

Exercise 2  
**The Effect of Technological Diversification to Firm’s Innovation Performance: Empirical Study on French Companies**

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**Contents**

[Abstract 3](#_Toc68091677)

[1. Introduction 3](#_Toc68091678)

[2. Literature Review and Hypothesis Development 4](#_Toc68091679)

[2.1 Technological Diversification and firm’s Innovation Performance 4](#_Toc68091680)

[2.2 Absorptive Capacity 5](#_Toc68091681)

[2.3 Environmental Dynamism 6](#_Toc68091682)

[3. Method and Variables 7](#_Toc68091683)

[3.1 Data and Sample 7](#_Toc68091684)

[3.2 Variables and Measures 8](#_Toc68091685)

[3.2.1 Technological diversification 8](#_Toc68091686)

[3.2.2 Absorptive capacity 8](#_Toc68091687)

[3.2.3 Environmental dynamism 8](#_Toc68091688)

[3.2.4 Innovation Performance (Patent Value) 8](#_Toc68091689)

[4. Result 8](#_Toc68091690)

[5. Conclusion 13](#_Toc68091691)

[References 13](#_Toc68091692)

# **Abstract**

From the previous literature review, we discussed how firms’ performance is facilitated by technological diversification and geographical dispersion. We then determined that firms’ innovation performance and technological diversification is bolstered by internal and external factors — absorptive capacity and environmental dynamism. Through this study, we were also inspired to reinvestigate whether technological diversification has a positive and significant effect on firms' innovation performance by doing an empirical study based on French companies data from 2010 to 2012. Our study is aiming to observe and track the interaction between technological diversification and innovation performance, and to what extent can it be positively correlated with absorptive capacity and environmental dynamism.

Keywords: Technological diversification, innovation performance, absorptive capacity, environmental dynamism

# **Introduction**

Our current economy is going fast and becoming more dynamic. Firms need to be more resilient and push them to innovate and innovate even more. The integration of knowledge sources, both internal and external facilitates technological diversification. Technological diversification and geographical dispersion strategy are important in order to boost a firm’s research and development as well as innovation investment and innovation performance. Some studies proved that technological diversification has positive and significant effects on firms innovation performance.

Technological diversification and geographical dispersion are important strategies in order to boost a firm’s effort to survive in a competitive market. Technological diversification is widely considered as a vehicle of firms’ growth (Lin & Chang, 2012) as well as on innovation performance. The technological capabilities of a company are also interpreted as the foundations of the sustainable competitiveness of a company, since they are considered as a strategic value in modern business as well as to improve firm’s innovation performance. Companies could not depend solely on the strength of their existing core technological skills. To survive in the long term and be profitable in the years ahead, companies must continually explore and exploit exciting and innovative technologies at a faster pace and at lower costs than their competitors. A firm’s size is prone to impact its ability to conduct diversified technological undertakings (Lin & Chang, 2012), and smaller firms are more likely to carry negative aspects in this regard, like structural divisibility and the lack of certain resources internally. In our analysis, our study will not focus or be limited to larger firms, but specifically French owned or France based. The first aim of this study is thus technological diversification has positive and significant effects on firms innovation performance.

According to Chiu et al. (2008) studies, their findings proved that complementary assets have a positive effect on technological diversification. Technology diversification offers stakeholders with a wide range of technology possibilities that cannot only be used to gain entry to different markets or new technology domains, but also to enable the development and capabilities to improve the current products by assimilating different technologies, through internal and external R&D strategy. Precisely, a given firm’s own skills and competences likely moderate, positively or negatively, a firm’s performance when undertaking technological diversification. However, from the various existing capabilities specific to a firm's organizational structure, its absorptive capacity is a crucial capability to ensure a successful knowledge and later technology integration. Thereby, our second aim of this study is to see the interaction effect on technological diversification and absorptive capacity.

In addition to firm’s capabilities to absorb and knowledge integration, an external environment may also enhance and accelerate firms’ capabilities to diversify their portfolios and to adapt with our fast changing and dynamic environment. As Lin and Chang (2012) asserts, firms relying on external collaboration will see benefits from a large technology base elsewhere, which will in turn provide opportunities to integrate and combine sources of knowledge from various fields, hence enabling innovative products and services creation. Through external collaboration firms will be able to access external knowledge and integration to boost company performance. Other limitations of collaboration may also increase the cost of technological and organization integration of new knowledge as new knowledge requires changes in network relation. Lastly, our third aim is to see the effect of interaction between technological diversification and environmental dynamism.

# **Literature Review and Hypothesis Development**

## **2.1 Technological Diversification and firm’s Innovation Performance**

From the previous literature review, we concluded that firms’ performance and technological diversification is consequently reinforced by firms’ internal and external factors. We have also established that technological diversification can be understood as a key driver for firms’ growth – also called organizational growth. That diversification itself refers to an extension in both the quantitative and diversity factors in technologies that firms would rely on. In addition, diversification can be measured not only by the number of industries in which a firm is active, but also by the distribution of the firm's productive activity among those industries (Berry, 1975).

This argument can be supported because a broad technology base will enable firms to integrate and recombine knowledge inputs originating from various sources and domains, which in turn will facilitate the creation of knowledge-intense innovative products (Breschi et. al 2003). However, this reliance on multiple sources, as well as firms spread regarding their technology base, may bring challenges in terms of incurred costs for the firm. Indeed, because of such a spreaded dependency, firms will be bound by coordination, integration and communication efforts, which will result in additional expenditure. What is more, for specialised investments in niche market technologies, those extra costs will result in the firm failing to achieve economies of scale levels (Leten et. al 2007).

