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TESIS DOCTORAL

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Three essays on value creation through diversification and product innovation: an update during a period of economic crisis.

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Resumen

La globalización económica ha supuesto un cambio radical en cómo las empresas se organizan y se enfrentan al entorno. La competencia internacional y la evolución de las tecnologías animan a las empresas a ser organizaciones cada vez más dinámicas (Teece, 2014). Hoy en día, es fácil encontrar empresas presentes en distintos sectores económicos o en varios mercados internacionales. De igual modo, las empresas han interiorizado que la innovación es una herramienta útil para diferenciarse de las competidoras y proveer valor a los clientes (Sirmon, Hitt, y Ireland, 2007). Así, las estrategias de diversificación (geográfica o en producto) o diferenciación (a través de innovaciones) son cada vez más utilizadas para generar ventaja competitiva y valor para la empresa.

Y es que a pesar de que ambas estrategias han sido ampliamente estudiadas en las últimas décadas, el efecto que provocan sobre el rendimiento de la empresa todavía está en debate y necesita ser actualizado (Ahuja & Novelli, 2016). Primero, un grupo significativo de autores obtiene que la diversificación de producto reduce el rendimiento de la empresa (ver Benito-Osorio, Guerras-Martín, y Zuñiga-Vicente, 2012), pero como antes indique, las empresas se siguen diversificando en producto. Por tanto, cabe preguntarse: ¿Produce la diversificación de producto efectos secundarios positivos sobre otras características de la empresa?

Segundo, las empresas que buscan ampliar el alcance de sus actividades pueden hacerlo a través de las dimensiones geográficas y de las de los productos (Mayer, Stadler, y Hautz, 2015; Ref, 2015). Teorías como la Visión Basada en Recursos (RBV) y la Economía de los Costes de Transacción (TCE) sugieren que ambos tipos de diversificación son impulsados por mecanismos similares para generar rendimiento en la empresa (Bowen y Wiersema, 2009; Hitt, Hoskisson, y Kim, 1997; Hitt, Tihanyi, Miller, y Connelly, 2006). Sin embargo, la mayoría de los estudios previos investigan el efecto de la diversificación geográfica o del producto sobre el rendimiento de la empresa por separado (Kirca et al., 2011). Sólo en los últimos años algunos estudios controlan por el otro tipo de diversificación, pero no profundizan en el efecto de la interacción entre diversificación producto y geográfica en el rendimiento de la empresa (Oh y Contractor, 2012). Por lo tanto, analizar ambas estrategias conjuntamente puede por un lado, proporcionar una comprensión más efectiva de la relación entre ambos tipos de diversificación con el rendimiento de la empresa, y por otro profundizar en cómo cada una de las estrategias de diversificación se interrelacionan e influyen en los rendimientos del otro tipo de diversificación.

Finalmente, la mayoría de estudios sobre el efecto de la innovación de producto se dan en un contexto de expansión (Antonioli, Bianchi, Mazzanti, Montresor, y Pini, 2013; Kuppuswamy and Villalonga, 2015). Precisamente, la última crisis económica de 2008, es un buen banco de pruebas para diagnosticar y probar la eficiencia de la diversificación y la diferenciación a través de la innovación. En este sentido, la crisis económica de 2008 trajo consigo un descenso de la proporción de empresas innovadoras y de la inversión total en innovación en la mayoría de los países desarrollados (OECD, 2012). Esta evolución pro cíclica de la innovación puede condicionar también los outputs de la innovación y el rendimiento en la empresa que ellos

generan. Por lo que un análisis conjunto de: la decisión de innovar, cuánto innovar, qué outputs genera esa innovación y cómo estos outputs afectan al rendimiento de la empresa, es necesario en periodos de crisis, para entender el alcance que tiene la innovación de producto sobre el rendimiento de la empresa.

Objetivos

Así, basándome en la perspectiva de la creación de valor a través de las decisiones estratégicas y con un enfoque microeconómico, el objetivo de esta tesis es expandir el análisis sobre cómo la diversificación, tanto de producto y geográfica, y diferenciación de producto a través de las innovaciones, afectan al rendimiento de las empresas. Para ello he elaborado tres capítulos con objetivos específicos en cada uno de ellos.

