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Article

The different effects of basic research in enterprises on economic growth: Income-level quantile analysis

Euy-Young Jung[1,2] **and Xielin Liu**[1,*]

[1]School of Economics and Management, University of Chinese Academy of Sciences, Youth Apartment 7-317, Zhongguancun East Road 80, Beijing, 100190, China and [2]Technology Management, Economics and Policy Program · Institute of Engineering Research, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea

*Corresponding author. Email: liuxielin@ucas.ac.cn

Abstract

In the open innovation era, enterprises should conduct more of their own basic research or not rely on contextual factors. We use quantile regression to determine that basic research in the business sector has different effects on economic performance by national income level using thirty-one Organization for Economic Co-operation and Development (OECD) and non-OECD countries including China during 1996–2014. We find that basic research expenditure has a negative relationship with economic growth in low-income countries, whereas in high-income countries, the relationship is positive. Furthermore, the greater the national income, the higher the importance of basic research for economic growth. However, increased absorptive capacity mediates the positive relationship between basic research investment and economic growth in high-income countries, and, in low-income countries, it mediates the negative relationship between the two. In this study, we provide a more detailed understanding of the relationships between basic research investment in the business sector and economic growth.

Key words: basic research, business sector, economic growth, national income level, quantile regression

1. Introduction

Basic research is directly related to country and industrial productivity growth (Mansfield 1980), in that research findings can be sound starting points for remarkable ideas and products (Fabrizio 2009; Gambardella 1992). At the business level, basic research can bring a first-mover advantage (Rosenberg 1990) and increase the firms' absorptive capacity to allow company managers to better screen and absorb external information (Martínez-Senra et al. 2015; Rosenberg 1990). However, despite the importance of basic research in the business sector, entering the open innovation era (Chesbrough 2004), companies in developed countries have cut spending on basic research and outsourced it to universities to increase efficiency and the speed of development (Bahemia et al. 2017; Hodson 2016). In addition, in the United States, government funding for basic research (as a percentage of GDP) is at a lower level than half a century ago, and some scholars consider this as an obstacle to sustainable economic growth (Stiglitz 2016). At the same time, business leaders in the emerging countries such as China are beginning to spend more money on basic research, following the model of Korea and Japan (Kobayashi and Okubo 2004; Ministry of Science and ICT 2017).

Against this background, it is interesting to study the relationship between basic research and economic growth in different country contexts, especially by income levels, but until now, there have been few basic research studies with comparisons by national income level were extremely limited although they are meaningful because different situations can lead to different outcomes. We hypothesized that return on investment in basic research on economic growth in low-income countries is limited by these countries' low absorptive capacity, environments in which is it difficult to create innovative breakthroughs, and less development-oriented innovation activity than that in high-income countries.

Therefore, for this paper, we used quantile regression to analyze the heterogeneous effect of basic research in the business sector on economic growth according to national income levels. The remainder of this paper is organized as follows. The next chapter is a review of the literature related to the subject, and in Chapter 3 we describe the data and methodology. Chapter 4 presents empirical results and in Chapter 5 we discuss the results and draw conclusions and policy implications.

2. Literature review and hypothesis

According to the OECD *Frascati Manual* (OECD 2015), “basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view”, “applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective”, and “experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products or devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.” Basic research can be divided into pure basic research and oriented basic research[1] which is generally carried out in enterprises.

In the 1940s, many scholars realized that science is a source of economic growth (Bush 1945), and this argument helped the United States to set up institutions for supporting R&D at the national level. This entailed what was called the linear model, which consists of basic, applied, and experimental development that are directly related to productivity growth (Mansfield 1980). Griliches (1986) argued that basic research has a more significant impact on productivity than any other type of R&D.

At the business level, many studies also showed that basic research can bring a first-mover advantage for enterprises (Rosenberg 1990); this research has served as starting points for industrial breakthrough since the 1970s. That was a golden era of R&D for large US enterprises, and there were many world-class R&D institutions with well-known scientists who won Nobel prizes. Internal R&D was regarded as a strategic asset and viewed as a competitive entry barrier in many industries (Chesbrough 2004). In particular, large research-based companies such as DuPont, Merck, IBM, GE, and AT&T with long-term research programs and resources gained most of their profits in this way; competitors had to raise their own resources and build their own labs.

However, by the end of the 1970s, US industry had lost international competitiveness to Europe and Asia, especially Japan. American industries lost competitiveness in mature industries such as automobiles and television and in emerging industries such as manufacturing computer memory chips. Japanese companies used basic US and European technologies to dominate in new industries such as making VCRs and compact discs (Stevens 2004). Small north-west European countries were able to easily access and benefit from the world’s knowledge pool without major investments in basic research (Pavitt 2001). In addition, it was discovered that there was a death of valley between science and final innovations caused by technical and market uncertainty. Therefore, the United States enacted the Bayh-Dole Act in 1980 and set up the SME innovation fund to help the technology transfer from science to innovation.

In the 1990s, many US firms were failing to obtain adequate returns from their R&D investments (Jensen 1993) and therefore used acquisitions as a substitute for innovation (Hitt et al. 1990). Large US companies also reduced their R&D investments and moved from basic research to research that could quickly achieve results (Mowery and Rosenberg 1993). In addition, there were movements toward open innovation to commercialize new ideas through cooperation. New companies with little or no basic research, such as Intel, Microsoft, Sun, Oracle, Amgen, and Genzyme, caught up with existing companies to achieved innovative success with other’s research discoveries (Chesbrough 2004). In the era of open innovation, companies can use internal as well as external ideas to advance the technology, and companies in developed countries are collaborating with universities and research institutes rather than conducting basic research internally.

Now, companies in developing countries such as China are starting to spend more money on basic research. Most of the time, latecomer countries depend more on foreign direct investment, technology transfer, and even imitation for catch-up. However, when companies in developing countries are emerging as developed countries, they have strengthened investment in basic research as an important strategic tool. For example, in Japan, the importance of basic research emerged as a response to trade friction in the 1970s, when Japan was criticized as being "the free rider of basic science". Japanese business leaders strengthened basic research to alleviate trade disputes and maintain competitiveness and independence in global technology competition. They also perceived the importance of basic research because they thought that universities and public research institutes could not produce enough knowledge to maintain national economic competitiveness. Therefore, private companies accelerated internationalization by establishing R&D laboratories abroad and employing foreign researchers from companies, universities and national institutions (Kobayashi and Okubo 2004). In Korea in the 1990s, there were few models to follow, risks and uncertainties increased, and the technology needed is more complex and sophisticated than what business leaders and policymakers expected. Therefore, basic research begun to be emphasized in order to break the pattern of imitation and develop leading technology. In particular, as Korean companies have faced intense competition from both developing and technology-leading countries since the 2000s, business leaders and policymakers have grown are more committed to basic research (Ministry of Science and ICT 2017).

This pattern is reflected in the basic research activities of companies worldwide, but it is still unclear how these various activities relate to national economic growth. In particular, for companies in developing countries whose leaders consider strengthening basic research investment a key strategy for catch-up and the windows of opportunity. Specifically, business and government leaders in developing countries need to understand whether and how investment in basic research will contribute to their countries’ national economic development. However, despite the importance of this topic, there has been unfortunately little research on the subject.

Authors of more recent studies still confirm that enterprises’ basic research is effective for developing leading ideas and products (Fabrizio 2009; Gambardella 1992), and it can increase firms’ absorptive capacity, which allows managers to better screen and absorb external information (Martínez-Senra et al. 2015; Rosenberg 1990). Basic research can enhance firms’ innovation performance (Fabrizio 2009; Gambardella 1992), lead to pioneering and revolutionary ideas (Pavitt 1991), and wide ranges products and opportunities for commercialization, and it can increase productivity (Cassiman et al. 2002; Griliches 1986; Mansfield 1980) and corporate profits (Bean 1995). In short, basic research has an important influence on business development, which becomes the cornerstone of the national economic growth.

However, these results may vary depending on individual countries’ economic development; researchers have confirmed that at the national level, R&D investment is crucial to economic growth (Aghion and Howitt 1998; Galindo and Méndez 2014; Grossman and Helpman 1991; Romer 1990). More specifically, much research has been done on the relationship between R&D and economic development in high-tech industries; and researchers have found that the higher the R&D expenditure in high-tech industries, the greater the economic growth (Falk 2007; Ortega-Argilés et al. 2010). In addition, Prettner and Werner (2016) elucidated the positive association between the level of GDP per capita and expenditures for basic research.

In contrast, Wang et al. (2013) found that it was not necessarily the case that the impact of R&D spending on high-tech industries on economic growth depends on the national income level. Only in countries with the highest income levels does high-tech R&D have a positive impact on economic growth.

As were the cases in Korea and Japan in the past, companies' investment intensity in basic research is changing with the times, and can differ according to countries' stages of growth or income levels. In Germany, developments for the Second World War stimulated science and basic research, which then preceded technology growth. Rapid economic development in developing countries is based on excellence in applied science and technology capabilities, including emphasis on incremental improvement at the manufacturing stage and market-driven new product development, rather than scientific leadership (Kiba and Collinson 1998). In other words, the rate and direction of a country's scientific development are strongly influenced by the level of economic development (Pavitt 1998). Therefore, we determine the following specific factors need to be considered in low-income countries.

First, countries need sophisticated infrastructures, with trained labor forces, institutions, and networks, to assimilate the results of other countries or companies' basic research activities (Pavitt 2001), which Cohen and Levinthal (1989)

Second, because of poor overall infrastructure, it can be difficult for business leaders in low-income countries to achieve anything meaningful from their basic research activities even when they are able to disseminate their basic research findings. In addition, company leaders whose firms see results from basic research may not enjoy the first-mover advantage. Because of poor systems of intellectual property protection, companies may not obtain monopolistic market positions. In short, the basic research investments of companies in developing countries may not lead to concrete performance gains.