In order to tackle the increasing complexity of technological innovations, some have argued for the merging and integration of various types of knowledge, to shorten product life cycles, and for the expansion of technology options. This in turn will consequently result in increased demand for diversified technology portfolios (Subramaniam, 2005). Furthermore, as there are more and more technology intensive industries, we can add that firms size matters. Precisely, large firms will have more capabilities and organisation skills to launch and develop diversified technological projects, whereas smaller firms will lack the internal resources and structures for such an undertaking. This justifies our special interest to focus on large firms. However, in this case for France we are not limiting our scope to only large corporations.

Several studies on the factors explaining firm’s performance show that successfully operating firms have improved skills to identify, bolster and take advantage of the core assets that fuel and cultivate sustainable competitive advantages in the market (Cohen et. al 1990; Chang et. al 2010). Therefore, we can assume here that a firm’s internal capabilities and skillset possibility moderate positively the performance effect of technological diversification. Thus, we can conclude that building a diversified technological portfolio provides firms with more opportunities for combining and recombining their existing technological capabilities, and thus reduces the threats from an ever-changing environment. But on the other side, one could argue that specialization enables firms to take advantage of the economies of scale that result from exploitation of existing technologies, with more reliable returns as well. Some would go so far as to say that technological specialization and diversification are incompatible.

However, collected evidence regarding advantages of a firm undergoing technological diversification is still conflicting. For this reason, some researchers believe that technological diversification is somewhat of a double-sword, and further propose that an inverted-U relationship exists between technological diversification and firm’s performance (Leten et. al, 2007). A potential reason for this conflicting relationship is that the firm's size was not taken into consideration; but even with this new criteria, there are differences of opinions. One side would argue that smaller firms have more advantages in technological innovation because of their flexibility and lack of inertial constraints whereas others suggest that larger firms are more effective in innovation because they have more resources and professional talents (McCutehen et. al, 1996).

Precisely, a firm's internal resources matter tremendously to enhance the effectiveness of technological diversification, by simultaneously managing multiple projects, requiring large resources, and skilled labor or organisation management skills that only large firms possess. Hence, we could conclude that the firm size could be one of the most important contextual factors which governs a firm’s technological diversification performance. Therefore, we can infer the following hypothesis:

*H1: Technological diversification has positively correlated with firm’s innovation performance.*

## **2.2 Absorptive Capacity**

A firm’s absorptive capacity is an organization's ability to recognize the value of external knowledge to evaluate emerging technology and to predict the future technological advances (Cohen et. al 1990). Consequently, how a firm identifies and manages its technological knowledge bases will be determined by its absorptive capacity (Janssen et. al 2005; Lane et. al 2006). It is crucial for a firm to recognize and understand potentially valuable new technologies, in order to fully exploit its assets and gain a competitive advantage through innovative performance. Firms which rely on absorptive capacity are more inclined to harvest the advantages from having a rich and diverse technological portfolio, while at the same time, enable them to reach higher performance levels. By doing so, firms can also stay aware of technological advancements and developments originating from beyond their core areas of operations. Consequently, firms can thereby decrease the risks of so-called ‘technological lock-in effects’, as it is not likely that the skills-destroying and business opportunity aspects from alternative technologies are overlooked.

To give an example of a firm that underwent that road, Samsung's performance in the smartphone sector in recent years, a propeller of its growth which was largely built on its rich technological portfolio of products, from semiconductors to digital and home appliances.  The synergy and complementarity of various technologies keep the company ahead of its rivals in the Android segment, while others like Nokia did not have such a diversified portfolio and in-house absorptive capacity that resulted in its downfall with the turn of the smartphone era.

Indeed, by relying on absorptive capacity, firms can broaden their knowledge base to further strengthen its assimilation and exploitation capabilities, thereby augmenting their ability to perform on technological domains (Pandza et. al 2007). Therefore, we can infer that there is no easy correlation between a technology portfolio’s size and the associated firm’s performance: it very much depends on the firm’s ability to identify beneficial and effective technological opportunities, and to then seek and capitalize on those value-adding assets.  Therefore, we can infer the following hypothesis:

*H2: The relationship between a firm's technological diversification and its innovation performance can be positively moderated by absorptive capacity.*

## **2.3 Environmental Dynamism**

Environmental dynamism is an important contextual factor in defining the drivers and boundaries limiting the advantages associated with firm-specific technological skills. It also defines the rate and instability of environmental change along two key concepts. The first one refers to the variance in the rate of technological change, which itself is related to the unpredictability in technology outcomes in an industry. The second one refers to the market volatility across industries, which itself is linked to the volatility in customer demand for certain products. That is to say, when the environment becomes more dynamic and volatile, a particular technological solution may suffer from a significant depreciation in value.

Our era is showing more and more unstable and rapidly changing environments, where technologies can quickly become obsolete, hence hindering firms ability to assess the utility and effectiveness of current products or services. Such dynamic environments result in firms having to adapt rapidly and thereby diversify their portfolio to face that hostile external situation. Therefore we can conclude that environmental dynamism can be an important barrier factor for firm’s operations and performance overall.

Studies based on large technology-intense industries, have found that greater benefits from innovative products are linked to specialised innovation derived from a firm’s decision to focus on a unique field of knowledge. However, that correlation between firm-specific innovations and its derived value-adding returns, tend to be negatively moderated when that firm is operating in a highly dynamic environment. Similar studies have also argued that, under dynamic environment conditions, diversification of knowledge portfolio is a relevant mitigating step for firms to hedge the risks associated with value erosion around firm-specific innovations (Wang & Chen, 2010).

