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# **The Role of Internationalization Strategy in Fostering Innovation: An Empirical Study Using Machine Learning**

*Short Paper*

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## **Abstract.**

*In today's highly dynamic global market, firms increasingly conduct R&D internationally to enhance their innovation and competitiveness. We analyze the relationship between firm internationalization strategy and innovation performance. We argue that the relationship is inverse U-shaped, due to concave returns and convex costs of firm internationalization regarding innovation performance. We test our hypothesis using a novel machine-learning technique and develop a dictionary on internationalization, based on the most-cited papers on firm internationalization. We then apply this dictionary to firms' 10-K annual reports to obtain a unique score of each firm's internationalization strategy and use panel data econometrics to analyze the relationship with innovation performance. The results support the hypothesis of an inverted U-shape relationship between firms' internationalization strategy and innovation performance. Further tests substantiate the findings. Our study contributes to the literature on firm internationalization and firm innovation by identifying a trade-off in benefits and costs of firm internationalization.*

**Keywords:** internationalization strategy, innovation performance, machine-learning, inverse U-shape

## **Introduction**

On March 22<sup>nd</sup> 2023, the Future of Life Institute published an open letter with a call “to immediately pause for at least 6 months the training of AI systems more powerful than GPT-4” (Future of Life Institute 2023). The letter was signed by plenty of influential figures in the tech industry, such as Elon Musk, CEO of SpaceX, Tesla, and Twitter, or Steve Wozniak, Co-founder of Apple. This development with both the excitement as well as fear of AI technologies such as Chat GPT is emblematic of the breakneck speed of development in the field of digital innovation. To survive in such a highly competitive and rapidly evolving market, any firm needs to keep innovating. According to the Economist, the five U.S. giant tech companies – Google Alphabet, Amazon, Apple, Meta, and Microsoft – collectively spent more than 220 billion U.S. dollars on research and development in 2022, up from just 110 billion in 2019, keeping market pressures high and driving the development in digital innovation even further (The Economist 2023). The U.S. tech giants have in common that they are all Multinational Enterprises (MNEs), that conduct research and development in countries around the world. Whereas the giant U.S. tech companies are prime examples of driving radical innovation processes, they are not alone in leveraging a research network within their firm that spans the globe. In a globalized world, with a multitude of different national innovation systems, each with its

strengths and weaknesses, R&D is conducted across borders, with MNEs from a wide range of industries playing an integral role in these processes. MNEs organize cross-border knowledge flows through a variety of activities, such as trade, cross-patenting, or engaging in international scientific and technological cooperation (Narula and Zanfei 2009), by international R&D alliances, for example (Carlsson 2006).

Whereas a substantial body of research studied the relationship between internationalization and performance (e.g., Berry and Kaul 2016; Contractor et al. 2003; Lu and Beamish 2004; Hitt et al. 1997), research on the link between firm internationalization and firm innovation is comparatively small. In this stream of research, various studies argue for a positive relationship between firm internationalization and firm innovation and utilize the resource-based view, knowledge-based view, or an organizational learning perspective (Ding et al. 2021). According to the resource-based view, for example, international firms enjoy an advantage by having access to resources, markets, and knowledge (Tseng et al. 2007). Scholars adherent to the organizational learning perspective put the learning by exporting (LBE) effect to the forefront and contend that firms that are present in foreign markets gather a diverse set of experiences that they can utilize for strategic adjustments and realignment of their products and services (Salomon and Jin 2008, 2010). Internationalization, however, may also reduce the effectiveness of innovation activities by adding complexity and coordination challenges to the process.