Third, business leaders in low-income countries who pursue rapid growth through imitation prioritize technology development rather than basic research, unlike company leaders in developed or high-income countries. The CEOs and other managers are likely to sell improved products to existing markets rather than selling new products in new markets. These business leaders imitate or introduce proven technologies and products from global companies in developed or high-income countries, and because imitation and incremental improvement are routine for them, it is neither familiar nor easy for them to increase their competitiveness through basic research.

Therefore, we can derive the following hypothesis:

> *H1: In high-income countries, there is a positive relationship between basic research investment in the business sector and economic growth.*
> *H2: In low-income countries, there is a negative relationship or no relationship between basic research investment in the business sector and economic growth.*

However, although absorptive capacity in low-income countries can be lower than that in high-income countries, the greater the absorptive capacity, the more results can be obtained from basic research. As low-income countries' absorptive capacity increases, business leaders and policymakers can more easily apply and rapidly commercialize the results of basic research from high-income and advanced countries. In addition, although high-income countries have greater absorptive capacity, it is more difficult to obtain unlimited results from basic research. It takes time for the results of basic research to be linked to commercialization. In addition, high absorptive capacity can include more highly talented labor, and the higher cost of these skilled workers can have a negative impact on performance.

> *H3: In high-income countries, increased absorptive capacity will mediate the positive relationship between basic research investment and economic growth.*
> *H4: In low-income countries,* increased *absorptive capacity will mediate the negative relationship between basic research investment and economic growth.*

3. Methodology

We used data from thirty-one countries[2] provided by the OECD from 1996 to 2014 and data from the World Bank in addition to the OECD data. Although there are only a few low-income countries that are not OECD members, these countries have a high share in the global economy and are actively engaged in R&D activities.

The independent variable in this study is the ratio of basic research expenditure in the business sector to gross domestic expenditure on R&D (GERD), similar to the calculations of Czarnitzki and Thorwarth (2012), who used basic research share as an independent variable and applied a panel regression model to analyze the effect of basic research on performance. The dependent variable is GDP per capita, which reflects the level of economic growth (Wang et al. 2013). The basic research ratio is defined as the ratio of the business sector's basic research expenditure[3] to GDP. We computed absorptive capacity by taking the natural logarithm of the ratio of researchers per million population as the proportion of researchers who could increase the absorptive capacity of companies and countries as a whole. In addition, we used fixed capital investment ratio (Czarnitzki and Thorwarth 2012), GERD ratio (Czarnitzki and Thorwarth 2012), and year dummy as control variables. We present descriptive statistics and the definition of each variable are shown in Table 1.

The basic research ratio of the lower 10 per cent of countries was 0.9 per cent, which is more than six times that of the top 10 per cent of countries. The GDP per capita was about 42,000 USD for the top 10 per cent of countries, four times greater thatn the GDP per capita for the bottom 10 per cent, about 13,000 USD.

We used quantile regression to elucidate that the basic research expenditure ratio has different effects on performance depending on the national income level. Quantile regression entails inferring the results of the conditional functions for different quantiles, and it is very useful when we want to analyze something happening at the bottom or top of a distribution that will not be captured by modeling the conditional mean. Therefore, we can analyze the relationship between variables for which effects may vary with outcome levels. Wang et al. (2013) used quantile regression to show that R&D spending in the high-tech industries has different effects depending on the national income level. They used GDP per capita as a dependent variable and the share of business enterprise R&D expenditures in the high-tech sector as an independent variable.

Koenker and Bassett (1978) introduced the quantile regression model, which can be written as:

$$y_{i=}\beta_\theta x_i + \varepsilon_{\theta i} \text{ with median } (\varepsilon_{\theta i}|x_i) = 0,$$

where y_i is the dependent variable, x_i is vector of regressors, and β_θ is the vector of parameters to be estimated. The θth regression

Table 1. Descriptive statistics

Variables	Definition	Mean	SD	Q10	Q25	Q50	Q75	Q90
Basic research ratio	Basic research expenditure ratio in the business sector / GERD*100	3.12	2.01	0.90	1.73	2.78	4.05	5.80
GDP per capita	Real GDP per capita (thousand 2010 USD)	27.56	10.85	13.42	19.35	27.56	35.96	42.23
Fixed capital investment ratio	Gross fixed capital formation/GDP*100	23.79	5.38	18.33	20.44	22.49	26.29	30.59
GERD ratio	GERD/GDP*100	1.51	0.87	0.53	0.86	1.23	2.13	2.80
Absorptive capacity	Log (number of researchers per million population)	4.11	1.64	2.03	2.86	3.93	5.50	6.49

quantile ($0 < \theta < 1$) is defined as any solution to the minimization problem:

$$\min_{\beta} \left\{ \sum_{i:\ y_i \geq x_i\beta} \theta|y_i - x_i\beta| + \sum_{i:\ y_i < x_i\beta} (1-\theta)|y_i - x_i\beta| \right.$$

When $\theta = 0.5$, the quantile regression is the median regression because the above equation changes to $\sum_{y_i} |y_i - x_i\beta|$, indicating that the observed values above and below the median values are given the same weights.

Linear regression model is as follows:

GDP per capita$_i$ = α + β_1Basic research ratio$_i$ + β_2Fixed capital investment ratio$_i$ + β_3GERD ratio$_i$ + β_4Absorptive capacity$_i$ + year dummy + ε_i

According to Mansfield (1998), the time it takes for academic research to materialize into industrial innovation varies widely, ranging from 2 to 10 years. In addition, researchers such as Czarnitzki and Thorwarth (2012) considered various time differences from one year. We considered the time lags in basic research ratio and absorptive capacity from one to nine years based on data availability. Furthermore, considering the time difference also helps in solving endogeneity problem[4] because of simultaneity between basic research and economic growth (Czarnitzki and Thorwarth 2012). We also control for common macroeconomic shocks by including year dummies.

Figure 1A shows the quantile distribution of GDP per capita for thirty-one countries from 1996 to 2014. Figure 1B shows the basic research rate and GDP per capita by country in 2011. Korean companies had the highest ratio, followed by the Netherlands, Slovenia and Japan, whereas the ratio in China was the lowest at 0.08, followed by Estonia and Portugal. The United States had the highest GDP per capita, followed by the Netherlands and Ireland, while China had the lowest, followed by South Africa and Mexico.

The changes in the basic research ratio and GDP per capita for each year for relatively low-income (China, Hungary, and Poland) and high-income (Japan, Korea, and the USA)[5] countries are shown in Fig. 2. China's basic research ratio was the lowest among the six countries and did not exceeded 1 per cent of GERD from 1996 to 2013. Hungary had large fluctuations by year, exceeding 5 per cent in 2004, showing higher than Japan and the United States. Poland also had large changes in basic research ratio by year, similar to Hungary. Japan's ratio was second only to Korea's and increased gradually increasing beginning in 1997. Korea's ratio was the highest among the six countries. In particular, the basic research ratio in Korea increased sharply from 2000 to 2004, decreased in 2007, but rose again and was more than 10 per cent since 2009. The ratio for the United States was lower than that of Korea and Japan, and it varied from year to year. After reaching 4.6 per cent in 1997, it remained in the middle at 2 per cent level from 1998 to 2006. Since 2008, the US basic research ratio in the business sector rose and fell.

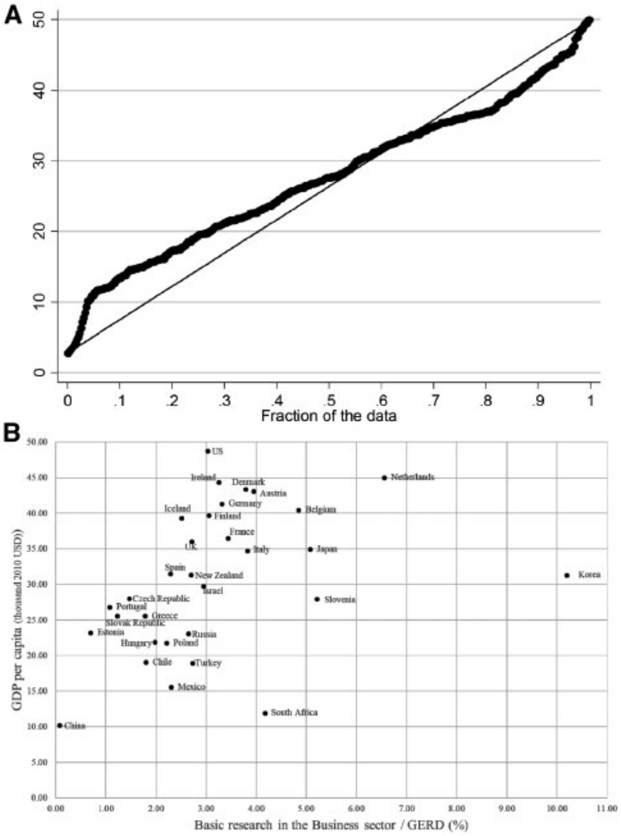


Figure 1. (A) Quantile distribution of GDP per capita and (B) basic research ratio and GDP per capita in 2011.

GDP per capita also increased in all six countries. Among the high-income countries, GDP per capita was highest in the United States, but Korea's growth rate was the largest. Hungary and Poland had similar values in 2013, and China's increased the fastest among the low-income countries.

When we look at the relationship between basic research ratio and GDP per capita, the yearly volatility in the basic research ratio as an independent variable was significantly larger than the volatility in dependent variable.