A firm’s operational environment and its business surroundings has a direct effect on the value of its internal resources and skill sets, which includes innovation-led knowledge sources (Barney, 2001). Firms’ direct environmental dynamism is thus a crucial element to consider in the analysis of innovation developments and value appropriation, in addition to the importance of the boundary settings definition which itself can hinder the benefits related to firm-specific innovations (Sirmon et al., 2007).

It has been long established that technological progress can result both in the destruction of certain skills and in the improvement of existing ones, that factor is more likely to result in skills destruction for firms engaging in specific internal innovations. Indeed, it can be challenging for those firms to identify alternative routes of development and applications for those innovations being built internally. Therefore, one can argue that when the environment setting of a firm-specific innovation development is occurring, this can derive into a value depreciation of the resulting innovation. The main factor behind that matter is that because of the rapid diffusion of innovation knowledge due to the globalisation technological progress, added to the threat of innovation reproduction by competitors, the value generated from a firm’s innovations is prone to expropriation by less innovative rivals. (Liebeskind, 1996).

Studies have established that firm-specificity in the creation of innovation augments its value appropriability, which encompasses the environmental factors that govern an innovator's ability to capture profits generated by an innovation. Environmental dynamism in itself creates more risks for firm-specific innovations value, because of its negative correlation with firm-specific innovations, a changing environment surrounding it, and overall lack of adaptability of firms engaged in firm-specific innovations (Ghemawat and Del-Sol, 1998). In addition, a firm with a more diversified technological portfolio is better equipped to hedge those risks associated with firm-specific innovations, while diversification enables its adaptability to recombine knowledge from diverse sources, and multiply alternative designs options (Fleming and Sorenson, 2001). Hence, Wang & Chen (2010) argue that technological diversity mitigates the negative effect of environmental dynamism on the relationship between firm specificity in innovations and firm performance. Therefore, we can infer the following hypothesis:

*H3: The relationship between a firm's technological diversification and firm’s innovation performance can be positively moderated by environmental dynamism.*

# **3. Method and Variables**

## **3.1 Data and Sample**

Inspired by the empirical study of Lin and Chang (2012) on the study of S&P 500 manufacturing firms, it has been proven that technological diversification has an effect on firms' innovative performance, which itself is driven by internal and external factors - absorptive capacity and environmental dynamism, respectively. This study is aiming to examine the hypothesis mentioned above using samples of various manufacturing industries in France, operating all over Europe as well, for a total number of locations reaching 4,925. Additionally, this data is using the *OECD REGPAT Database March 2018* and *JRC-OECD COR&DIP©Database, v.1 2017* from 2010 to 2012 in order to measure firm’s innovation performance and technological diversification using patent portfolio, financial, and industry category data. We are using a sample of around 66 French companies.

## **3.2 Variables and Measures**

### **3.2.1 Technological diversification**

To measure technological diversification, we adopt the common measure degree of diversification using Herfindahl index (Berry, 1975) as follows: Technological diversification = 1 - Herfindahl index = 1 – ∑i p2 i. Where *Pi* represents the proportion of a firm's patent portfolio in the technological field *i*.

### **3.2.2 Absorptive capacity**

The literature proposes several different measures of absorptive capacity, as Cohen et al (1990) studies, established that absorptive capacity can be defined by a firm’s capacity to appreciate and integrate information contents, which are in return essential to spur innovation performance. We will hereby measure absorptive capacity by R&D intensity. To build this variable, therefore, we used the firm's R&D investment divided by sales using financial data of the companies as it is also present in Lin and Chang (2012) studies.

### **3.2.3 Environmental dynamism**

As an example, in one of the studies, environmental dynamism defines the rate and instability of environmental change along with two concepts: (1) the variance in the rate of technological change, which is related to the unpredictability in technology outcomes in an industry, (2) the market volatility across industries, which is linked to the volatility in customer demand for certain products. In order to measure environmental dynamism, we group company data with the industry codes using NACE2 variables then we group by industry and compute industry-level R&D.

### **3.2.4 Innovation Performance (Patent Value)**

As a dependent variable, we can argue that technological diversification has a direct impact on firms’ other performance indicators (Quintana-Garcia et. al, 2008). In other words, we can infer that a firm’s technologically-diversified portfolio’s value can be indicated by the level of its innovation performance, as described with the above variable. In addition, our argument here relied on Levitas and Mcfadyen (2009) assessment of patent values to determine the firm’s innovation performance. Thus, to measure innovation performance of the firms, we first counted the number of times each of a firm's patents, issued during the period 2010 to 2012, we counted 66 French companies. We sum the number of patents (Patent\_appln\_id) for each company name in the accumulated year, in the regression we introduce log of this variable *+ 1* because it has wide heterogeneity.

# **4. Result**

Linear regression was used to test our hypothesis 1 on the effect of technological diversification on firm’s innovation performance. Our results of the regression analysis for innovation performance are shown in our Model 3, which we include two control variables and we also introduce a dummy of company name, prior year and number of locations to control the heterogeneity. In support of our hypothesis 1, Model 3 is showing the coefficient of technological diversification has positively correlated with innovation performance (β = 1.627; p < 0.001) in support of hypothesis 1. However, the possible impacts of quadratic designation had to be examined, as the inverted-U shaped link was not evident in our research context, which then supports our findings from using hypothesis 1.

