3. Descriptive Statistics of DEA Parameters and Beta Regression Determinants

Variable	Average	Standard deviation	Median
<b>Input DEA parameters</b>			
$R\&Dint_{i,t}$	0.1026	0.1303	0.0492
$CAPEXint_{i,t}$	0.0547	0.0951	0.0233
$Ln(Intangibles_{i,t})$	0.2284	0.7647	0.0149
$MtB_{i,t}$	3.0072	14.4005	1.9241
<b>Output DEA parameters</b>			
$Ln(RevGrowth)_{i,a}$	0.9573	4.2157	0.6357
$ROA_{i,a}$	2.3858	10.2538	3.8342
<b>Independent beta regression variables</b>			
$R\&Dint_{i,a}$	0.1088	0.2466	0.0339
$GERD_{i,a}$	2.3362	1.0495	2.7136
$CAPEXint_{i,a}$	0.0583	0.0705	0.0312
$Ln(Intangibles_{i,a})$	0.9434	1.8086	0.5011

Source: composed by the authors.

Figure 1. Distribution of DEA Estimates



Source: composed by the authors.



Table 4. Beta Regression Results

Dependent variable	DEA estimates			
	Coefficients	Standard error	t-value	p-value
Intercept	1.6179	0.1851	8.741	0.000***
$R\&Dint_{i,a}$	-0.7445	0.4525	-1.645	0.100*
$GERD_{i,a}$	-0.0942	0.0391	-2.408	0.016**
$CAPEXint_{i,a}$	-3.4135	0.4393	-7.769	0.000***
$Ln(Intangibles_{i,a})$	-0.0111	0.0186	-0.596	0.551
Number of observations: 322				
Note: This table shows the post-M&A beta regression results. *, **, *** denote significance at the 10%, 5% and 1% levels, respectively.				
Source: composed by the authors.				

The sample's descriptive statistics (Table 3) show that the target companies in M&A deals tend to make relatively low investments in intangible assets compared to buyers. The share of intangible assets varies significantly between the deal parties. Their average R&D cost intensity figures are similar, but the standard deviation is higher for buyers. The average GERD-to-GDP ratio in buyer companies' home countries is relatively high, at about 2.3% of GDP.

## Results

The DEA estimate distribution is shown in Figure 1. The values range from 0 to 1, with relatively less effective deals in the sample located closer to 0 and relatively more effective ones closer to 1.

To test R&D expenditures' contribution to the relative effectiveness of M&A, a beta regression analysis of buyer companies' technological characteristics was conducted. The results are presented in Table 4. Their significance is at 10%.

High R&D expenditures of buyer companies negatively affect M&A results. A possible explanation is that firms which actively conduct R&D on their own tend to use technologies obtained through mergers less effectively, while the knowledge acquired as

a result of the deal replaces the existing one. The GERD-to-GDP ratio of the buyer's home country also negatively affects M&A results. Therefore, the less technologically developed a country is, the more sense M&A deals with ICT companies make for firms registered there.

The regression results (Table 4) indicate that target companies' intangible assets do not make a positive impact upon the buyer's relative productivity after the deal is concluded (the coefficient sign is in the negative, low value zone). This suggests that after an M&A deal, buyers who invest a lot in intangible assets find it more difficult to efficiently handle the acquired company's technology. Finally, buyer companies' capital investment intensity is significant and negatively affects their post-M&A performance.

## Conclusion

Data Envelopment Analysis and a beta regression model were applied in this study to assess the effects of M&A deals with ICT companies. The results show that the effectiveness of such transactions is negatively dependent upon the level of R&D expenditures, by the buyer company and in its home country alike. This may be a consequence of the technology substitution effect [King *et al.*, 2008] discovered in a number of studies in relation to ICT sector players. The effectiveness of applying digital technologies obtained from a target company depends upon the buyer's motivation to acquire new knowledge this way. There is a possibility that, if the buyer company actively conducts R&D, the newly acquired technologies will turn out to be incompatible with its own unique developments. Accordingly, companies with a developed R&D base may have problems finding a player on the market acquiring whom would lead to a tangible increase in their competitiveness. The conclusions formulated in this paper can help not only with making investment decisions, but also with developing digitization strategies which involve acquiring technology and knowledge through the M&A mechanism.

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