Bajo la asunción de que las decisiones sobre qué producir y dónde vender se toman conjuntamente en el seno de la empresa, el capítulo 1 se focaliza en: El efecto que produce la interacción de la diversificación de producto y geográfica sobre el rendimiento de la empresa; y el impacto que provoca la crisis económica en la relación entre diversificación (de producto y geográfica) y el rendimiento de la empresa. Este capítulo amplía estudios previos en el campo en dos aspectos: en primer lugar, analizando la interacción entre producto y diversificación geográfica, ya que la mayoría de los estudios previos investigan el efecto de la diversificación geográfica o del producto sobre el rendimiento de la empresa por separado (Kirca et al., 2011). En segundo lugar, el capítulo examina esas relaciones en un período de crisis económica, lo que amplía la evidencia en torno a la diversificación.

El capítulo 2 profundiza en la necesidad de incluir tanto la diversificación de producto como geográfica en un mismo análisis para el estudio de la diversificación. Ahora, el objetivo es analizar no solo si la interacción de ambas estrategias influye en los rendimientos de la empresa sino determinar también el efecto que cada estrategia provoca en el rendimiento de la otra estrategia. Además el modelo permite medir el efecto que tienen ambos tipos de diversificación en la relación de otras características internas de la empresa (como liquidez o deuda) en el rendimiento de la empresa. Así, este capítulo enriquece los estudios previos desarrollando hipótesis separadas en las que cada tipo de diversificación puede moderar el desempeño del otro tipo de manera diferente. Y también amplía los resultados del capítulo 1 investigando el efecto secundario de la diversificación geográfica y de producto sobre el rendimiento de otras características internas de la empresa.

Por último, el capítulo 3 se centra en el papel de la innovación de producto para generar crecimiento en la empresa. El objetivo es analizar los determinantes y consecuencias de la innovación tanto en periodos de pre crisis como de crisis. Así, el capítulo pretende responder cuatro cuestiones diferenciando entre un periodo de crecimiento y otro de recesión: (1) la decisión de innovar, (2) cuánto invertir en innovación, (3) qué outputs genera esa inversión y (4), cómo afectan estos outputs al crecimiento de las empresas antes y durante la crisis. Bajo una perspectiva de la creación de valor al consumidor, se analiza cómo la introducción de nuevos productos para la empresa o el mercado afecta al performance de las empresas. Este capítulo arroja luz sobre la importancia y el rendimiento de la innovación durante un período de crisis para las empresas.

Metodología

He elaborado modelos separados para cada uno de los capítulos que explicaré a continuación, y en todos ellos he puesto especial cuidado en el control de la endogeneidad. Y es que la dificultad para analizar estrategias es elevada. Las empresas toman decisiones dependiendo de sus características internas y del entorno. Pero dichas decisiones tienen también efecto sobre las propias características internas de la empresa y algunas veces sobre los factores externos. Esta simultaneidad del efecto, unido a la omisión de variables relevantes o errores de medida invalidan los estimadores MCO de los parámetros del modelo, que serán inconsistentes. Por ello, en los modelos de los tres artículos, tanto la diversificación geográfica, como la de producto, al igual que la diferenciación del producto a través de la innovación, son consideradas variables endógenas. También he utilizado efectos fijos en los dos primeros capítulos, así como inversas de Mills en el capítulo 3 para corregir por omisión de variables relevantes.

Tanto para el capítulo 1 como el capítulo 2, he elaborado una base de datos propia debido a la dificultad para encontrar información sobre diversificación de producto y geográfica para empresas españolas. Para ello, he recopilado manualmente los segmentos de negocios y geográficos por año de las empresas españolas e independientes del mercado continuo. Dicha información por segmentos se basa en los Segmentos Operativos de las Normas Internacionales de Información Financiera (NIIF 8), disponibles en los informes anuales y en las cuentas consolidadas de las empresas. Además, amplié la base de datos mediante la obtención de datos sobre las acciones en bolsa de la compañía, capitalización de mercado y bonos españoles a diez años utilizando la base de datos de Bloomberg. También recogí información sobre el gobierno corporativo de los Informes Anuales de Gobierno Corporativo de las empresas y de la Comisión Nacional de Valores (CNMV). Para el capítulo 3, he confiado en los datos del Panel de Innovación Tecnológica (PITEC), que es una encuesta para estudiar la actividad innovadora de las empresas españolas a lo largo del tiempo.