Our hypothesis 2 proposed the relationship between a firm's technological diversification and its innovation performance can be positively moderated by absorptive capacity. Hence we can argue that firms relying strongly on absorptive capacity will witness a deeper link between innovation performance and technological diversification. From our Model 5 result, the interaction between technological diversification and absorptive capacity are positively correlated to firm’s innovation performance (β = 4.031), showing that innovation performance is moderate by absorptive capacity. Meanwhile, in our Model 4, the coefficient of interaction between technological diversification and absorptive capacity is negative when we regress using control variables such as locations and dummies variables, that being said there is a possibility for a negative correlation finding under certain conditions.

Moreover, hypothesis 3 assessed the relationship between firm's technological diversification and firm’s innovation performance can be positively moderated by environmental dynamism. As shown in our Model 6 and Model 7, the coefficients of the terms presenting the interaction effect between technological diversification and environmental dynamism are negatively correlated (Model 6: β = -0.0004; Model 7: β = -0.002; p < 0.05). In order to justify our result, environmental dynamism could also risk the firms innovation value as the firms might lack adaptability and to engage with external parties.

In order to support our analysis, on the result of our last Model 8, we wanted to see the interaction between firm’s technological diversification and innovation performance can be positively related by geographical dispersion, identified by the number of locations where their presence. The coefficient on that term showing that the higher number of locations where the firms are present is positively correlated with firms innovation performance (Model 8: β = 0.001; p < 0.1). The more dispersed geographically, the higher degree of their innovation performance.

**Table 1. Summary statistic**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | |
| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|  | | | | | | | |
| Prio\_year | 173 | 2,010.908 | 0.794 | 2,010 | 2,010 | 2,012 | 2,012 |
| Technological\_diversification | 173 | 0.236 | 0.220 | 0.027 | 0.087 | 0.312 | 1.000 |
| Absorptive\_Capacity | 168 | 0.053 | 0.060 | 0.0004 | 0.012 | 0.060 | 0.298 |
| Innovation\_Performance | 173 | 58.486 | 97.462 | 1 | 5 | 52 | 535 |
| Environmental\_Dynamism | 173 | 436.311 | 782.261 | 13.000 | 47.438 | 527.000 | 4,909.000 |
| Locations | 173 | 479.902 | 849.361 | 1 | 34 | 354 | 4,925 |