4. Results

We analyze the relationship between basic research ratio in the corporate sector and GDP per capita using quantile regression to examine the effects of the income level more specifically. Table 2 reports results from ordinary least squares (OLS) and quantile regression estimation. Looking at the OLS results, the coefficients of

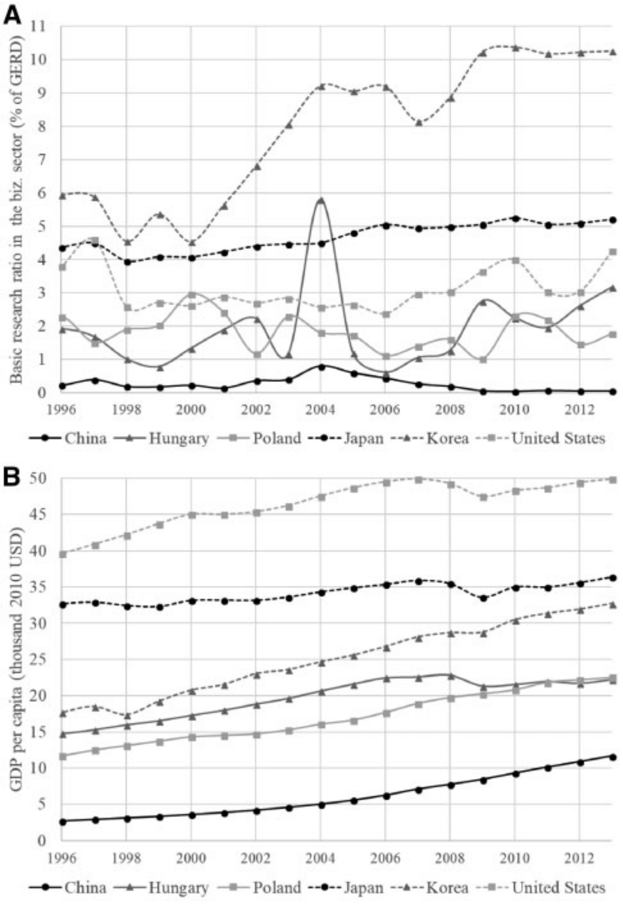


Figure 2. Changes in (A) basic research ratio and (B) GDP per capita by year (1996–2013).

the basic research ratio from time lag 2 (L2.BR) to 9 years (L9.BR) are not statistically significant. At time lag 1 (L1.BR), the basic research ratio shows a significant positive coefficient. The reason for this statistical insignificance or low significance is that the basic research ratio has different effects on national income levels.

When the time lag is 1 (L1.BR), the coefficients of the basic research ratio are significantly positive in the lower 50 per cent (Q50), 75 per cent (Q75), and 90 per cent (Q90). In addition, the higher the national income, the greater the magnitude of the significant positive coefficient. With L2.BR, the basic research ratio in the lower 10 per cent countries (Q10) has a significant negative coefficient, which is larger than that of the lower 25 per cent countries (Q25, insignificant). Similar to L1.BR, a significant positive coefficient increases from 50 per cent (Q50, insignificant) to the top 25 per cent (Q75) and 10 per cent (Q90), which means that the higher the national income level, the more the basic research contributes to economic development. We obtain similar results for L3.BR, L4.BR, and L5.BR, and all the coefficients are statistically significant. In the case of L6.BR, there are significantly positive coefficients for more than 50 per cent of the countries and significantly negative coefficient for fewer less than 10 per cent. In L7.BR and L8.BR, the coefficients of the lower 10 per cent have a significant negative value. In L8.BR and L9.BR, the coefficients of the top 10 per cent aresignificantly positive. Based on these results, two of our hypotheses are verified. In high-income countries, there is a positive relationship between basic research investment in the business sector and economic growth, whereas there is a negative relationship or no such relationship in low-income countries.

In sum, there is a strong link between basic research investment and economic growth in the top 25 per cent and 10 per cent of countries. And the higher the national income level, the greater the effect of basic research on economic development, which strongly supports Hypothesis 1. Even in the middle-level countries (Q50), basic research has a positive effect on economic development, but its intensity and statistical significance are lower than those of the top countries. This might have been because these countries are in a transition period from imitation to innovation. In the lower 25 per cent and 10 per cent, firm's basic research shows no or negative impact on national economic development, which strongly supports Hypothesis 2. Some might consider basic research burdensome because of the required development-oriented innovation activities, low absorptive capacity, and systems and environments in which it is difficult to create innovative breakthroughs. Meanwhile, even though we consider multiple time lags, the significant consistency in the results indicates that our results are robust.

In particular, our finding that there is a positive relationship between basic research and economic growth in high-income countries, is consistent with the results of Wang et al. (2013), who showed that high-tech industrial R&D spending has a strong positive effect on GDP per capita at the highest quantile of the distribution. As in the case of basic research, high-tech is more likely to succeed in countries with innovative R&D rather than imitation, high absorptive capacity, and good institutional environment for innovation. In addition, basic research plays an important role in most high-tech industries such as pharmaceuticals, computers, aerospace, chemicals, and telecommunications and electronics (Czarnitzki and Thorwarth 2012; Salter and Martin 2001).

Table 3 shows results from OLS and quantile regression estimation, including interaction term between basic research ratio and absorptive capacity. Looking at the OLS results, the coefficients of interaction term from time lag 1 year (L1.BR*L1.AC) to 9 years (L9.BR*L9.AC) are significantly negative. However, these results seem to have been influenced by the results of high-income countries.

In countries with relatively high-income levels (Q50, Q75, and Q90), the coefficients of absorptive capacity are significant positive, indicating a positive relationship between absorptive capacity and economic growth. In contrast, the coefficient of the interaction term between basic research ratio and absorptive capacity is significantly negative, which demonstrates that the positive impact of basic research investments on economic growth decreases as absorptive capacity increases. In other words, increasedabsorptive capacity mediates the positive relationship between basic research investment and performance, which supports Hypothesis.

At the lower 10 per cent (Q10), the coefficients of absorptive capacity are significantly negative, indicating a negative relationship between absorptive capacity and economic growth. However, increased absorptive capacity mediates the negative relationship between basic research investment and performance. All coefficients of the interaction term are significantly negative, which indicates that increased absorptive capacity mediates the negative relationship between basic research investment and economic growth, which supports Hypothesis 4.

Figure 3 confirms that the quantile regressiondelivers considerably richer information than does OLS regression. From L1 to L7, the sign of the basic research ratio changes from negative to positive in the lower 40 per cent to the 50 per cent range. In L8 and L9, a positive value appears at more than 70 per cent (top 30 per

Table 2. Results of quantile regression

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L1.BR	0.523**	–0.600	–0.223	0.787**	1.707***	2.581***
($N = 365$)	–2.172	(–1.542)	(–0.869)	–2.143	–4.45	–7.581
L1.AC	–0.737***	–1.226***	–0.860***	–0.861**	–0.991**	0.468
	(–2.675)	(–2.752)	(–2.929)	(–2.049)	(–2.257)	–1.2
(Pseudo-) R^2	0.511	0.341	0.354	0.342	0.301	0.301
L2.BR	0.311	–1.099***	–0.367	0.447	1.364****	2.354***
($N = 346$)	–1.297	(–2.754)	(–1.205)	–1.388	–3.518	–7.118
L2.AC	–0.870***	–1.222***	–1.184***	–0.996***	–0.967**	0.243
	(–3.107)	(–2.627)	(–3.334)	(–2.656)	(–2.139)	–0.631
(Pseudo-) R^2	0.513	0.356	0.36	0.342	0.3	0.3
L3.BR	0.217	–1.028***	0.591**	0.698**	1.414***	1.896***
($N = 316$)	–0.862	(–3.510)	(–2.058)	–2.022	–3.174	–5.005
L3.AC	–1.082***	–1.504***	–1.335***	–1.147***	–1.024**	0.033
	(–3.719)	(–4.451)	(–4.029)	(–2.881)	(–1.993)	–0.075
(Pseudo-) R^2	0.533	0.397	0.382	0.359	0.309	0.3
L4.BR	0.132	–1.081***	–0.581**	0.671**	1.169**	1.437***
($N = 296$)	–0.523	(–3.395)	(–2.108)	–2.165	–2.484	–3.166
L4.AC	–1.344***	–1.700***	–1.607***	–1.262***	–1.345**	–0.377
	(–4.502)	(–4.519)	(–4.932)	(–3.441)	(–2.416)	(–0.703)
(Pseudo-) R^2	0.552	0.432	0.398	0.374	0.315	0.296
L5.BR	0.052	–0.961***	–0.723***	0.664*	0.933*	1.257**
($N = 268$)	–0.195	(–2.876)	(–2.762)	–1.914	–1.859	–2.507
L5.AC	–1.484***	–1.462***	–1.546***	–1.383***	–1.578***	–0.532
	(–4.758)	(–3.752)	(–5.066)	(–3.417)	(–2.697)	(–0.910)
(Pseudo-) R^2	0.559	0.456	0.407	0.374	0.317	0.291
L6.BR	0.069	–0.910***	–0.467	0.562*	0.947*	1.733****
($N = 248$)	–0.262	(–3.551)	(–1.500)	–1.905	–1.749	–3.354
L6.AC	–1.569***	–1.634***	–1.720***	–1.220***	–1.590**	–0.266
	(–4.960)	(–5.312)	(–4.602)	(–3.447)	(–2.448)	(–0.429)
(Pseudo-) R^2	0.569	0.471	0.42	0.387	0.321	0.295
L7.BR	0.038	–0.739***	–0.382	–0.140	0.559	1.091
($N = 221$)	–0.138	(–2.614)	(–1.070)	(–0.405)	–1	–1.631
L7.AC	–1.551***	–1.355***	–1.606***	–1.341***	–1.812***	–1.725**
	(–4.703)	(–4.005)	(–3.757)	(–3.250)	(–2.706)	(–2.154)
(Pseudo-) R^2	0.582	0.489	0.427	0.393	0.334	0.299
L8.BR	0.049	–0.753***	–0.024	0.034	0.248	2.023***
($N = 200$)	–0.181	(–2.727)	(–0.072)	–0.111	–0.477	–2.891
L8.AC	–1.467***	–1.126***	–1.283***	–1.394***	–1.598**	–0.851
	(–4.377)	(–3.294)	(–3.069)	(–3.641)	(–2.486)	(–0.983)
(Pseudo-) R^2	0.597	0.5	0.429	0.407	0.341	0.312
L9.BR	0.076	–0.418	0.007	0.089	0.041	1.248*
($N = 176$)	–0.262	(–1.523)	–0.019	–0.262	–0.082	–1.856
L9.AC	–1.389***	–1.031	–0.890*	–1.399***	–1.477**	–2.064**
	(–4.020)	(–3.167)	(–1.940)	(–3.494)	(–2.503)	(–2.587)
(Pseudo-) R^2	0.621	0.521	0.442	0.422	0.371	0.347

BR, AC, and N indicate basic research ratio, absorptive capacity, and the number of observations, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed t tests at the 99% (***), 95% (**), and 90% (*) significance. The remaining coefficients (see Appndix) are omitted from the table. All models were tested for VIF (variance inflation factor) and showed no multicollinearity.

cent or more), which is consistent with the quantile regression results(see Appendix for more detail).