En el primer capítulo elaboro cinco modelos, para cubrir tanto el efecto de la diversificación de producto y geográfica, como de la interacción sobre el rendimiento de la empresa. En esta tesis se entiende por diversificación de producto los segmentos de negocios horizontales, utilizando el código de la Clasificación Europea de Actividades Económicas (NACE2009 rev.2). Mientras que la diversificación geográfica será el nivel de ventas de una empresa en diferentes localizaciones o mercados en el extranjero. Utilizando como medida de rendimiento de la empresa el Valor Económico Añadido (EVA) y el Beneficio Antes de Intereses e Impuestos (EBIT), entre otras, se analiza el efecto de la diversificación utilizando un modelo en dos etapas (2SLS). Hasta donde yo sé, EVA no se había utilizado antes en el campo de la diversificación.

Para el capítulo 2, me he apoyado en la Regresión por Umbrales desarrollada por Kourtellos, Stengos, and Tan (2015). Esta técnica es novedosa también en el campo de la diversificación y permite: Primero, analizar el efecto secundario que tanto la diversificación de producto como geográfica puede tener en cómo se relacionan otras características de la empresa con el rendimiento de la empresa. Y segundo, profundizar en la interacción a través de hipótesis en la que la diversificación de productos o geográfica puede modelar la relación entre en otro tipo de diversificación y el rendimiento de la empresa.

Por último, el capítulo 3 recoge un modelo secuencial de cuatro etapas para entender la innovación de producto y su efecto en el crecimiento de la empresa. Así el modelo presenta: (1) la decisión de innovar, (2) cuánto innovar, (3) los outputs que se sacan de esa inversión y (4), el efecto de estos outputs en el crecimiento de la empresa. Este modelo, desarrollado originalmente por Crepon, Duguet, y Mairessec (1998), es una herramienta fundamental para corregir por la endogeneidad de la innovación. He puesto especial hincapié en analizar el efecto de la innovación de producto sobre el crecimiento en el periodo de pre crisis y de crisis económica. Las dos primeras etapas han sido calculadas con un "Double Hurdle Model" mientras que la tercera y la cuarta etapa a través de Mínimos cuadrados de tres etapas (3SLS).

Resultados

En el capítulo 1, los resultados muestran que la combinación de ambas estrategias afecta al rendimiento de la empresa. Esto amplia los estudios anteriores mostrando que la combinación de la diversificación geográfica y de productos aumenta el rendimiento de la empresa más allá de lo que estas estrategias pueden contribuir por separado. Cuando analizo cada estrategia por separado, encuentro una relación en forma de U de la diversificación geográfica con respecto al rendimiento de la empresa y la falta de evidencia de que la diversificación de producto añada valor a la compañía, salvo que esté combinada con niveles altos de diversificación geográfica. Por lo tanto, la diversificación geográfica es una estrategia eficaz en las recesiones económicas sólo si la empresa ya tiene cierta exposición a los mercados extranjeros. Los resultados son robustos después de controlar la endogeneidad de ambos tipos de diversificación.

En el capítulo 2, los resultados revelan que la diversificación geográfica y de producto puede influir en el rendimiento de las características de la empresa. Concretamente, la diversificación de producto tiene un efecto positivo en el rendimiento que la empresa obtiene de la liquidez, mientras que diversificación geográfica afecta positivamente al rendimiento que la empresa genera de la deuda a largo plazo. Además, este capítulo corrobora y amplía los resultados del capítulo 1 ya que la diversificación geográfica influye positivamente en la relación diversificación del producto con rendimiento de la empresa. Sin embargo, la diversificación de productos no tiene un impacto claro en cómo la diversificación geográfica afecta al rendimiento de la empresa. Además, los resultados confirman que se necesita una inversión inicial mínima en la estrategia de diversificación geográfica para generar un efecto positivo en el rendimiento de la diversificación de productos. Este resultado refuerza la necesidad de una inversión inicial en la estrategia de diversificación geográfica para generar beneficios netos, descritos en S.-H. Lee and Makhija (2009), y también amplía el valor de la diversificación geográfica con efectos secundarios positivos en el rendimiento de la diversificación de productos. Desde una perspectiva de las opciones reales, es importante mantener una inversión en la diversificación geográfica para, al menos, dejar que la empresa redistribuya fácilmente los productos y servicios si es necesario.