**Table 2. Regression result**

The effect of technological diversification on firm’s innovation performance.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | |
|  | Dependent variable: | | | | | | | |
|  |  | | | | | | | |
|  | Innovation\_Performance | | | | | | | |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|  | | | | | | | | |
| Technological Diversification | 1.633\*\*\* |  | 1.627\*\*\* | 1.981\*\*\* | -6.122\*\*\* | 1.729\*\*\* | -4.599\*\*\* | 0.997\*\*\* |
|  | (0.312) |  | (0.326) | (0.378) | (0.815) | (0.325) | (0.618) | (0.322) |
|  |  |  |  |  |  |  |  |  |
| Technological Diversification 2 |  | 1.865\*\*\* |  |  |  |  |  |  |
|  |  | (0.374) |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| Locations |  |  |  |  |  |  |  | 0.0002\*\* |
|  |  |  |  |  |  |  |  | (0.0001) |
|  |  |  |  |  |  |  |  |  |
| Absorptive Capacity |  |  | 0.011 | 2.080 | 1.522 |  |  | -1.261 |
|  |  |  | (3.974) | (4.121) | (3.198) |  |  | (3.610) |
|  |  |  |  |  |  |  |  |  |
| Environmental Dynamism |  |  | -0.0002 |  |  | -0.0002 | 0.001\*\*\* | 0.0004 |
|  |  |  | (0.0005) |  |  | (0.0005) | (0.0002) | (0.0005) |
|  |  |  |  |  |  |  |  |  |
| log(Locations) | 0.788\*\*\* | 0.756\*\*\* | 0.788\*\*\* | 0.793\*\*\* |  | 0.774\*\*\* |  | 0.679\*\*\* |
|  | (0.038) | (0.035) | (0.040) | (0.040) |  | (0.039) |  | (0.043) |
|  |  |  |  |  |  |  |  |  |
| factor(Prio\_year)2011 | 0.0003 | 0.0004 | 0.010 | 0.006 |  | -0.004 |  | 0.033 |
|  | (0.055) | (0.055) | (0.059) | (0.057) |  | (0.056) |  | (0.053) |
|  |  |  |  |  |  |  |  |  |
| factor(Prio\_year)2012 | -0.095 | -0.094 | -0.076 | -0.100 |  | -0.100 |  | -0.033 |
|  | (0.079) | (0.080) | (0.086) | (0.085) |  | (0.081) |  | (0.080) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)AKKA TECHNOLOGIES | 0.335 | 0.200 | 0.331 | 0.389 |  | 0.346 |  | 0.448 |
|  | (0.357) | (0.362) | (0.471) | (0.460) |  | (0.357) |  | (0.427) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)ALCATEL-LUCENT | 1.061\*\*\* | 1.060\*\*\* | 1.659 | 0.936 |  | 1.757 |  | -0.169 |
|  | (0.377) | (0.381) | (1.264) | (0.686) |  | (1.193) |  | (1.212) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)ALSTOM | 1.108\*\*\* | 0.983\*\*\* | 1.302\*\* | 1.130\*\*\* |  | 1.365\*\*\* |  | 0.823\* |
|  | (0.357) | (0.359) | (0.532) | (0.376) |  | (0.519) |  | (0.492) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)AREVA | 1.200\*\*\* | 1.091\*\*\* | 1.287\*\*\* | 1.199\*\*\* |  | 1.398\*\*\* |  | 0.626 |
|  | (0.389) | (0.395) | (0.450) | (0.411) |  | (0.437) |  | (0.456) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)ARKEMA | 0.660\* | 0.548 | 0.673\* | 0.707\* |  | 0.758\*\* |  | 0.562\* |
|  | (0.356) | (0.359) | (0.369) | (0.364) |  | (0.363) |  | (0.335) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)BIC | -0.276 | -0.325 | -0.287 | -0.277 |  | -0.258 |  | -0.201 |
|  | (0.342) | (0.346) | (0.351) | (0.347) |  | (0.343) |  | (0.318) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)BIOMERIEUX | 0.297 | 0.252 |  |  |  | 0.396 |  |  |
|  | (0.348) | (0.351) |  |  |  | (0.358) |  |  |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)BOLLORE | 0.652\* | 0.540 | 0.655\* | 0.656\* |  | 0.673\*\* |  | 0.552\* |
|  | (0.337) | (0.341) | (0.346) | (0.342) |  | (0.338) |  | (0.314) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)BOUYGUES | 0.955\*\*\* | 0.827\*\* | 0.964\*\*\* | 1.030\*\*\* |  | 1.021\*\*\* |  | 0.844\*\* |
|  | (0.346) | (0.346) | (0.359) | (0.356) |  | (0.349) |  | (0.325) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)BURELLE | 0.232 | 0.172 | 0.244 | 0.262 |  | 0.318 |  | 0.265 |
|  | (0.351) | (0.354) | (0.367) | (0.362) |  | (0.356) |  | (0.332) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)CGGVERITAS | 0.832\*\* | 0.884\*\* | 0.835\*\* | 0.830\*\* |  | 0.876\*\* |  | 0.994\*\*\* |
|  | (0.350) | (0.352) | (0.366) | (0.361) |  | (0.351) |  | (0.332) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)CHRISTIAN DIOR | 0.852\*\* | 0.840\*\* | 0.847\*\* | 0.856\*\* |  | 0.865\*\* |  | 0.766\*\* |
|  | (0.414) | (0.418) | (0.426) | (0.420) |  | (0.414) |  | (0.385) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)DANONE | -0.165 | -0.149 | -0.127 | -0.141 |  | -0.047 |  | -0.190 |
|  | (0.354) | (0.358) | (0.378) | (0.361) |  | (0.369) |  | (0.342) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)DASSAULT AVIATION | 0.941\*\*\* | 0.814\*\* | 0.989\*\* | 0.929\*\* |  | 1.042\*\*\* |  | 0.841\*\* |
|  | (0.345) | (0.346) | (0.426) | (0.418) |  | (0.361) |  | (0.387) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)DASSAULT SYSTEMES | 0.824\*\* | 0.858\*\* | 0.887 | 0.836 |  | 0.962\*\* |  | 1.011 |
|  | (0.348) | (0.351) | (0.763) | (0.754) |  | (0.376) |  | (0.692) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)ELECTRICITE DE FRANCE | 0.703\*\* | 0.533 | 0.808\* | 0.787\*\* |  | 0.871\*\* |  | 0.490 |
|  | (0.353) | (0.355) | (0.428) | (0.364) |  | (0.411) |  | (0.392) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)ERAMET | -0.582 | -0.615 | -0.589 | -0.548 |  | -0.534 |  | -0.575 |
|  | (0.419) | (0.422) | (0.430) | (0.425) |  | (0.420) |  | (0.388) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)ESSILOR INTERNATIONAL | 0.296 | 0.198 | 0.312 | 0.324 |  | 0.368 |  | 0.251 |
|  | (0.344) | (0.346) | (0.361) | (0.356) |  | (0.348) |  | (0.327) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)FINATIS | -1.248\*\*\* | -1.231\*\*\* | -1.258\*\*\* | -1.227\*\*\* |  | -1.214\*\*\* |  | -1.171\*\*\* |