5. Summary and discussion

We determined that basic research investment in the business sector has different effects on economic growth depending on the national income level. Unlike OLS estimates, quantile regression showed that basic research investment is not always positive for economic development. In lower-income countries, the proportion of basic research has a negative relationship with economic growth, while in higher-income countries it is positive. Furthermore, the lower a country's income level (bottom 25 per cent of countries), the larger the negative effect between economic growth and basic research, while the higher the national income level (top 25 per cent or more countries), the greater the economic growth and the positive effect. In the middle-level countries, although they were positive, the strength and statistical significance were smaller than they were in the countries with higher incomes. This seems to be related to the firm's routine that pursuits short-term performance with imitation and

Table 3. Results of quantile regression including interaction term

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L1.BR	1.757***	–2.484***	–1.111	3.287***	5.989***	6.41***
($N = 365$)	(2.938)	(–2.746)	(–1.502)	(3.840)	(6.271)	(10.273)
L1.AC	–0.033	–2.007***	–1.24**	0.541	3.089***	4.615***
	(–0.080)	(–3.189)	(–2.409)	(0.908)	(4.651)	(10.635)
L1.BR*L1.AC	–0.3**	0.39*	0.178	–0.644	–1.275***	–1.416***
	(–2.252)	(1.933)	(1.076)	(–3.373)	(–5.985)	(–10.175)
(Pseudo-) R^2	0.518	0.367	0.356	0.356	0.326	0.368
L2.BR	1.352**	–2.635***	–1.959**	3.716***	5.266***	6.51***
($N = 346$)	(2.302)	(–3.527)	(–2.252)	(5.081)	(5.307)	(10.855)
L2.AC	–0.265	–2.025***	–1.861***	0.373	2.329***	4.718***
	(–0.635)	(–3.809)	(–3.007)	(0.717)	(3.298)	(11.057)
L2.BR*L2.AC	–0.264*	0.424**	0.296	–0.758***	–1.151***	–1.502***
	(–1.940)	(2.455)	(1.472)	(–4.484)	(–5.016)	(–10.827)
(Pseudo-) R^2	0.519	0.389	0.362	0.358	0.323	0.367
L3.BR	1.563**	–2.489***	–1.17	3.942***	4.261***	6.205***
($N = 316$)	(2.535)	(–3.668)	(–1.537)	(4.954)	(4.042)	(8.400)
L3.AC	–0.323	–2.163**	–1.669***	0.482	1.448**	4.13***
	(–0.753)	(–4.578)	(–3.151)	(0.870)	(1.973)	(8.031)
L3.BR*L3.AC	–0.344**	0.435***	0.122	–0.829***	–1.024***	–1.384***
	(–2.388)	(2.743)	(0.688)	(–4.457)	(–4.156)	(–8.017)
(Pseudo-) R^2	0.541	0.42	0.383	0.377	0.328	0.358
L4.BR	1.644***	–2.118***	–0.577	2.97***	3.011***	5.983***
($N = 296$)	(2.743)	(–3.046)	(–0.679)	(4.021)	(2.829)	(8.656)
L4.AC	–0.487	–2.326***	–1.608***	0.001	0.004	3.791***
	(–1.140)	(–4.695)	(–2.653)	(0.002)	(0.005)	(7.694)
L4.BR*L4.AC	–0.403***	0.346**	–0.001	–0.701***	–0.757***	–1.359***
	(–2.774)	(2.050)	(–0.006)	(–3.913)	(–2.932)	(–8.109)
(Pseudo-) R^2	0.563	0.448	0.398	0.39	0.334	0.36
L5.BR	1.689***	–2.026***	0.078	3.105***	2.48**	6.057***
($N = 268$)	(2.645)	(–3.700)	(0.084)	(3.989)	(1.978)	(8.473)
L5.AC	–0.586	–2.408***	–1.275**	–0.251	–0.715	3.394***
	(–1.321)	(–6.335)	(–1.984)	(–0.464)	(–0.821)	(6.838)
L5.BR*L5.AC	–0.443***	0.35***	–0.162	–0.734***	–0.635**	–1.466***
	(–2.814)	(2.595)	(–0.712)	(–3.829)	(–2.057)	(–8.326)
(Pseudo-) R^2	0.572	0.468	0.408	0.397	0.333	0.36
L6.BR	1.698***	–2.292***	0.418	2.708***	2.063	5.911***
($N = 248$)	(2.759)	(–4.552)	(0.466)	(4.194)	(1.642)	(8.393)
L6.AC	–0.629	–2.49***	–1.32**	–0.301	–0.787	3.125***
	(–1.404)	(–6.794)	(–2.019)	(–0.640)	(–0.861)	(6.095)
L6.BR*L6.AC	–0.467***	0.385***	–0.238	–0.684***	–0.484	–1.433***
	(–2.919)	(2.944)	(–1.020)	(–4.075)	(–1.483)	(–7.828)
(Pseudo-) R^2	0.584	0.479	0.423	0.409	0.332	0.358
L7.BR	1.773***	–1.571***	0.851	2.572***	2.548*	5.767***
($N = 221$)	(2.722)	(–2.914)	(0.924)	(3.892)	(1.789)	(7.856)
L7.AC	–0.571	–2.073***	–1.078	–0.433	–0.437	2.729***
	(–1.224)	(–5.374)	(–1.637)	(–0.916)	(–0.429)	(5.194)
L7.BR*L7.AC	–0.501***	0.286**	–0.312	–0.684***	–0.635*	–1.368***
	(–2.928)	(2.023)	(–1.292)	(–3.946)	(–1.699)	(–7.104)
(Pseudo-) R^2	0.598	0.492	0.43	0.422	0.346	0.363
L8.BR	1.578**	–1.756***	1.667*	1.846***	2.632*	5.82***
($N = 200$)	(2.466)	(–3.208)	(1.923)	(2.856)	(1.870)	(5.972)
L8.AC	–0.552	–1.766***	–0.247	–0.531	–0.195	2.03***
	(–1.149)	(–4.304)	(–0.381)	(–1.096)	(–0.185)	(2.778)
L8.BR*L8.AC	–0.454***	0.303**	–0.457*	–0.536***	–0.683*	–1.372***
	(–2.628)	(2.054)	(–1.954)	(–3.079)	(–1.800)	(–5.221)
(Pseudo-) R^2	0.611	0.510	0.441	0.430	0.353	0.360
L9.BR	1.817***	–1.817***	1.694	2.263***	2.936**	5.515***
($N = 176$)	(2.625)	(–2.667)	(1.616)	(3.653)	(2.052)	(3.077)
L9.AC	–0.35	–1.678***	–0.164	–0.31	–0.003	2.365*
	(–0.691)	(–3.366)	(–0.214)	(–0.684)	(–0.003)	(1.802)
L9.BR*L9.AC	–0.512***	0.327*	–0.442	–0.603***	–0.753*	–1.325***
	(–2.761)	(1.790)	(–1.574)	(–3.631)	(–1.962)	(–2.758)
(Pseudo-) R^2	0.637	0.529	0.45	0.452	0.392	0.369

BR, AC, and N indicate basic research ratio, absorptive capacity, and the number of observations, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed t tests at the 99% (***), 95% (**), and 90% (*) significance levels. The remaining coefficients (see Appndix) are omitted from the table. All models were tested for VIF (variance inflation factor) and showed no multicollinearity.

incremental innovation; their low absorptive capacity, which assimilates and exploits externally available information; and institutional environments that are not friendly to innovation derived from basic research in low-income countries.

In addition, we found that the increased absorptive capacity mediated the positive relationship between basic research investment and performance in high-income countries, whereas in low-income countries, it mediated the negative relationship between the two.

The relationships we identified in this study between heterogeneous basic research and economic growth according to national income level can provide new and diverse perspectives on the existing fact that basic research has a positive impact on national economic growth. That is, different approaches are needed depending on national income levels.

Recently, not only high-income countries but also low-income countries are supporting the expansion of basic research investment nationwide. The United States, with the Strategy for American Innovation, emphasized its role as the world's leading investor in basic research, and the US government continues to invest more than 30 billion USD annually in basic research: 33.82 billion USD in 2017 and 35.3 billion USD in 2019.[6] In 2019, an additional 14 billion USD will be allocated in addition to the sizes requested by individual agencies: National Institutes of Health, 9.2 billion USD; National Science Foundation (NSF), 2.2 billion USD; and the Department of Energy, 1.2 billion USD. The NSF, the leading basic research support organization in the United States, supports research funding for ten unexplored science and technology fields (Big ideas)[7] that require large-scale investment.

Expanding basic research investment is one of the main contents of the 5th Science and Technology Basic Plan (2016–20) in Japan. The Japanese government has reformed and strengthened the R&D subsidy and intensify international joint research. In addition, it intends to create concrete results by practical use of basic research results. Korea is also continuing to expand its basic research, making various attempts to create world-class research results, cultivate next-generation R&D manpower, and link basic research results to commercialization. According to the 4th Basic Research Promotion Plan (2018–22), the Korean government plans to increase basic research investment to 2.2 billion USD by 2022, which is twice the investment of basic research in 2017. China has strengthened the basic research investment through the 13th Five-Year Plan of Science and Technology Development (2016–20) and actively promotes international macro science projects. The Chinese Academy of Sciences, a leading Chinese research institute, will invest 40 per cent of its budget in basic research by 2020.[8]

Based on our results, high-income countries must continue to support basic research, especially enterprise research; as absorptive capacity increases, performance may decrease, but it can be overcome by shortening the time to commercialization.