We take those different theoretical lines of argument on the relationship between internationalization and innovation as our starting point and revisit this relationship by using a novel method, which enables us to create a text-based measure of internationalization at the firm strategy level (Schäper et al. 2023). We contend that the effect of internationalization on innovation can be characterized by diminishing marginal returns and increasing marginal costs. This trade-off leads to a relationship in which the internationalization strategy first increases innovation performance, but then decreases innovation performance after reaching a maximum value. We, therefore, argue that the relationship between internationalization strategy and innovation performance is inverse U-shaped. Additionally, in the body of research analyzing internationalization empirically, the independent variable is usually measured by using either the firm's share of foreign sales (Tallman and Li 1996) or geographical scope, measured as the number of countries a firm has establishments (Berry and Kaul 2016; Morck and Yeung 1991). Those traditional metrics are useful in measuring specific aspects of a firm's strategy, such as its orientation toward exports, or the historically grown international orientation of the company. However, we provide a text-based measure that reflects international strategy from a more comprehensive and forward-looking perspective.

To create our text-based measure, we employ a machine-learning technique to create a dictionary on internationalization based on the 1,000 most-cited papers addressing firm internationalization in the domain of international business and global strategy. We then apply the dictionary to companies' 10-K annual reports to provide a measure that captures the degree to which internationalization topics are prevalent in corporate strategy. Subsequently, we combine archival accounting data from CRSP/Compustat to create a large longitudinal data set. Finally, we regress our internationalization measure on innovation performance to investigate how internationalization strategy drives innovation performance. Our results provide evidence for an inverse U-shape relationship between internationalization strategy and innovation performance. Thus, the empirical findings of our approach support our arguments and hypothesis. The empirical tests we employ show that the results cannot be ascribed to spurious correlation patterns.

Our work contributes to the literature on internationalization and innovation (Salomon and Jin 2010; Tseng et al. 2007) in several ways. We show and validate the presence of the resulting inverted U relationship between internationalization strategy and innovation performance. This finding underscores the importance of balancing out the benefits of internationalization, such as access to resources, technologies, new ideas, and learning effects, with costs, such as complexity and coordination problems, for innovation activities. Moreover, we address specific calls for the use of novel methods in IB research with our empirical methodology, such as text-based analysis which allows researchers to advance theoretical understanding (Nielsen et al. 2020; Ramani and Aguinis 2023). As we use this novel method for measuring internationalization at the firm level, we demonstrate the power of this method to deepen our theoretical understanding of the firm in an international environment and avoid systematic biases in research.

## **Conceptual Background & Hypothesis**

Multiple different theoretical lenses have been used to explain the effect of firm internationalization on innovation, such as the resource-based view, the knowledge-based view, the dynamic capabilities view, network theory, or organizational learning (Ding et al. 2021). The resource-based view puts special emphasis on the larger base of resources that comes with a more international firm (Prange and Pinho 2017; Tseng et al. 2007). In contrast, the knowledge-based view accentuates the role of the processes through which firms utilize resources. The dynamic capabilities view puts work routines and practices at the center stage (Ding et al. 2021). From those perspectives, internationalization is beneficial for innovation as being present in several countries enables firms to utilize a bigger variety of cultural perspectives and a broader set of knowledge (Beugelsdijk et al. 2018; Jiang et al. 2016). According to a network perspective a larger international network benefits firms' innovation processes as the firm has a larger set of diverse resources it can utilize. In addition, a larger network may help firms organize information flows more efficiently (Almeida and Phene 2004; Frenz and Ietto-Gillies 2009). From an organizational learning perspective, more international firms can accumulate more knowledge, through a so-called learning by exporting (LBE) effect. This effect describes the process of firms accumulating knowledge as they export to foreign countries which then enables them to gain from knowledge transfer (Salomon and Jin 2008, 2010). From those various perspectives, internationalization has a positive influence on firms' innovation activities, with arguably diminishing marginal returns such that the first steps of internationalization have a greater marginal benefit for innovation performance than later ones.