|  | (0.361) | (0.365) | (0.375) | (0.371) |  | (0.363) |  | (0.339) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)FIVES | 0.826\*\* | 0.710\*\* | 0.812\*\* | 0.878\*\* |  | 0.855\*\* |  | 0.736\*\* |
|  | (0.343) | (0.343) | (0.352) | (0.349) |  | (0.344) |  | (0.319) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)FRANCE TELECOM | 0.968\*\*\* | 0.941\*\*\* | 1.150\*\* | 1.003\*\*\* |  | 1.238\*\* |  | 0.648 |
|  | (0.352) | (0.355) | (0.519) | (0.358) |  | (0.502) |  | (0.481) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)GDF SUEZ | 0.686\*\* | 0.549 | 0.723\* | 0.760\*\* |  | 0.780\*\* |  | 0.532 |
|  | (0.346) | (0.347) | (0.369) | (0.357) |  | (0.357) |  | (0.336) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)GROUPE SEB | 0.974\*\*\* | 1.003\*\*\* | 0.971\*\* | 0.999\*\*\* |  | 1.057\*\*\* |  | 1.058\*\*\* |
|  | (0.363) | (0.366) | (0.374) | (0.370) |  | (0.368) |  | (0.339) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)GUERBET | -0.869\*\* | -0.957\*\* | -0.868 | -0.739 |  | -0.876\*\* |  | -0.490 |
|  | (0.427) | (0.437) | (0.539) | (0.533) |  | (0.427) |  | (0.494) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)INGENICO | 0.594\* | 0.512 | 0.596 | 0.576 |  | 0.654\* |  | 0.635 |
|  | (0.345) | (0.347) | (0.457) | (0.449) |  | (0.347) |  | (0.413) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)INSIDE SECURE | 0.572\* | 0.540 | 0.558 | 0.566 |  | 0.603\* |  | 0.946 |
|  | (0.342) | (0.345) | (1.121) | (1.080) |  | (0.343) |  | (1.019) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)IPSEN | -0.700\* | -0.642\* | -0.666 | -0.645 |  | -0.603 |  | -0.423 |
|  | (0.366) | (0.368) | (0.744) | (0.732) |  | (0.377) |  | (0.678) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)L'AIR LIQUIDE | 0.777\*\* | 0.621 | 0.802\*\* | 0.850\*\* |  | 0.906\*\* |  | 0.714\*\* |
|  | (0.370) | (0.374) | (0.389) | (0.380) |  | (0.382) |  | (0.355) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)L'OREAL | 0.259 | 0.360 | 0.412 | 0.261 |  | 0.538 |  | -0.260 |
|  | (0.395) | (0.396) | (0.514) | (0.406) |  | (0.507) |  | (0.504) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)LAFARGE | 0.152 | 0.131 | 0.172 | 0.190 |  | 0.243 |  | 0.192 |
|  | (0.368) | (0.371) | (0.383) | (0.375) |  | (0.374) |  | (0.346) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)LATECOERE | 0.487 | 0.476 | 0.478 | 0.505 |  | 0.508 |  | 0.509 |
|  | (0.415) | (0.419) | (0.475) | (0.466) |  | (0.416) |  | (0.430) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)LEGRAND | 1.072\*\*\* | 1.009\*\*\* | 1.100\*\*\* | 1.092\*\*\* |  | 1.169\*\*\* |  | 1.074\*\*\* |
|  | (0.348) | (0.351) | (0.378) | (0.372) |  | (0.357) |  | (0.342) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)LFB | 0.359 | 0.336 | 0.362 | 0.308 |  | 0.413 |  | 0.593 |
|  | (0.361) | (0.364) | (0.765) | (0.747) |  | (0.363) |  | (0.695) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)LISI | 0.816\*\* | 0.765\*\* | 0.803\*\* | 0.843\*\* |  | 0.833\*\* |  | 0.774\*\* |
|  | (0.339) | (0.342) | (0.350) | (0.345) |  | (0.340) |  | (0.317) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)LVMH | 0.188 | 0.086 | 0.185 | 0.200 |  | 0.227 |  | 0.215 |
|  | (0.342) | (0.347) | (0.355) | (0.351) |  | (0.343) |  | (0.321) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)MGI COUTIER | 0.788\*\* | 0.660\* | 0.782\* | 0.812\*\* |  | 0.786\*\* |  | 0.829\*\* |
|  | (0.356) | (0.361) | (0.396) | (0.389) |  | (0.357) |  | (0.359) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)MICHELIN | 0.993\*\*\* | 0.953\*\*\* | 1.116\*\* | 1.023\*\*\* |  | 1.201\*\*\* |  | 0.678 |
|  | (0.354) | (0.358) | (0.443) | (0.363) |  | (0.434) |  | (0.411) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)NEOPOST | 1.114\*\*\* | 1.010\*\*\* | 1.106\*\*\* | 1.136\*\*\* |  | 1.165\*\*\* |  | 1.113\*\*\* |
|  | (0.345) | (0.347) | (0.379) | (0.372) |  | (0.348) |  | (0.342) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)NEXANS | 0.757\*\* | 0.697\* | 0.660 | 0.720\* |  | 0.846\*\* |  | 0.707\* |
|  | (0.360) | (0.364) | (0.400) | (0.397) |  | (0.366) |  | (0.361) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)NEXTER | 0.934\*\*\* | 0.856\*\* | 0.927\*\* | 0.933\*\* |  | 0.997\*\*\* |  | 1.016\*\*\* |
|  | (0.349) | (0.351) | (0.408) | (0.400) |  | (0.352) |  | (0.369) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)PARROT | 0.838\*\* | 0.686\* | 0.826 | 0.727 |  | 0.891\*\* |  | 0.948 |
|  | (0.347) | (0.348) | (0.637) | (0.624) |  | (0.350) |  | (0.577) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)PEUGEOT (PSA) | 1.348\*\*\* | 1.215\*\*\* | 1.939 | 1.364\*\*\* |  | 1.934 |  | 0.282 |
|  | (0.370) | (0.375) | (1.221) | (0.389) |  | (1.170) |  | (1.156) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)RENAULT | 0.970\*\*\* | 0.817\*\* | 1.414 | 0.983\*\*\* |  | 1.562\* |  | 0.203 |
|  | (0.350) | (0.356) | (0.939) | (0.373) |  | (0.915) |  | (0.886) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SAFRAN | 1.155\*\*\* | 1.035\*\*\* | 1.346\*\* | 1.123\*\* |  | 1.425\*\*\* |  | 0.745 |
|  | (0.374) | (0.379) | (0.557) | (0.430) |  | (0.531) |  | (0.519) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SAFT | -0.240 | -0.233 | -0.252 | -0.227 |  | -0.194 |  | -0.125 |
|  | (0.347) | (0.350) | (0.383) | (0.377) |  | (0.349) |  | (0.348) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SAINT-GOBAIN | 0.712\* | 0.579 | 0.798\* | 0.786\*\* |  | 0.890\*\* |  | 0.398 |