Finalmente en el capítulo 3, los resultados corroboran que para el periodo de crisis económica, la inversión en innovación sigue siendo determinante para generar innovaciones de producto exitosas, aunque con un

efecto ligeramente menor. En periodos contractivos, tanto la experiencia previa como la I+D de manera continua dentro de la empresa son dos factores fundamentales para generar outputs de las innovaciones (la cuota de venta de nuevos productos o servicios a la empresa o al mercado). Sin embargo, el efecto positivo de los outputs de la innovación sobre el crecimiento de la empresa se reduce a la mitad en periodos de crisis. Estos resultados confirman una inversión pro cíclica en la innovación, pero también una producción pro cíclica de la innovación de productos.

Conclusiones

Esta tesis incrementa la evidencia del rendimiento de dos estrategias ampliamente utilizadas por la empresa en la actualidad: la diversificación empresarial (producto y geográfica) y la diferenciación de productos a través de la innovación. Aunque en las conclusiones de cada capítulo hay conclusiones adicionales y más detalladas, aquí están las principales conclusiones que vienen de esta tesis. Particularmente, analizo la relación entre estas estrategias y el desempeño de la empresa enfocándome en tres aspectos principalmente: (1) La interacción entre diversificación de productos y geográfica; (2) el efecto secundario de la diversificación geográfica y de los productos en el rendimiento de otras características de la empresa; Y (3) cuál es el efecto de la crisis económica en el rendimiento de las innovación del producto y de la diversificación de la empresa. En cada capítulo hay conclusiones adicionales y discusiones más detalladas, pero las principales conclusiones de esta tesis son:

En primer lugar, los resultados destacan la importancia de un análisis conjunto de ambos tipos de diversificación para comprender y determinar el rendimiento real de la diversificación corporativa de la empresa. Esto tiene importantes implicaciones para los investigadores, que tienden a analizar únicamente la diversificación de productos o geográfica, sin controlar para el otro tipo de diversificación. Por lo tanto, es necesario comprobar si la interacción de ambas estrategias es significativa cuando se analiza el rendimiento de la diversificación de producto o geográfica.

En segundo lugar, en un período de crisis económica, si las empresas desean aumentar su rendimiento mediante la diversificación de producto, deben buscar clientes internacionales y mercados externos donde competir. La diversificación geográfica reduce las desventajas de la diversificación de productos en periodos de crisis económica. Cuando las empresas interactúan con ambas estrategias están menos expuestas a las grandes fluctuaciones del entorno. Por lo tanto, los gerentes deben implementar y desarrollar rutinas para conectar e integrar ambos tipos de estrategias de diversificación. En otras palabras, al menos durante un período de crisis económica, los gerentes deben determinar si un nuevo negocio es lo suficientemente fuerte como para competir en los mercados extranjeros y si tiene clientes potenciales en el exterior. De lo contrario, la diversificación de producto puede disminuir el rendimiento de la empresa.

En tercer lugar, la diversificación de producto no mejora el rendimiento de la empresa en ninguno de los modelos utilizados en esta investigación, a menos que se combine con altos niveles de diversificación geográfica. Esto puede ser debido a que la estrategia de diversificación de productos puede ser más lenta de

redefinir que la diversificación geográfica, lo que condiciona su rendimiento ante cambios bruscos en el entorno -como en un período de crisis económica. La transferencia de tecnología, recursos o activos entre segmentos no es inmediata, y las empresas pueden encontrar más fácil y más rápido reorganizar su estrategia de diversificación geográfica en lugar de adaptar su estrategia de diversificación de producto (Lee y Makhija, 2009; Shaver, 2011). Por lo tanto, la flexibilidad obtenida por la diversificación geográfica afecta positivamente al rendimiento tanto de la empresa a nivel general como al de la diversificación de producto. Cuando las empresas tienen los canales de distribución, la red y el conocimiento apropiados, la diversificación geográfica puede ser una estrategia positiva para corregir desequilibrios en la demanda de algunas de las líneas de negocio de la empresa.