However, internationalization also comes with costs for innovation performance. MNEs face various barriers when they internationalize, such as cultural, geographical, or institutional distance (Beugelsdijk et al. 2018; Hutzschenreuter et al. 2016). Those distance concepts represent tangible barriers to the firm's innovation performance. For instance, it may very well be that research collaboration is hindered by different cultural attitudes toward the "right" way to do research or by the geographical distance between research subsidiaries and the time difference that comes along with those. Similarly, various institutional regulations represent barriers to research, as strict EU regulation on gene-modification of crops illustrates (Max-Planck-Gesellschaft 2019). In addition, managing research collaboration within a firm becomes more difficult with a larger international footprint, as coordination challenges increase with the added complexity (Rangan and Drummond 2011; Zeng et al. 2023). Furthermore, additional internationalization may lead firms to prioritize exploitation instead of exploration (Piao and Zajac 2016) in the R&D process, leading to a diversion of resources away from innovation activities which would come with substantial innovative gains. Instead, firms may allocate R&D spending towards research projects with only incremental innovation value, such as adjusting a product to a local market. We contend that the costs are of a convex nature, such that they marginally increase with a higher level of firm internationalization.

We take those perspectives together and argue that the relationship between internationalization strategy is characterized by an inverse U-shape relationship. We contend that the benefits of firm internationalization for firm innovation performance are characterized by diminishing marginal returns, such that a firm's initial steps of internationalization have a greater impact on firm innovation than later ones. Similarly, the costs of internationalization for innovation performance are convex, so that the adverse marginal effects of firm internationalization on innovation performance increase with a firm's level of internationalization. Taking those perspectives together, we assert that first, with an increasing level of internationalization, the benefits dominate the costs until benefits and costs are equalized. Then, the adverse effects dominate the benefits. Those two latent processes together result in an inverted U-shape relationship (Haans et al. 2016). Formally:

*Hypothesis:* The relationship between internationalization strategy and innovation performance takes the functional form of an inverted U.

## **Empirical Methodology**

In this section, we introduce our empirical methodology. We outline our approach for retrieving a text-based measure that quantifies firms' internationalization strategies, how we constructed our final sample and variables. Finally, we elucidate the regression model employed.

### Text-based Measure for Internationalization Strategy

This section focuses on the development of our measure of internationalization strategy. We followed the methodology of Schäper et al. (2023) and derived the measure by applying a two-step content analysis which makes a systematic analysis of text data possible (Hoberg and Lewis 2017). The method is based on two main components. The first component is a dictionary which covers the common topics and themes within a body of text. The second component is an algorithm that applies this dictionary to textual data and analyzes the prevalence of occurrence of those identified themes.

Topic	Example Keywords	Topic	Example Keywords
<b>Export, Inter-National Sales and Trade</b>	Foreign Sales International Sales International Pricing International Earnings Export Export Performance International Export International Import International Trade Foreign Trade Overseas Trade Global Trade	<b>Inter-Nationalization and Diversification</b>	Geographic Diversification Expansion International Expansion International Operations International Activities Internationalization Knowledge Development Market Knowledge
	<b>Emerging &amp; Developing Economies</b>		Emerging Economy Emerging Market Emerging Country Developing Economy Developing Market
<b>Top Management Team &amp; Decision Making</b>		International Directors International Top Management Team International Experience Team Internationalization Global Officer Tmt International Experience International Alliance	<b>MNCs and Born Goals</b>
<b>Joint Ventures, Wholly Owned Subsidiaries, Knowledge Transfer</b>	International Partnership International Joint Venture International Alliance Subsidiary Regional Headquarter Foreign Subsidiaries	<b>Transaction Costs, Supply Chain and Outsourcing</b>	Outsourcing Offshoring Offshore Outsourcing Transaction Cost Supply Chain

**Table 1. Internationalization dictionary**

We developed the dictionary on internationalization by analyzing the 1,000 most-cited papers addressing firm internationalization in the domain of international business and global strategy. We followed previous research (Kim and Aguilera, 2016) and limited our search to the core international business and management journals<sup>1</sup>. We used the database *Web of Science* to compile our list of articles. Then, we employed an unsupervised topic modeling algorithm to identify the prevalent themes within all articles in our list. After cleaning and refining the keywords, we obtained our final internationalization dictionary, with 10 different topics and 161 different keywords. The dictionary with example topics and example keywords is presented in Table 1.