|  | (0.370) | (0.374) | (0.429) | (0.381) |  | (0.415) |  | (0.403) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SANOFI-AVENTIS | 0.174 | 0.204 | 1.302 | 0.098 |  | 1.460 |  | -2.364 |
|  | (0.376) | (0.379) | (2.209) | (0.609) |  | (2.147) |  | (2.151) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SCHNEIDER | 1.404\*\*\* | 1.271\*\*\* | 1.569\*\*\* | 1.435\*\*\* |  | 1.647\*\*\* |  | 1.128\*\* |
|  | (0.371) | (0.375) | (0.508) | (0.383) |  | (0.495) |  | (0.468) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SERVIER | -0.200 | -0.193 | -0.019 | -0.269 |  | 0.064 |  | -0.205 |
|  | (0.356) | (0.360) | (0.845) | (0.819) |  | (0.489) |  | (0.769) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SNCF | 0.850\*\* | 0.725\*\* | 0.865\*\* | 0.924\*\* |  | 0.931\*\*\* |  | 0.773\*\* |
|  | (0.347) | (0.349) | (0.362) | (0.358) |  | (0.352) |  | (0.328) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SOCIETE GENERALE | -0.002 | 0.014 | 0.048 | -0.016 |  | 0.077 |  | -0.028 |
|  | (0.411) | (0.415) | (0.434) | (0.417) |  | (0.422) |  | (0.393) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SOITEC | 0.194 | 0.289 | 0.187 | 0.231 |  | 0.242 |  | 0.505 |
|  | (0.376) | (0.377) | (0.525) | (0.513) |  | (0.377) |  | (0.482) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)SOMFY | 0.912\*\* | 0.824\*\* | 0.904\*\* | 0.924\*\* |  | 0.980\*\*\* |  | 0.994\*\*\* |
|  | (0.351) | (0.354) | (0.388) | (0.382) |  | (0.355) |  | (0.351) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)STALLERGENES | -0.436 | -0.466 | -0.441 | -0.274 |  | -0.433 |  | -0.117 |
|  | (0.365) | (0.370) | (0.583) | (0.572) |  | (0.365) |  | (0.533) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)TECHNICOLOR | 1.035\*\*\* | 1.033\*\*\* | 1.051\*\* | 1.045\*\*\* |  | 1.162\*\*\* |  | 0.743\*\* |
|  | (0.379) | (0.383) | (0.403) | (0.396) |  | (0.390) |  | (0.371) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)TECHNIP | 0.681\* | 0.598 | 0.681\* | 0.740\* |  | 0.755\*\* |  | 0.735\*\* |
|  | (0.368) | (0.371) | (0.379) | (0.376) |  | (0.372) |  | (0.343) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)THALES | 1.146\*\*\* | 1.018\*\*\* | 1.282\*\*\* | 1.153\*\*\* |  | 1.370\*\*\* |  | 0.884\*\* |
|  | (0.376) | (0.381) | (0.481) | (0.398) |  | (0.468) |  | (0.443) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)TOTAL | 0.593 | 0.450 | 0.759 | 0.680\* |  | 0.835\* |  | 0.186 |
|  | (0.371) | (0.375) | (0.526) | (0.386) |  | (0.495) |  | (0.492) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)VALEO | 1.379\*\*\* | 1.237\*\*\* | 1.510\*\*\* | 1.367\*\*\* |  | 1.598\*\*\* |  | 1.094\*\* |
|  | (0.376) | (0.381) | (0.481) | (0.410) |  | (0.463) |  | (0.447) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)VALLOUREC | 0.407 | 0.377 | 0.410 | 0.438 |  | 0.470 |  | 0.473 |
|  | (0.364) | (0.368) | (0.374) | (0.370) |  | (0.367) |  | (0.339) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)VEOLIA ENVIRONNEMENT | 0.390 | 0.325 | 0.401 | 0.441 |  | 0.471 |  | 0.392 |
|  | (0.350) | (0.353) | (0.365) | (0.360) |  | (0.355) |  | (0.330) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)VINCI | 0.928\*\*\* | 0.762\*\* | 0.919\*\* | 1.022\*\*\* |  | 1.002\*\*\* |  | 0.924\*\*\* |
|  | (0.353) | (0.355) | (0.367) | (0.369) |  | (0.358) |  | (0.332) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)VIVENDI | 0.077 | 0.076 | 0.321 | 0.094 |  | 0.423 |  | -0.296 |
|  | (0.360) | (0.363) | (0.600) | (0.375) |  | (0.589) |  | (0.559) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)WENDEL | -0.435 | -0.428 | -0.443 | -0.406 |  | -0.389 |  | -0.349 |
|  | (0.364) | (0.367) | (0.375) | (0.372) |  | (0.366) |  | (0.340) |
|  |  |  |  |  |  |  |  |  |
| factor(Company\_name)ZODIAC AEROSPACE | 0.718\*\* | 0.671\* | 0.742\* | 0.712\* |  | 0.828\*\* |  | 0.801\*\* |
|  | (0.357) | (0.361) | (0.412) | (0.406) |  | (0.367) |  | (0.373) |
|  |  |  |  |  |  |  |  |  |
| Technological\_Diversification X Absorptive\_Capacity |  |  |  | -6.679 | 4.031 |  |  |  |
|  |  |  |  | (4.082) | (11.051) |  |  |  |
|  |  |  |  |  |  |  |  |  |
| Technological Diversification X Environmental Dynamism |  |  |  |  |  | -0.0004 | -0.002\*\* |  |
|  |  |  |  |  |  | (0.0003) | (0.001) |  |
|  |  |  |  |  |  |  |  |  |
| Technological Diversification X Locations |  |  |  |  |  |  |  | 0.001\* |
|  |  |  |  |  |  |  |  | (0.001) |
|  |  |  |  |  |  |  |  |  |
| Constant | -1.700\*\*\* | -1.275\*\*\* | -1.692\*\*\* | -1.845\*\*\* | 4.108\*\*\* | -1.697\*\*\* | 3.667\*\*\* | -1.208\*\*\* |
|  | (0.346) | (0.317) | (0.359) | (0.363) | (0.206) | (0.348) | (0.164) | (0.339) |
|  |  |  |  |  |  |  |  |  |
|  | | | | | | | | |
| Observations | 173 | 173 | 168 | 168 | 168 | 173 | 173 | 168 |
| R2 | 0.977 | 0.977 | 0.977 | 0.978 | 0.383 | 0.978 | 0.471 | 0.982 |
| Adjusted R2 | 0.962 | 0.961 | 0.961 | 0.962 | 0.372 | 0.962 | 0.462 | 0.968 |
| Residual Std. Error | 0.290 (df = 103) | 0.293 (df = 103) | 0.297 (df = 97) | 0.294 (df = 97) | 1.187 (df = 164) | 0.290 (df = 101) | 1.092 (df = 169) | 0.269 (df = 95) |
| F Statistic | 64.087\*\*\* (df = 69; 103) | 62.851\*\*\* (df = 69; 103) | 59.125\*\*\* (df = 70; 97) | 60.628\*\*\* (df = 70; 97) | 33.974\*\*\* (df = 3; 164) | 62.307\*\*\* (df = 71; 101) | 50.253\*\*\* (df = 3; 169) | 70.650\*\*\* (df = 72; 95) |
|  | | | | | | | | |
| Note: | *p<0.1;****p<0.05;***p<0.01 | | | | | | | |