Sin embargo, la diversificación de producto genera un efecto secundario positivo en el rendimiento de la liquidez, que puede significar ventajas de financiación y de inversión durante un período de crisis económica. Esto está en línea con estudios recientes como Kuppuswamy and Villalonga (2015) o Hovakimian (2011). Además, las empresas que aumentan su nivel de diversificación geográfica obtienen mayores beneficios de su composición de deuda de largo plazo que puede significar mejores condiciones de financiación externa (Shaver, 2011).

En términos de diferenciación por innovación de producto, los resultados confirman que se ha reducido drásticamente el porcentaje de empresas que han introducido innovaciones en el período de crisis, especialmente en las micro y pequeñas empresas. Los tiempos de crisis, bajo la mezcla de incertidumbre y riesgo, dificultan el acceso de las pequeñas empresas a los mercados de capitales externos para financiar proyectos de innovación (Hall, Moncada-Paternò-Castello, Montresor, y Vezzani, 2016; N. Lee, Sameen, y Cowling, 2015). Sin embargo, para las empresas que deciden innovar, la crisis no disminuye la intensidad del gasto en innovación (especialmente en las medianas y grandes empresas). Además, la experiencia en innovación y la participación en actividades continuas de I+D aumentan los outputs de la innovación de producto en períodos de crisis. La experiencia en proyectos relacionados puede crear capacidades internas dentro de la organización, economías de aprendizaje y "spillovers internos" que reducen los efectos secundarios negativos de la crisis económica en el rendimiento de la innovación (Phene y Almeida, 2008). Este resultado está en línea con Amore (2015) que obtuvo que las empresas con experiencia en innovación durante crisis económicas anteriores obtienen mayor rendimiento de la innovación en nuevas crisis. Adicionalmente, bajo la perspectiva evolutiva, las empresas que llevan a cabo actividades de I+D de forma continua acumulan conocimientos y extraen las trayectorias tecnológicas y tecnológicas que les ayudan a mejorar el rendimiento de la innovación (Peters, 2009; Raymond, Mohnen, Palm, y Loeff, 2010).

Aunque los productos de innovación ayudan al crecimiento de la empresa, su efecto es la mitad en periodos de crisis que en el período anterior a la crisis. Una posible explicación del menor efecto positivo de la innovación de producto en el crecimiento de la empresa en crisis es que las innovaciones introducidas pueden no ser suficientemente radicales para generar una ventaja competitiva en tiempos de crisis (Choi y Williams, 2014). Estos periodos recesivos obligan a las empresas a mantener sólo los proyectos de innovación que les

permitan mantener su posición relativa en el mercado en comparación con los competidores, en términos de tecnología y conocimiento (Auh y Menguc, 2005; March, 1991). Así, los resultados confirman una inversión pro cíclica en la innovación, así como una reducción del efecto positivo de los productos innovadores en el rendimiento de la empresa. Esto no invalida la perspectiva Schumpeteriana o Evolutiva, pero las empresas deberían: primero, recalcular el coste de oportunidad de la innovación; segundo, invertir en proyectos con experiencia previa, o cooperar con empresas experimentadas en innovación; y tercero, concentrarse en actividades continuas de I+D, con un conocimiento para la empresa ya asentado. Todo esto ayuda a las empresas en períodos de contracción para reducir el riesgo y para tener externalidades positivas de las características de la empresa en la innovación.

Introduction

Economic globalization has brought a radical change in how companies organize themselves and face the environment. International competition and the evolution of technologies encourage companies to become increasingly dynamic organizations (David J Teece, 2014). Nowadays, it is easy to find companies acting in different economic sectors or in several international markets at the same time. Similarly, companies have internalized that innovation is a useful tool to differentiate themselves from competitors and provide value to customers (Sirmon, Hitt, & Ireland, 2007). Thus, diversification strategies -- product or geographical--, or differentiation through innovations are increasingly used to generate competitive advantage and value for the company.