We then applied the dictionary to companies' 10-K annual reports. We obtained reports from the United States Securities and Exchange Commission (SEC) database for all years between 1999 through 2019. Approximately, the resulting database contained 245,000 reports of more than 40,000 publicly listed firms.

<sup>1</sup> *International Business Review (IBR), International Marketing Review (IMR), Journal of International Business Studies (JIBS), Journal of International Management (JIM), Journal of World Business (JWB), Multinational Business Review (MBR), Management International Review (MIR), Global Strategy Journal (GSJ), Academy of Management Review (AMR), Academy of Management Journal (AMJ), Administrative Science Quarterly (ASQ), Asia Pacific Journal of Management (APJM), British Journal of Management (BJM), Journal of Management (JOM), Journal of Management Studies (JOMS), Long Range Planning (LRP), Organization Science (OS), Strategic Management Journal (SMJ)*

We then applied the algorithm, which takes language specificities such as stemmed words or common stopwords into account, and calculated our internationalization strategy score. The final score is then determined as the ratio of common words between the dictionary and the 10-K filing to the total word count of the 10-K filing. Since the companies' reports are published on an annual basis, our obtained measure is available on the firm-year level.

### **Sample construction**

To investigate the relationship between internationalization strategy and innovation performance, we constructed our final sample by putting three databases together. For our dependent variable – firm innovation performance - we used U.S. patent data (Kogan et al. 2017). We then adjoined data from the CRSP/ Compustat merged database. This allows us to incorporate accounting data with common factors affecting firm performance in our analysis (Deb et al. 2017; Kim and Bettis 2014). Finally, we added our internationalization strategy score as our independent variable. Our final sample consists of 53,985 firm-year observations of more than 7,600 firms from various industries over the period from 1999 to 2019.

### **Variables**

*Dependent Variable.* We measured innovation performance by using the value of innovation measure, developed by Kogan et al. (2017). This metric captures a firm's value of innovation by dividing the sum of the firm's dollar values of patents - the stock market measure of innovation – by the firm's book assets. The firm's book assets serve as a proxy for the firm's size. Thus, by dividing these figures, the measure reflects the firm's scaled value of innovation. Consequently, the measure makes the innovation output of firms of different sizes comparable.

*Independent Variable.* The independent variable in our analysis is our measure of a firm's internationalization strategy. This variable captures internationalization strategy per year and reflects the ratio of words associated with internationalization (from our dictionary) to the overall word count of the analyzed text. We also incorporated the squared term of the independent variable to facilitate the examination of non-linear relationships.

*Control Variables.* Following established procedures in research (Deb et al. 2017; Kim and Bettis 2014), we included multiple control variables to take confounding effects into account. We included the log-transformed total sales to account for firm size, total sales growth as a proxy for firm growth, and the undistributed cash flow for slack resources (Kim and Bettis 2014). We also included the industry mean value of our dependent variable to account for industry-specific trends (the mean was calculated by using the four-digit SIC level). We further added research and advertising intensity as controls, calculated with expenditures scaled by assets (Hall 1992). Additionally, we followed previous research (Blagoeva et al. 2020; Himmelberg et al. 1999) and replaced missing values of R&D and advertising expenditures with zeros to prevent those observations from sample dropout, resulting in a bias toward R&D- and advertising-intensive firms. For those special cases, however, we also included two dummy variables that take the value 1 when there was initially a missing value for R&D expenditure or advertising expenditure, respectively. We also restricted R&D- and advertising intensity to a maximum value of one. Finally, we included year dummy variables to account for time-specific, unobserved effects.