# **5. Conclusion**

As the main purpose of this study is to assess the effect of technological diversification and firms’ innovation performance, as well as to its relationship on internal and external moderation, some studies mentioned that not all firms have capabilities or enough sources to diversify their technological portfolios, otherwise we don’t limit our analysis on a large French corporation only. Following the results of our analysis on French manufacturing companies, we can consequently argue from evidence that a diversified portfolio of technologies is significantly affecting firms’ innovation performance. Furthermore, our study aimed to assess the moderating roles and impacts of external and internal components, contributing to the academic progress in our appreciation of technological diversification, while exploring new roads on the situational elements of this domain. Our empirical study shows that internal absorptive capacity has a positive moderating effect on innovation performance, while external environmental dynamism has a negative moderating effect on firms' innovation performance.

Based on our findings, our study could provide empirical evidence that firms with higher levels of technological diversification are more likely to achieve higher innovation performance. Our findings also show the result that technological diversification interacts positively with geographical dispersion on innovation performance. The advantage that firms can benefit from with regards to geographical dispersion and technological diversification is the key sources and contribution to firms' innovativeness. Companies are required to constantly improve and diversify their capability in order to survive in the market competition. As various studies we have discovered that technological diversification increases innovation value that we can use as an extensive evidence in support of our exercise study. Nevertheless, other benefits from technological diversification, is facilitating knowledge embeddedness and knowledge spillover that spur and drive firm innovation performance.

Furthermore, our empirical evidence affirms that the relationship between a firm's technological diversification and its innovation performance can be positively moderated by absorptive capacity under certain conditions. Indeed, our findings show that, based on a Model without certain control variables such as years and locations, the correlation found between absorptive capacity and innovation performance is positive. That is because by depending on absorptive capacity, firms will expand their knowledge base to new sources which will further improve their integration and exploitation skills. This in turn will consequently enable them to grasp the full benefits from their leading position, gaining a competitive advantage thanks to their innovative performance. Besides, by keeping an eye for outside technological breakthroughs emanating from outside their domain of operations, firms relying on absorptive capacity will stay ahead of competition by investing in new fields of knowledge as a first entry actor.

However on the other hand, our study also shows that there is a possibility for a negative correlation finding under certain conditions, that is when, on the contrary to the above mode, the control variable includes years and locations. That can be explained by the negative impacts we should consider regarding firm’s absorptive capacity on innovation performance, as not all firms can harvest its benefits. First, firms need to reach a certain critical mass size to be able to identify, integrate and then exploit the leading competitive advantage derived from it. Second, firms relying on absorptive capacity can potentially be impacted by increased costs of technological and organization integration of new knowledge, as it often requires changes in network relations adaptation.

Finally, looking at our last hypothesis, our findings have proven negative on our original statement, which was asserting that the relationship between a firm's technological diversification and firm’s innovation performance could be positively moderated by environmental dynamism. Indeed, our findings reflect a negative correlation between the interaction of technological diversification and environmental dynamism, and here is the reasoning we would consider to justify it. First, because firms operating in a dynamic environment have to adapt to a fast-moving situation, the following technological and market turbulence can result in a faster obsolescence of technologies and innovation developments. This is associated also with the overall market volatility across industries, and depreciation in value for certain technologies that emerge from that unpredictable operational environment. Second, globalisation-incurred environmental dynamism can result in unforeseen impacts on innovation reproduction and expropriation, due to the rapid diffusion of innovation-led knowledge and its ‘democratization’ among competing firms.

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