Although these strategies have been extensively studied in recent decades, the effect they have on firm performance is still under debate. First, a significant group of authors finds that product diversification reduces firm performance (see Benito-Osorio, Guerras-Martín, & Zuñiga-Vicente, 2012), but product diversification is a strategy used frequently by companies. Therefore, it is reasonable to ask: Does product diversification generate positive side effects on the performance of other characteristics of the company?

Second, companies seeking to expand the scope of their activities can do so by geographic, as well as, product dimensions (Mayer, Stadler, & Hautz, 2015; Ref, 2015). Theories such as the Resource-Based View (RBV) and Transaction-Cost Economics (TCE) suggest that both types of diversification are driven by similar mechanisms to generate company performance (Bowen & Wiersema, 2009; Hitt, Hoskisson, & Kim, 1997; Hitt, Tihanyi, Miller, & Connelly, 2006). However, the majority of previous studies investigate the effect of product or geographic diversification on company performance separately (Kirca et al., 2011). Only in recent years some studies control by the other type of diversification but not inspect the effect of the interaction between product and geographic diversification on company performance (Oh & Contractor, 2012). Thus, analysing both strategies together may provide a more effective understanding of the product and geographic diversification-performance relationship, in which decisions on geographic market can affect the product diversification-performance relationship and vice-versa.

Finally, most studies on the effect of product and geographic diversification as well as product innovation on firm performance are given in a context of expansion (Antonioli, Bianchi, Mazzanti, Montresor, & Pini, 2013; Kuppuswamy & Villalonga, 2015). The last economic crisis started in 2008, is a good test bench for the diagnosis and efficiency of diversification and differentiation through innovation. In this sense, the last economic crisis declines the proportion of innovative firms and the total investment in innovation in most developed countries (OECD, 2012). This pro cyclical evolution of innovation investment can also affect the outputs of product innovation and the firm performance which they generate. Therefore, a joint analysis of the (1) decision to innovate, (2) investment in innovation, (3) the outputs of that investment and (4) how these outputs affect the performance of the company is necessary to fully understand the scope of product innovation on the performance of the company in periods of economic crisis.

Objectives

Based on the perspective of creating value through strategic decisions, the objective of this thesis is to expand the analysis on how diversification, both product and geographic, and differentiation through product innovations, affect the performance of companies. To accomplish this objective, I have elaborated three chapters with specific objectives in each one of them.

Under the assumption that decisions about what to produce and where to sell are taken jointly within the company, chapter 1 focuses on: the effect of the interaction between product and geographic diversification on company performance. And the impact of the 2008 economic crisis on the relationship between diversification (product and geographic) and company performance. This chapter expands previous studies in the field in two aspects: First, analysing the interaction between product and geographic diversification, in contrast to the majority of previous studies which investigate the effect of product or geographic diversification on company performance separately (Kirca et al., 2011). Second, this chapter investigates these relationships in a period of economic crisis that may change the effect of the aforementioned strategies on company performance.

Chapter 2 explores how product and geographic diversification moderate the relationship between other firm characteristics (such as liquidity or debt structure) and firm performance. It also extends the results of Chapter 1 developing separate hypotheses in which each type of diversification may moderate the performance of the other type differently. Thus, this chapter enriches previous studies by investigating the side effect of geographic and product diversification in an integrative econometric model that also expands the understanding of the interaction between both types of diversification.

Finally, Chapter 3 studies the role of product innovation to drive growth in the company. The objective is to analyze the determinants and consequences of innovation in both pre economic crisis and crisis periods. In particular, the chapter aims is to answer four questions differentiating between a period of growth and a period of recession: (1) the decision to innovate, (2) how much to invest in innovation, (3) what outputs the investment generates, and (4) how these outputs affect the firm growth before and during the crisis. From a perspective of creating consumer value, we analyze how the introduction of new products for the company or market affects the performance of companies. This chapter sheds light on the importance and performance of innovation during a period of crisis for firms.

Methodology

Separate models have been developed for each of the chapters that are explained below, and in each of them, I have been particularly careful to control for endogeneity. Companies make decisions depending on their internal characteristics, and external factors. But such decisions also have an effect on theses internal characteristics of the company and sometimes on external factors. This simultaneity of the effect, together with the omission of relevant variables, invalidates the OLS estimators of the model parameters, which will be inconsistent. Thus, in the models of the three chapters, geographic and product diversification, as well as

product differentiation through innovation, are considered endogenous variables. I used also fixed effects in the first two chapters' models, as well as inverse Mills ratio in Chapter 3 to correct the omission of relevant variables.