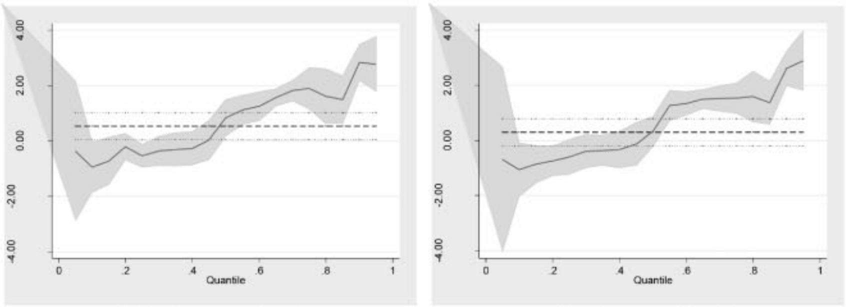
Policymakers in low-income countries may be reluctant to encourage the basic research investment in the corporate sector because there is a negative relationship between basic research investment and economic growth. However, basic research is necessary in order for companies in low-income or developing countries to compete equally with advanced companies in the global market. Particularly, basic research is critical for emerging from the developing stage and advancing to the development levels of high-income countries (Lee 2005; Mazzoleni and Nelson 2007). As in the cases of Japan and Korea, when economic development reaches a certain level, there are no objects that can be imitated. It can be very effective for companies to cooperate with or outsource research to universities and government-funded research institutes because it takes too long to commercialize and the technical uncertainty of basic research is large (Niosi 1999). In the long term, increasing basic research investment in the business sector requires increasing companies' absorptive capacity and creating new markets and products. In addition, it is also necessary to improve the absorptive capacity of the society as a whole and to protect intellectual property.

As shown in the quantile regression results (Table 2) and the coefficient estimates (Fig. 3), countries in the 40–70 per cent range in terms of GDP per capita are at the branch point in terms of corporate basic research. This is because the relationship between basic research investment and economic growth changes from negative to positive, and the positive effect of basic investment is unclear and not strong. Greece, Spain, Portugal, Russia, and Turkey belong to this range from 40 per cent to 70 per cent. Interestingly, Greece, Spain, and Portugal were once members of what economists labeled PIGS, Russia and Turkey continued to talk about the economic crisis. In these countries, there is a need for solid economic growth through basic research and strong policy support.

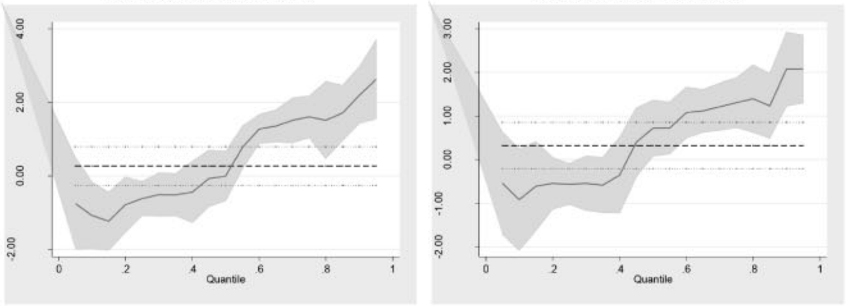
This study provides new insights into the role of firms' basic research investments in national economic growth using quantile regression, and we have made an academic contribution by showing the importance of model selection when attempting to detect nonlinear relations between basic research investment and economic growth. The results of this study will provide valuable guidance to both researchers and policymakers on the promotion effects of firms' basic research investments.

Notes

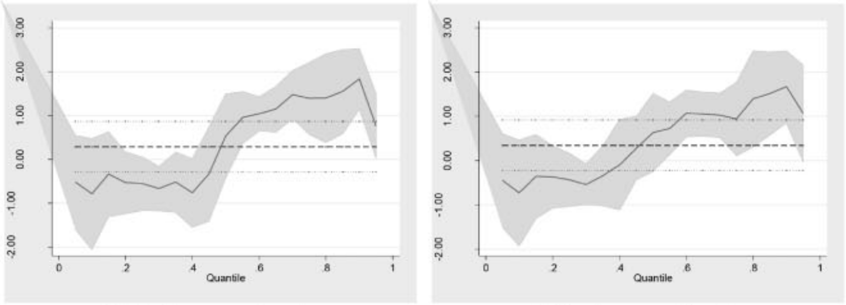
1. Oriented basic research is carried out with the expectation that it will produce a broad base of knowledge likely to form the basis of the solution to recognized or expected current or future problems or possibilities.
2. Austria, Belgium, Chile, China, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Poland, Portugal, Russia, the Slovak Republic, Slovenia, South Africa, Spain, Turkey, the UK, and the USA.
3. The OECD provides intramural R&D expenditure data, which is synonymous with the performance of R&D within a statistical unit. Therefore, funding for or expenditure on extramural R&D (that is, R&D performed outside the statistical unit) is not included in intramural R&D performance totals (OECD 2015).
4. Falk (2007) used system GMM to solve the problem of endogeneity problem between R&D investment and economic growth. However, in this study, looking at the annual basic research ratio and GDP (or GDP per capita) firm trends (Fig. 2), it appears that there is no simultaneity between basic research ratio and GDP.
5. We selected from among thity-one countries six countries that had a large amount of valid data.
6. See <https://mcmprodaaas.s3.amazonaws.com/s3fs-public/AAAS%20R%26D%20Report%20FY19%20Final.pdf?4LWpHlD69_hmH5PvKJ_RnkFtYNciOFhM> accessed 17 Feb 2019.
7. See <https://www.nsf.gov/news/special_reports/big_ideas/> accessed 17 Feb 2019.
8. See <http://english.cas.cn/newsroom/news/201609/t20160909_167591.shtml> accessed 17 Feb 2019.



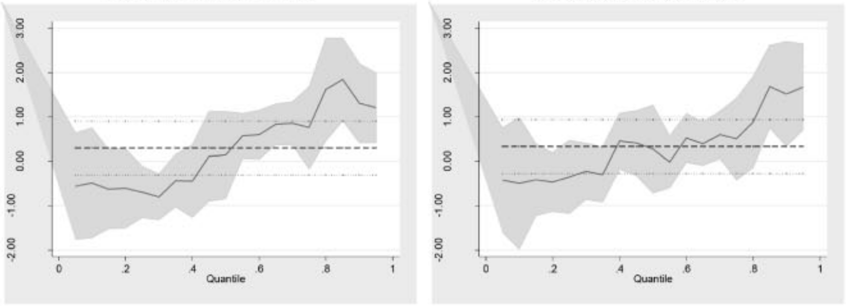
L1.basic research ratio L2.basic research ratio



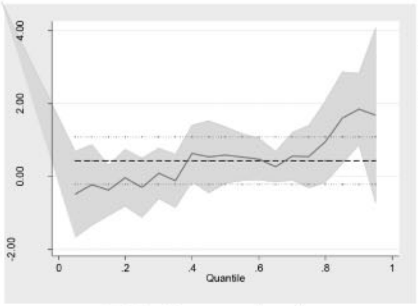
L3.basic research ratio L4.basic research ratio



L5.basic research ratio L6.basic research ratio



L7.basic research ratio L8.basic research ratio



L9.basic research ratio

Notes: The solid line is a coefficient of quantile regression. The shaded area represents the confidence interval of the coefficient. The horizontal dash line is a coefficient of OLS. The scattered line is the confidence interval of the OLS regression.

Figure 3. Coefficient estimates of OLS and quantile regressions.

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Appendix

A.1. Results of quantile regression

Table A.1.1. Results of quantile regression for L1.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L1.BR	0.523**	−0.600	−0.223	0.787**	1.707***	2.581***
	(2.172)	(−1.542)	(−0.869)	(2.143)	(4.450)	(7.581)
Fixed cap. inv. ratio	−0.677***	−0.549***	−0.687***	−0.729***	−0.704***	−0.344***
	(−8.983)	(−4.509)	(−8.556)	(−6.343)	(−5.867)	(−3.232)
L1.GERD ratio	7.599***	9.157***	8.766***	8.574***	6.725***	5.577***
	(12.536)	(9.349)	(13.580)	(9.278)	(6.965)	(6.509)
L1.AC	−0.737***	−1.226***	−0.860***	−0.861**	−0.991**	0.468
	(−2.675)	(−2.752)	(−2.929)	(−2.049)	(−2.257)	(1.200)
Constant	34.035***	24.934***	29.553***	33.869***	38.000***	28.591***
	(15.779)	(7.153)	(12.866)	(10.299)	(11.059)	(9.376)
Observations	365	365	365	365	365	365
(Pseudo-) R^2	0.511	0.341	0.354	0.342	0.301	0.301

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.2. Results of quantile regression for L2.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L2.BR	0.311	−1.099***	−0.367	0.447	1.364***	2.354***
	(1.297)	(−2.754)	(−1.205)	(1.388)	(3.518)	(7.118)
Fixed cap. inv. ratio	−0.654***	−0.565***	−0.684***	−0.743***	−0.737***	−0.300***
	(−8.523)	(−4.430)	(−7.016)	(−7.214)	(−5.947)	(−2.831)
L2.GERD ratio	8.174***	10.281***	9.590***	9.008***	7.322***	5.862***
	(13.011)	(9.847)	(12.023)	(10.697)	(7.218)	(6.774)
L2.AC	−0.870***	−1.222***	−1.184***	−0.996***	−0.967**	0.243
	(−3.107)	(−2.627)	(−3.334)	(−2.656)	(−2.139)	(0.631)
Constant	34.283***	25.482***	30.730***	35.508***	39.075***	28.982***
	(15.715)	(7.029)	(11.096)	(12.143)	(11.094)	(9.644)
Observations	346	346	346	346	346	346
(Pseudo-) R^2	0.513	0.356	0.360	0.342	0.300	0.300