### **Statistical Model**

Using our longitudinal data, we can leverage both variation within units and variation over time to account for the changes observed in our dependent variable (Wooldridge 2008). Thus, we employ a panel regression in which we regress our dependent variable, innovation performance, on our independent variable, the internationalization strategy measure and a set of controls. To identify whether a random or fixed effects model is better suited for our data we employ a Hausmann test (Hausman 1978). According to the test results, a fixed effects panel regression is more appropriate for our dataset. In addition, we checked with a modified Wald-test whether heteroskedasticity is present in our fixed effects model (Greene 2012). Based on the test results heteroskedasticity is present. Therefore, we employ a fixed effects panel regression with cluster-adjusted standard errors on the firm-level. A fixed effects panel regression analyzes the effect of internationalization strategy on innovation performance within units (firms) over time.

## Results

In Table 2, we report the descriptive statistics of our statistical analysis. The regression results of our statistical model are presented in Table 3. The coefficient of *Internationalization strategy*, our main independent variable, is positive and statistically significant at the 1% level ( $\beta = 0.041$ ;  $p = 0.005$ ). The coefficient of *Internationalization strategy squared* is negative and also significant at the 1% level ( $\beta = -0.026$ ;  $p = 0.005$ ). These findings indicate that the relationship between firm internationalization and firm innovation performance can be characterized by an inverse U-shape.

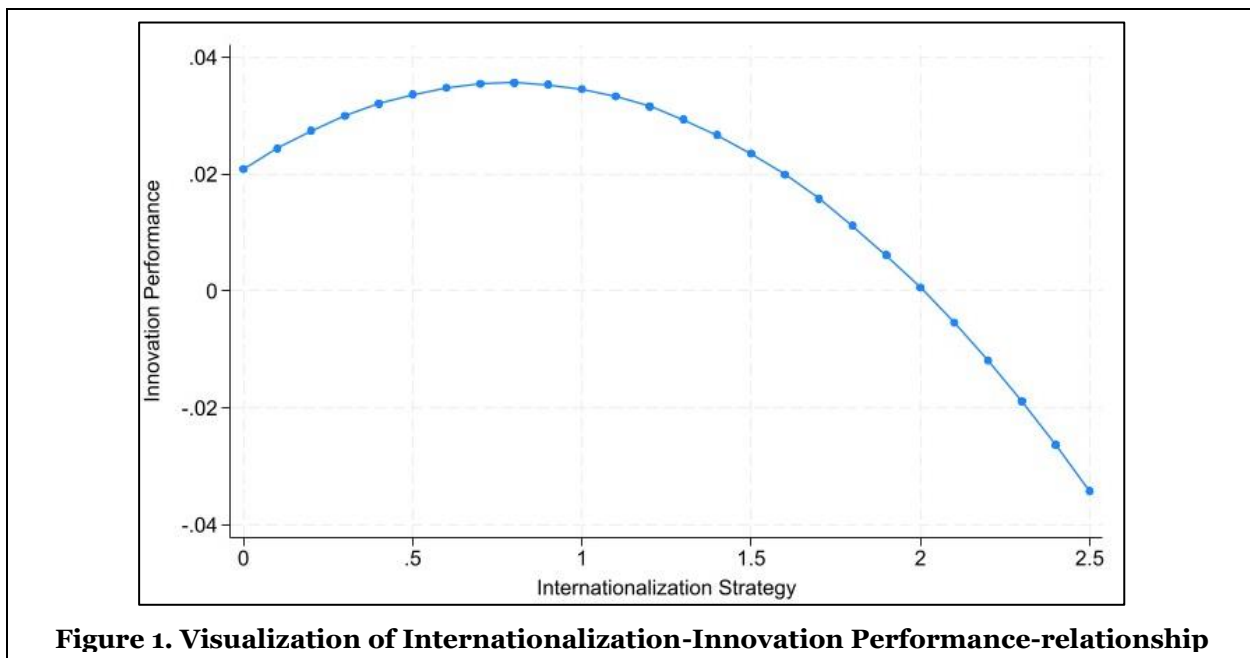
Variables	Mean	Std. dev.	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Innovation Performance	0.03	0.22	-								
2. Internationalization Strategy	0.47	0.25	0.047***	-							
3. Industry Innovation Performance	0.03	0.08	0.388***	0.135***	-						
4. Firm Size	5.87	2.10	0.050***	-0.003	-0.133***	-					
5. Firm Growth	0.04	1.14	-0.022***	-0.050***	-0.058***	0.229***	-				
6. Undistributed Cashflow	0.05	0.19	0.008*	0.012***	-0.042***	0.263***	-0.146***	-			
7. Advertising Intensity	0.01	0.03	0.014***	0.010**	0.007	0.005	0.000	-0.057***	-		
8. R&D Intensity	0.05	0.10	0.183***	0.008*	0.318***	-0.275***	-0.032***	-0.304***	0.035***	-	
9. Missing Advertising Expenditures	0.64	0.48	-0.014***	0.025***	0.004	-0.035***	-0.032***	0.006	-0.514***	-0.040***	-
10. Missing R&D Expenditures	0.47	0.50	-0.126***	-0.025***	-0.252	0.093***	-0.009**	0.056***	-0.075***	-0.412***	0.205***