For Chapter 1 and Chapter 2, I built a novel database on product and geographic diversification for Spanish companies. I manually collected business and geographical segments by year for independent Spanish listed companies. This segment information is based on the International Financial Reporting Standards Operating Segments (IFRS 8), available in the annual reports and consolidated accounts of companies. Additionally, I expanded the database by obtaining data on company shares, market capitalization and Spanish ten-year bonds using the Bloomberg database. Further, I collected corporate governance information from the Companies' Annual Corporate Governance Reports and from the Spanish National Securities Commission (CNMV). For the chapter 3, I relied on the Spanish Technological Innovation Panel database (PITEC), which is a survey to study the innovation activity of Spanish firms over time.

In the first chapter, I elaborate 5 models, to cover the effect of product, geographic diversification and their interaction on company performance. In this thesis product diversification means horizontal business segments, using the code of the European Classification of Economic Activities (NACE2009 rev.2), while geographic diversification is the level of sales of a company in different locations or markets abroad. Using the Economic Value Added (EVA) and Earnings before Interest and Tax (EBIT), among others, I analyze the effect of diversification using a two-stage model (2SLS). As far as I know, EVA has not been used before in the field of diversification.

In the Chapter 2, I rely on Structural Threshold Regression developed by Kourtellos, Stengos, and Tan (2015). This technique is also new in the field of diversification and allows in this field: (1) to inspect the side effect of product and geographic diversification on the relationship between other company characteristics and company performance. And (2) to expand the interaction analysis developing separated hypotheses in which product or geographic diversification may moderate the relationship between the other type of diversification and performance.

Finally, Chapter 3 presents a sequential four-stage model for understanding product innovation and its effect on company growth. The model presents: (1) The decision to innovate, (2) how much to innovate, (3) the outputs of that investment and (4) the effect of those outputs on company growth. I employ the model originally developed by Crepon, Duguet, and Mairessec (1998), which corrects for the endogeneity of innovation. I place special emphasis on analyzing the effect of product innovation on firm growth in the period of pre-economic crisis and economic crisis. The first two stages are calculated with a Double Hurdle Model while the third and fourth stages are calculated by three-stage least squares (3SLS).

Results

In chapter 1, the results reveal that the combination of product and geographic diversification increases company performance beyond what these strategies can contribute separately. This result confirms the linked

effects of product and geographic diversification on company performance. Further, when I analyse each type of diversification separately, I find a U-Shaped geographic diversification-performance relationship, and a lack of evidence of product diversification added value, unless combined with high levels of geographic diversification. Thus, geographic diversification is an effective strategy in economic downturns only if the company already has certain exposure to foreign markets. The results are robust after controlling for the endogeneity of both types of diversification.

Chapter 2 extends the analysis of the interaction between product and geographic diversification and what are the effect of diversification on the relationship between other firm characteristics and performance. The results reveal that product diversification has a significant positive side effect on liquidity-firm performance relationship whereas geographic diversification positively shapes the long-term debt and firm performance relationship. Further, this chapter corroborates and expands the results from chapter 1 showing that geographic diversification positively influences the product diversification–performance relationship. However, product diversification has no clear impact on the geographic diversification-performance relationship. Further, results show that a minimal upfront investment in geographic diversification is needed to generate a positive effect from product diversification. This result reinforces the need for an initial foothold investment in geographic diversification to generate net benefits, described in S.-H. Lee and Makhija (2009), and it also expands the value of geographic diversification with positive side effects on product diversification performance. From a real option perspective, it is important to keep an investment in geographic diversification to, at least, let the company shift easily among products and services if needed.

Finally in Chapter 3, results confirm that, for periods of economic crisis, investment in innovation remains decisive for generating outputs of innovation -measured by the sales share of new products or services to the firm or the market-, albeit with a slightly smaller effect. In contractive periods, both previous innovation experience and continuous R&D become more relevant factors to generate outputs of product innovations than in a period of pre economic crisis. In any case, the positive effect of the innovation outputs on firm growth is reduced by half in times of crisis. These results confirm a pro cyclical investment in innovation but also a pro cyclical output of product innovation.