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.3. Results of quantile regression for L3.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L3.BR	0.217	−1.028***	−0.591**	0.698**	1.414***	1.896***
	(0.862)	(−3.510)	(−2.058)	(2.022)	(3.174)	(5.005)
Fixed cap. inv. ratio	−0.648***	−0.501***	−0.592***	−0.682***	−0.719***	−0.602***
	(−8.263)	(−5.496)	(−6.625)	(−6.349)	(−5.192)	(−5.105)
L3.GERD ratio	8.961***	10.870***	10.415***	9.475***	6.796***	6.214***
	(13.169)	(13.755)	(13.436)	(10.171)	(5.653)	(6.078)
L3.AC	−1.082***	−1.504***	−1.335***	−1.147***	−1.024**	0.033
	(−3.719)	(−4.451)	(−4.029)	(−2.881)	(−1.993)	(0.075)
Constant	34.708***	24.660***	29.280***	33.949***	39.993***	37.713***
	(15.557)	(9.517)	(11.520)	(11.114)	(10.147)	(11.250)
Observations	316	316	316	316	316	316
(Pseudo-) R^2	0.533	0.397	0.382	0.359	0.309	0.300

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.4. Results of quantile regression for L4.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L4.BR	0.132	−1.081***	−0.581**	0.671**	1.169**	1.437***
	(0.523)	(−3.395)	(−2.108)	(2.165)	(2.484)	(3.166)
Fixed cap. inv. ratio	−0.637***	−0.478***	−0.609***	−0.692***	−0.697***	−0.537***
	(−8.228)	(−4.902)	(−7.214)	(−7.275)	(−4.829)	(−3.859)
L4.GERD ratio	9.677***	11.045***	10.797***	9.813***	8.113***	7.496***
	(13.364)	(12.103)	(13.663)	(11.037)	(6.010)	(5.759)
L4.AC	−1.344***	−1.700***	−1.607***	−1.262***	−1.345**	−0.377
	(−4.502)	(−4.519)	(−4.932)	(−3.441)	(−2.416)	(−0.703)
Constant	35.342***	25.972***	30.822***	34.712***	39.745***	37.558***
	(15.951)	(9.301)	(12.748)	(12.760)	(9.622)	(9.432)
Observations	296	296	296	296	296	296
(Pseudo-) R^2	0.552	0.432	0.398	0.374	0.315	0.296

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.5. Results of quantile regression for L5.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L5.BR	0.052	−0.961***	−0.723***	0.664*	0.933*	1.257**
	(0.195)	(−2.876)	(−2.762)	(1.914)	(1.859)	(2.507)
Fixed cap. inv. ratio	−0.603***	−0.505***	−0.592***	−0.663***	−0.652***	−0.307**
	(−7.725)	(−5.181)	(−7.759)	(−6.543)	(−4.450)	(−2.098)
L5.GERD ratio	10.093***	10.889***	11.005***	9.907***	8.784***	8.573***
	(13.133)	(11.344)	(14.640)	(9.938)	(6.094)	(5.949)
L5.AC	−1.484***	−1.462***	−1.546***	−1.383***	−1.578***	−0.532
	(−4.758)	(−3.752)	(−5.066)	(−3.417)	(−2.697)	(−0.910)
Constant	35.203***	26.085***	30.679***	34.811***	39.530***	32.799***
	(15.508)	(9.200)	(13.817)	(11.822)	(9.284)	(7.706)
Observations	268	268	268	268	268	268
(Pseudo-) R^2	0.559	0.456	0.407	0.374	0.317	0.291

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.6. Results of quantile regression for L6.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L6.BR	0.069	–0.910***	–0.467	0.562*	0.947*	1.733***
	(0.262)	(–3.551)	(–1.500)	(1.905)	(1.749)	(3.354)
Fixed cap. inv. ratio	–0.591***	–0.483***	–0.558***	–0.645***	–0.661***	–0.127
	(–7.552)	(–6.346)	(–6.036)	(–7.364)	(–4.114)	(–0.832)
L6.GERD ratio	10.195***	10.785***	10.787***	9.861***	8.605***	9.406***
	(12.985)	(14.129)	(11.632)	(11.223)	(5.338)	(6.116)
L6.AC	–1.569***	–1.634***	–1.720***	–1.220***	–1.590**	–0.266
	(–4.960)	(–5.312)	(–4.602)	(–3.447)	(–2.448)	(–0.429)
Constant	35.522***	26.983***	30.961***	34.220***	39.909***	24.798***
	(15.490)	(12.103)	(11.431)	(13.335)	(8.476)	(5.521)
Observations	248	248	248	248	248	248
(Pseudo-) R^2	0.569	0.471	0.420	0.387	0.321	0.295

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.7. Results of quantile regression for L7.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L7.BR	0.038	–0.739***	–0.382	–0.14	0.559	1.091
	(0.138)	(–2.614)	(–1.070)	(–0.405)	(1.000)	(1.631)
Fixed cap. inv. ratio	–0.587***	–0.486***	–0.536***	–0.677***	–0.686***	0.101
	(–7.403)	(–5.979)	(–5.224)	(–6.828)	(–4.262)	–0.525
L7.GERD ratio	10.298***	10.356***	10.592***	11.154***	9.760***	12.184***
	(12.538)	(12.293)	(9.952)	(10.856)	(5.855)	(6.11)
L7.AC	–1.551***	–1.355***	–1.606***	–1.341***	–1.812***	–1.725**
	(–4.703)	(–4.005)	(–3.757)	(–3.250)	(–2.706)	(–2.154)
Constant	35.676***	26.591***	30.464***	36.087***	41.552***	24.997***
	(15.278)	(11.102)	(10.068)	(12.355)	(8.768)	(4.409)
Observations	221	221	221	221	221	221
(Pseudo-) R^2	0.582	0.489	0.427	0.393	0.334	0.299

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.8. Results of quantile regression for L8.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L8.BR	0.049	–0.753***	–0.024	0.034	0.248	2.023***
	(0.181)	(–2.727)	(–0.072)	(0.111)	(0.477)	(2.891)
Fixed cap. inv. ratio	–0.586***	–0.499***	–0.542***	–0.622***	–0.731***	–0.193
	(–7.252)	(–6.046)	(–5.371)	(–6.734)	(–4.714)	(–0.923)
L8.GERD ratio	10.207***	10.243***	9.851***	10.576***	10.266***	9.945***
	(12.242)	(12.048)	(9.468)	(11.099)	(6.421)	(4.616)
L8.AC	–1.467***	–1.126***	–1.283***	–1.394***	–1.598**	–0.851
	(–4.377)	(–3.294)	(–3.069)	(–3.641)	(–2.486)	(–0.983)
Constant	35.715***	26.711***	29.597***	35.455***	42.232***	27.905***
	(15.206)	(11.152)	(10.098)	(13.208)	(9.377)	(4.597)
Observations	200	200	200	200	200	200
(Pseudo-) R^2	0.597	0.500	0.429	0.407	0.341	0.312

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.1.9. Results of quantile regression for L9.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L9.BR	0.076	−0.418	0.007	0.089	0.041	1.248*
	(0.262)	(−1.523)	(0.019)	(0.262)	(0.082)	(1.856)
Fixed cap. inv. ratio	−0.593***	−0.480***	−0.502***	−0.593***	−0.732***	−0.454**
	(−7.125)	(−6.123)	(−4.539)	(−6.152)	(−5.150)	(−2.365)
L9.GERD ratio	10.288***	9.306***	9.165***	10.928***	10.810***	12.183***
	(11.911)	(11.438)	(7.991)	(10.922)	(7.331)	(6.108)
L9.AC	−1.389***	−1.031***	−0.890*	−1.399***	−1.477**	−2.064**
	(−4.020)	(−3.167)	(−1.940)	(−3.494)	(−2.503)	(−2.587)
Constant	35.593***	26.569***	28.616***	34.459***	41.871***	38.498***
	15.098)	(11.965)	(9.141)	(12.618)	(10.404)	(7.072)
Observations	176	176	176	176	176	176
(Pseudo-) R^2	0.621	0.521	0.442	0.422	0.371	0.347

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

A.2. Results of quantile regression including interaction term

Table A.2.1. Results of quantile regression, including interaction term for L1.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L1.BR	1.757***	−2.484***	−1.111	3.287***	5.989***	6.410***
	(2.938)	(−2.746)	(−1.502)	(3.840)	(6.271)	(10.273)
Fixed cap. inv. ratio	−0.689***	−0.554***	−0.681***	−0.919***	−0.615***	−0.263***
	(−9.167)	(−4.874)	(−7.323)	(−8.548)	(−5.130)	(−3.359)
L1.GERD ratio	7.993***	8.935***	8.518***	8.461***	6.155***	6.722***
	(12.735)	(9.410)	(10.968)	(9.419)	(6.140)	(10.265)
L1.AC	−0.033	−2.007***	−1.240**	0.541	3.089***	4.615***
	(−0.080)	(−3.189)	(−2.409)	(0.908)	(4.651)	(10.635)
L1.BR*L1.AC	−0.300**	0.390*	0.178	−0.644***	−1.275***	−1.416***
	(−2.252)	(1.933)	(1.076)	(−3.373)	(−5.985)	(−10.175)
Constant	30.970***	29.010***	31.476***	33.554***	24.504***	13.850***
	(12.191)	(7.548)	(10.013)	(9.228)	(6.040)	(5.225)
Observations	365	365	365	365	365	365
(Pseudo-) R^2	0.518	0.367	0.356	0.356	0.326	0.368

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.2. Results of quantile regression including interaction term for L2.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L2.BR	1.352**	−2.635***	−1.959**	3.716***	5.266***	6.510***
	(2.302)	(−3.527)	(−2.252)	(5.081)	(5.307)	(10.855)
Fixed cap. inv. ratio	−0.665***	−0.501***	−0.622***	−0.882***	−0.718***	−0.125
	(−8.673)	(−5.143)	(−5.478)	(−9.239)	(−5.543)	(−1.602)
L2.GERD ratio	8.598***	8.448***	9.394***	9.208***	6.410***	6.717***
	(12.973)	(10.023)	(9.569)	(11.159)	(5.725)	(9.926)
L2.AC	−0.265	−2.025***	−1.861***	0.373	2.329***	4.718***
	(−0.635)	(−3.809)	(−3.007)	(0.717)	(3.298)	(11.057)
L2.BR*L2.AC	−0.264*	0.424**	0.296	−0.758***	−1.151***	−1.502***
	(−1.940)	(2.455)	(1.472)	(−4.484)	(−5.016)	(−10.827)
Constant	31.674***	29.565***	33.010***	32.924***	30.081***	11.135***
	(12.396)	(9.099)	(8.723)	(10.350)	(6.970)	(4.269)
Observations	346	346	346	346	346	346
(Pseudo-) R^2	0.519	0.389	0.362	0.358	0.323	0.367