**Table 2. Descriptive Statistics**

We followed the suggestions of established research (Haans et al. 2016) and conducted subsequent additional tests to reinforce our argument of an inverted U relationship between the variables of *Internationalization strategy* and *Innovation performance*. The result of the u-test (p-value of less than 0.01) indicated that the relationship is monotonic and positive before it reaches the maximum, after which the slope of the curve becomes negative. Likewise, we tested for an S-shaped relationship (Haans et al. 2016) by using a regression with an additional cubic term of *Internationalization strategy*. Both the squared and cubic term became insignificant. Taken together, the results strongly suggest the presence of an inverted U relationship that is very unlikely a product of chance. This is additionally reinforced by the visual representation of the estimated values, presented in Figure 1, which displays the typical form of an inverted U. The figure illustrates that the optimal level for innovation performance is found in firms where a little less than 1% of the words in the 10-K report are related to internationalization.

Dependent Variable	Innovation Performance		
	$\beta$	SE	p
<i>Controls</i>			
Industry Innovation Performance	1.263	0.204	0.000
Firm Size	-0.001	0.003	0.800
Firm Growth	-0.001	0.001	0.334
Undistributed Cashflow	0.006	0.007	0.389
R&D Intensity	-0.002	0.097	0.981
Missing R&D Expenditures	-0.010	0.005	0.058
Advertising Intensity	0.012	0.129	0.926
Missing Advertising Expenditures	-0.003	0.010	0.761
<i>Explanatory</i>			
Internationalization Strategy	0.041	0.015	0.005
Internationalization Strategy squared	-0.026	0.009	0.005
<i>Intercept</i>			
	0.014	0.024	0.550
Firm-fixed effects		Yes	
Year-fixed effects		Yes	
R-squared		0.15	
N		53,985	

**Table 3. Regression results**



**Figure 1. Visualization of Internationalization-Innovation Performance-relationship**

## Conclusion

In this study, we investigated the relationship between a firm's internationalization strategy and innovation performance. Based on theory and established evidence, we hypothesized an inverse U-shape due to concave benefits and convex costs. To test our conjecture, we developed a measure of internationalization strategy by using and applying a machine learning algorithm and derived a text-based measure that quantifies the degree of firms' internationalization strategy. We used this measure in conjunction with other firm-level data and statistically examined its impact on firms' innovation performance. The results confirm our hypothesis of an inverted U-shape.



Our study contributes to the literature on internationalization and innovation (Frenz and Ietto-Gillies 2009; Salomon and Jin 2010; Tseng et al. 2007) as we provide empirical support for an inverted U-shape between those constructs. Our findings suggest a trade-off between innovation gains through learning effects, access to new ideas, resources, technologies, and economies of scale, and additional costs from increased complexity and coordination problems as well as from institutional, cultural, and geographical distance. Our analysis suggests that from a managerial standpoint, it makes sense for managers to look for the right spot where internationalization strategy maximizes innovation performance.

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