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.3. Results of quantile regression, including interaction term for L3.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L3.BR	1.563**	−2.489***	−1.17	3.942***	4.261***	6.205***
	(2.535)	(−3.668)	(−1.537)	(4.954)	(4.042)	(8.400)
Fixed cap. inv. ratio	−0.663***	−0.429***	−0.616***	−0.912***	−0.782***	−0.152
	(−8.487)	(−4.990)	(−6.387)	(−9.047)	(−5.860)	(−1.626)
L3.GERD ratio	9.576***	8.714***	10.269***	9.028***	8.256***	7.200***
	(13.248)	(10.953)	(11.511)	(9.677)	(6.681)	(8.314)
L3.AC	−0.323	−2.163***	−1.669***	0.482	1.448**	4.130***
	(−0.753)	(−4.578)	(−3.151)	(0.870)	(1.973)	(8.031)
L3.BR*L3.AC	−0.344**	0.435***	0.122	−0.829***	−1.024***	−1.384***
	(−2.388)	(2.743)	(0.688)	(−4.457)	(−4.156)	(−8.017)
Constant	31.436***	27.752***	31.467***	34.431***	34.004***	13.580***
	(12.072)	(9.683)	(9.792)	(10.244)	(7.638)	(4.353)
Observations	316	316	316	316	316	316
(Pseudo-) R^2	0.541	0.420	0.383	0.377	0.328	0.358

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.4. Results of quantile regression including interaction term for L4.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L4.BR	1.644***	–2.118***	–0.577	2.970**	3.011***	5.983***
	–2.743	(–3.046)	(–0.679)	–4.021	–2.829	–8.656
Fixed cap. inv. ratio	–0.656***	–0.414***	–0.609***	–0.844***	–0.928***	–0.057
	(–8.533)	(–4.647)	(–5.583)	(–8.914)	(–6.804)	(–0.648)
L4.GERD ratio	10.530***	9.296***	10.815***	10.591***	9.902***	8.060***
	(13.515)	(10.289)	(9.785)	(11.033)	(7.158)	(8.971)
L4.AC	–0.487	–2.326***	–1.608***	0.001	0.004	3.791***
	(–1.140)	(–4.695)	(–2.653)	(0.002)	(0.005)	(7.694)
L4.BR*L4.AC	–0.403***	0.346**	–0.001	–0.701***	–0.757***	–1.359***
	(–2.774)	(2.050)	(–0.006)	(–3.913)	(–2.932)	(–8.109)
Constant	31.688***	28.450***	30.772***	33.684***	41.218***	12.478***
	(12.397)	(9.598)	(8.486)	(10.696)	(9.081)	(4.233)
Observations	296	296	296	296	296	296
(Pseudo-) R^2	0.563	0.448	0.398	0.390	0.334	0.360

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.5. Results of quantile regression including interaction term for L5.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L5.BR	1.689***	–2.026***	0.078	3.105***	2.480**	6.057***
	(2.645)	(–3.700)	(0.084)	(3.989)	(1.978)	(8.473)
Fixed cap. inv. ratio	–0.623***	–0.366***	–0.607***	–0.788***	–0.876***	0.026
	(–8.054)	(–5.519)	(–5.414)	(–8.352)	(–5.769)	(0.305)
L5.GERD ratio	11.088***	9.369***	11.345***	11.207***	10.601***	9.788***
	(13.248)	(13.06)	(9.354)	(10.99)	(6.455)	(10.451)
L5.AC	–0.586	–2.408***	–1.275**	–0.251	–0.715	3.394***
	(–1.321)	(–6.335)	(–1.984)	(–0.464)	(–0.821)	(6.838)
L5.BR*L5.AC	–0.443***	0.350***	–0.162	–0.734***	–0.635**	–1.466***
	(–2.814)	(2.595)	(–0.712)	(–3.829)	(–2.057)	(–8.326)
Constant	31.376***	27.747***	29.367***	33.074***	41.959***	11.414***
	(11.971)	(12.35)	(7.732)	(10.357)	(8.159)	(3.892)
Observations	268	268	268	268	268	268
(Pseudo-) R^2	0.572	0.468	0.408	0.397	0.333	0.36

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.6. Results of quantile regression including interaction term for L6.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L6.BR	1.698***	–2.292***	0.418	2.708***	2.063	5.911***
	(2.759)	(–4.552)	(0.466)	(4.194)	(1.642)	(8.393)
Fixed cap. inv. ratio	–0.616***	–0.356***	–0.562***	–0.771***	–0.821***	0.117
	(–7.942)	(–5.619)	(–4.969)	(–9.487)	(–5.192)	(1.320)
L6.GERD ratio	11.376***	9.419***	11.668***	11.719***	10.010***	10.211***
	(13.035)	(13.198)	(9.165)	(12.800)	(5.621)	(10.227)
L6.AC	–0.629	–2.490***	–1.320**	–0.301	–0.787	3.125***
	(–1.404)	(–6.794)	(–2.019)	(–0.640)	(–0.861)	(6.095)
L6.BR*L6.AC	–0.467***	0.385***	–0.238	–0.684***	–0.484	–1.433***
	(–2.919)	(2.944)	(–1.020)	(–4.075)	(–1.483)	(–7.828)
Constant	31.675***	28.548	28.681***	32.824***	41.438***	10.060***
	(12.114)	(13.349)	(7.519)	(11.965)	(7.765)	(3.363)
Observations	248	248	248	248	248	248
(Pseudo-) R^2	0.584	0.479	0.423	0.409	0.332	0.358

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.7. Results of quantile regression, including interaction term for L7.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L7.BR	1.773***	–1.571***	0.851	2.572***	2.548*	5.767***
	(2.722)	(–2.914)	(0.924)	(3.892)	(1.789)	(7.856)
Fixed cap. inv. ratio	–0.616***	–0.388***	–0.570***	–0.758***	–0.869***	0.171*
	(–7.841)	(–5.966)	(–5.135)	(–9.513)	(–5.060)	(1.928)
L7.GERD ratio	11.595***	9.233***	11.596***	12.196***	9.936***	10.805***
	(12.592)	(12.120)	(8.914)	(13.057)	(4.936)	(10.413)
L7.AC	–0.571	–2.073***	–1.078	–0.433	–0.437	2.729***
	(–1.224)	(–5.374)	(–1.637)	(–0.916)	(–0.429)	(5.194)
L7.BR*L7.AC	–0.501***	0.286**	–0.312	–0.684***	–0.635*	–1.368***
	(–2.928)	(2.023)	(–1.292)	(–3.946)	(–1.699)	(–7.104)
Constant	31.732***	27.726***	28.305***	33.507***	41.621***	9.485***
	(11.924)	(12.592)	(7.528)	(12.411)	(7.153)	(3.163)
Observations	221	221	221	221	221	221
(Pseudo-) R^2	0.598	0.492	0.430	0.422	0.346	0.363

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.8. Results of quantile regression including interaction term for L8.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L8.BR	1.578**	–1.756***	1.667*	1.846***	2.632*	5.820***
	(2.466)	(–3.208)	(1.923)	(2.856)	(1.870)	(5.972)
Fixed cap. inv. ratio	–0.616***	–0.418***	–0.623***	–0.728***	–0.888***	0.110
	(–7.659)	(–6.069)	(–5.716)	(–8.964)	(–5.019)	(0.894)
L8.GERD ratio	11.391***	9.111***	11.266***	12.103***	10.246***	12.190***
	(12.159)	(11.372)	(8.873)	(12.793)	(4.972)	(8.544)
L8.AC	–0.552	–1.766***	–0.247	–0.531	–0.195	2.030***
	(–1.149)	(–4.304)	(–0.381)	(–1.096)	(–0.185)	(2.778)
L8.BR*L8.AC	–0.454***	0.303**	–0.457*	–0.536***	–0.683*	–1.372***
	(–2.628)	–2.054	(–1.954)	(–3.079)	(–1.800)	(–5.221)
Constant	32.209***	27.875***	26.599***	33.550***	41.622***	12.390***
	(12.059)	(12.203)	(7.349)	(12.439)	(7.085)	(3.046)
Observations	200	200	200	200	200	200
(Pseudo-) R^2	0.611	0.51	0.441	0.43	0.353	0.36

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

Table A.2.9. Results of quantile regression including interaction term for L9.BR

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L9.BR	1.817***	–1.817***	1.694	2.263***	2.936**	5.515***
	(2.625)	(–2.667)	(1.616)	(3.653)	(2.052)	(3.077)
Fixed cap. inv. ratio	–0.640***	–0.425***	–0.599***	–0.720***	–0.901***	0.219
	(–7.673)	(–5.183)	(–4.741)	(–9.644)	(–5.224)	(1.014)
L9.GERD ratio	11.534***	8.792***	10.763***	11.903***	10.573***	12.061***
	(12.013)	(9.306)	(7.402)	(13.852)	(5.327)	(4.851)
L9.AC	–0.35	–1.678***	–0.164	–0.310	–0.003	2.365*
	(–0.691)	(–3.366)	(–0.214)	(–0.684)	(–0.003)	(1.802)
L9.BR*L9.AC	–0.512***	0.327*	–0.442	–0.603***	–0.753*	–1.325***
	(–2.761)	(1.790)	(–1.574)	(–3.631)	(–1.962)	(–2.758)
Constant	32.047***	28.388***	27.090***	32.617***	41.054***	8.726
	(12.112)	(10.902)	(6.760)	(13.773)	(7.506)	(1.274)
Observations	176	176	176	176	176	176
(Pseudo-) R^2	0.637	0.529	0.450	0.452	0.392	0.369

BR and AC indicate basic research ratio and absorptive capacity, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels.

A.3. Results of panel quantile regression.

Table A.3.1. Results of panel quantile regression

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L1.BR	0.321***	21.195	0.923	0.436	0.065	0.643
($N = 365$)	(2.781)	(0.436)	(0.912)	(1.408)	(0.130)	(0.728)
L1.AC	3.642***	−132.064	2.029	−0.684	−2.206***	5.439***
	(5.621)	(−0.387)	(1.530)	(−1.045)	(−3.021)	(3.492)
R^2	0.536					
L2.BR	0.296***	−0.890***	0.640	0.905***	1.456***	0.617
($N = 346$)	(2.844)	(−33.466)	(1.208)	(21.634)	(6.116)	(0.990)
L2.AC	3.148***	−1.817***	−2.481***	−1.339***	−2.084***	0.674**
	(5.039)	(−1779.065)	(−4.004)	(−21.591)	(−8.070)	(2.469)
R^2	0.527					
L3.BR	0.290***	−0.456**	0.459	−0.052	1.746***	0.658***
($N = 316$)	(2.735)	(−2.129)	(0.810)	(−0.085)	(6.983)	(2.603)
L3.AC	2.472***	0.279	5.310***	−0.941	−1.580***	−0.094
	(3.855)	(0.899)	(2.800)	(−0.437)	(−7.853)	(−0.267)
R^2	0.513					
L4.BR	0.184*	−0.512	0.024	0.307	0.807***	0.577
($N = 296$)	(1.853)	(−0.387)	(0.052)	(0.510)	(19.617)	(1.469)
L4.AC	1.818***	−4.435	−2.456***	−2.204**	−1.057***	0.209
	(2.778)	(−0.541)	(−4.205)	(−2.171)	(−17.546)	(0.402)
R^2	0.499					
L5.BR	0.096	−1.048	1300.109	0.542	−0.252	−0.088
($N = 268$)	(0.946)	(−0.582)	(0.474)	(1.536)	(−0.758)	(−0.118)
L5.AC	1.807***	−14.074	5536.940	−0.580	−2.639***	−0.189
	(2.735)	(−0.711)	(0.476)	(−0.823)	(−3.185)	(−0.225)
R^2	0.534					
L6.BR	0.011	−0.785***	−0.892**	0.538	0.921***	−0.063
($N = 248$)	(0.121)	(−7.065)	(−2.419)	(1.148)	(41.107)	(−0.084)
L6.AC	2.804***	−0.363	2.178**	1.870	−1.747***	0.721
	(4.375)	(−1.008)	(1.986)	(0.711)	(−30.515)	(1.342)
R^2	0.542					
L7.BR	0.001	15528.649	−0.472***	0.823***	0.580***	0.347
($N = 221$)	(0.008)	(0.293)	(−3.831)	(6.179)	(45.929)	(1.103)
L7.AC	2.929***	8957.349	−1.280***	0.278	−1.938***	0.197
	(4.197)	(0.293)	(−13.751)	(1.542)	(−146.665)	(0.310)
R^2	0.509					
L8.BR	0.052	−0.751***	0.915	−0.180	−0.570***	2.153***
($N = 200$)	(0.556)	(−4.095)	(0.263)	(−1.102)	(−4.286)	(8.891)
L8.AC	3.214***	−0.361	−93.032	−1.801***	−2.772***	−0.339
	(4.512)	(−1.943)	(−0.479)	(−28.506)	(−35.341)	(−0.531)
R^2	0.476					
L9.BR	0.055	−645.041	2.01E+06	0.071	−0.965	1.001*
($N = 176$)	(0.509)	(−0.378)	(0.418)	(1.383)	(−0.709)	(1.867)
L9.AC	3.484***	203.227	7.13E+06	−2.792***	−9.953***	−2.987**
	(4.545)	(0.381)	(0.418)	(−39.911)	(−2.661)	(−2.163)
R^2	0.48					

BR and *N* indicate basic research ratio and the number of observations, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels. The remaining coefficients are omitted from the table.

Table A.3.2. Results of panel quantile regression, including interaction term

	OLS	Quantile regression				
		Q10	Q25	Q50	Q75	Q90
L1.BR	0.222	–2.407***	–1.932***	3.054***	0.734	5.547***
(*N* = 365)	(0.805)	(–137.207)	(–4.568)	(4.002)	(0.333)	(26.940)
L1.AC	3.606***	–1.794***	–1.982***	1.292*	–1.121	4.241***
	(5.506)	(–121.763)	(–6.263)	(1.698)	(–0.773)	(18.959)
L1.BR*L1.AC	0.026	0.356***	0.337***	–0.602***	–0.274	–1.244***
	(0.399)	(98.634)	(3.803)	(–3.176)	(–0.509)	(–26.088)
R^2	0.536					
L2.BR	0.135	–2.507***	–0.775	–0.216	5.654***	5.044*
(*N* = 346)	(0.534)	(–174.753)	(–0.893)	(–0.319)	(9.663)	(1.794)
L2.AC	3.083***	–2.309***	–1.879**	–1.519*	–21.152*	1.943
	(4.876)	(–68.212)	(–2.499)	(–1.835)	(–1.650)	(0.941)
L2.BR*L2.AC	0.043	0.423***	0.351	0.003	–1.315***	–1.467***
	(0.696)	(76.528)	(1.236)	(0.014)	(–4.807)	(–3.328)
R^2	0.528					
L3.BR	0.123	–2.491***	–3.707***	0.851	3.118***	4.197***
(*N* = 316)	(0.448)	(–61.078)	(–9.427)	(0.967)	(30.697)	(4.906)
L3.AC	2.435***	–2.305***	–4.215***	–6.780***	0.927***	2.971***
	(3.778)	(–42.517)	(–12.099)	(–4.402)	(10.904)	(8.247)
L3.BR*L3.AC	0.043	0.417***	1.014***	–0.466***	–0.784***	–0.851***
	(0.661)	(36.282)	(8.479)	(–3.387)	(–45.437)	(–3.812)
R^2	0.514					
L4.BR	0.089	–2.323	–0.564	2.458***	2.615***	6.480***
(*N* = 296)	(0.343)	(–0.363)	(–0.757)	(32.737)	(23.727)	(15.831)
L4.AC	1.794***	–3.146	–2.861***	–0.103***	0.325***	4.109***
	(2.725)	(–0.555)	(–14.615)	(–3.941)	(3.707)	(10.655)
L4.BR*L4.AC	0.025	1.295	0.085	–0.565***	–0.719***	–1.400***
	(0.392)	(0.631)	(0.979)	(–33.853)	(–57.423)	(–12.154)
R^2	0.499					
L5.BR	0.138	3.713***	–0.442	–0.251	2.097***	5.704***
(*N* = 268)	(0.496)	(3.026)	(–0.615)	(–0.104)	(36.705)	(50.318)
L5.AC	1.813***	–1.701**	–2.916***	–3.348*	–0.774***	3.511***
	(2.734)	(–2.264)	(–3.839)	(–1.811)	(–14.298)	(17.132)
L5.BR*L5.AC	–0.011	–1.099***	0.174	0.219	–0.556***	–1.356***
	(–0.162)	(–3.871)	(0.943)	(0.444)	(–79.510)	(–40.770)
R^2	0.534					
L6.BR	–0.031	–2.005***	–0.505***	2.611***	1.106	4.438***
(*N* = 248)	(–0.134)	(–86.957)	(–4.270)	(8.611)	(1.335)	(9.875)
L6.AC	2.781***	–2.652***	–2.246***	1.309	–1.819***	2.652***
	(4.260)	(–219.749)	(–30.819)	(1.421)	(–4.731)	(13.465)
L6.BR*L6.AC	0.012	0.363***	–0.036	–0.780***	–0.116	–1.150***
	(0.195)	(65.118)	(–1.520)	(–9.291)	(–0.618)	(–13.841)
R^2	0.542					
L7.BR	–0.072	–1.554***	2.269***	0.234	0.997	7.393***
(*N* = 221)	(–0.277)	(–90.486)	(6.796)	(0.176)	(1.383)	(5.860)
L7.AC	2.895***	–2.036***	–0.183	–1.264***	–1.789***	1.817
	(4.088)	(–204.022)	(–0.774)	(–2.913)	(–5.582)	(1.534)
L7.BR*L7.AC	0.02	0.288***	–0.569***	–0.161	–0.049	–1.567***
	(0.303)	(67.410)	(–9.248)	(–0.548)	(–0.244)	(–5.236)
R^2	0.509					
L8.BR	–0.087	–1.426***	–1.013	2.549***	1.607	72.616
(*N* = 200)	(–0.355)	(–2.713)	(–0.487)	(9.599)	(0.921)	(0.512)
L8.AC	3.132***	0.872	–2.415	–0.012	–0.735	–42.194
	(4.313)	(0.378)	(–1.540)	(–0.079)	(–0.429)	(–0.377)
L8.BR*L8.AC	0.039	0.151	0.57	–0.634***	–0.372	–12.279
	(0.618)	(0.754)	(0.620)	(–9.587)	(–0.751)	(–0.563)
R^2	0.477					
L9.BR	–0.295	–1.572***	–6.04E+10	2.444***	2.108**	5.418***
(*N* = 176)	(–1.060)	(–7.389)	(–0.389)	(10.693)	(2.018)	(9.741)
L9.AC	3.358***	–1.532***	4.41E+10	–0.155**	–3.752***	2.216***
	(4.362)	(–22.671)	(0.389)	(–2.029)	(–5.403)	(3.766)
L9.BR*L9.AC	0.094	0.259***	1.34E+10	–0.629***	–0.651*	–1.485***
	(1.368)	(4.900)	(0.3890)	(–14.568)	(–1.686)	(–9.051)
R^2	0.486					

BR, AC, and *N* indicate basic research ratio, absorptive capacity, and the number of observations, respectively. The standard errors are shown in parentheses. The significance is shown for two-tailed *t* tests at the 99% (***), 95% (**), and 90% (*) significance levels. The remaining coefficients are omitted from the table.