Conclusion

This thesis aim is to expand the evidence of two widely used strategies by the firm nowadays: corporate diversification (product and geographic) and product differentiation through innovation. Particularly, I analyse the relationship between these strategies and firm performance focusing in three aspects mainly: (1) the interaction between product and geographic diversification; (2) the side effect of product and geographic diversification on the performance gathered from other firms characteristic; And (3) what are the effect of a period of economic crisis in the product innovation-firm performance and diversification-firm performance relationship. In each chapter there are extra conclusions and more detailed discussion, but the main conclusions coming from this thesis are:

First, the results highlight the importance of a joint analysis of both types of diversification to fully understand the performance of a company's actual level of corporate diversification. This has important implications for practitioners, who tend to analyse only product or geographic diversification without controlling for the other type of diversification. Thus, practitioners should check if the interaction of both strategies is significant when they are analysing the performance of product or geographic diversification.

Second, in a period of economic crisis, if companies wish to increase their performance by means of product diversification, they must seek potential international clients and overseas markets where they can compete. Geographic diversification reduces the downsides of product diversification in an economic crisis. When companies interact both strategies, they are less exposed to major environmental fluctuations and downturns. Thus, managers should integrate both types of diversification strategies. In other words, at least during a period of economic crisis, managers should determine if a new business of product sector is strong enough to compete in overseas markets and whether the sector can be expanded geographically. Otherwise, product diversification can decrease company performance.

Third, product diversification does not improve firm performance in any of the models used in this research, unless it is combined with high levels of geographic diversification. I suggest that product diversification strategy may be slower to readjust by firms than geographic diversification, in response to short–run environmental changes –such as in a period of economic crisis-. The transfer of technology, resources or assets between segments is not immediate, and companies may find it easier and quicker to reorganize their geographic diversification strategy rather than adapt their product diversification strategy (S.-H. Lee & Makhija, 2009; Shaver, 2011). Therefore, the flexibility obtained by geographic diversification positively affects performance, and positively influences product diversification performance. When firms have the appropriate overseas distribution channels, network and knowledge, geographic diversification may be a good strategy to fix imbalances in the demand for some of the firm’s business lines.

However, product diversification generates a positive side effect on the relationship between liquidity and company performance. This results suggests financing and investment advantages during a period of economic crisis, in line with recent studies by Kuppuswamy and Villalonga (2015) and Hovakimian (2011). Additionally, I find that geographic diversification generates greater returns from having a large long–term debt in period of economic crisis which may mean better external financing conditions (Shaver, 2011).

In terms of differentiation by product innovation, the percentage of firms that introduced innovations during the crisis period was reduced drastically, especially among micro and small enterprises. In times of crisis, under uncertainty and risk, it is difficult for small firms to access external capital markets to finance innovation projects (B. H. Hall, Moncada-Paternò-Castello, Montresor, & Vezzani, 2016; N. Lee, Sameen, & Cowling, 2015). However, for firms that decided to innovate, the crisis did not diminish the intensity of innovation spending (especially in medium and large companies).

Further, experience in innovation and continuous R&D enhance the outputs of product innovation in downturns. Experience in related projects can create internal capabilities within the organization, learning economies, and "internal spillovers" that reduce the negative side effects of the economic crisis on innovation performance (Phene & Almeida, 2008). This result is in line with Amore (2015) who finds that companies with experience in innovation during previous economic crises reap greater benefits from innovation in new crises. Additionally, from an evolutionary perspective, firms that carry out R&D activities on a continuous basis accumulate knowledge and technological trajectories which improve innovation performance (Peters, 2009; Raymond, Mohnen, Palm, & Loeff, 2010). Diversification through innovation drives company growth, but these effects halved during the period of economic crisis. One possible explanation of the lower positive effect of product innovation on firm growth is that the innovations introduced may be not radical enough to generate a competitive advantage in times of crisis (Choi & Williams, 2014). Recessive periods force firms to keep only the innovation projects which allow them to maintain their competitive position in the market, in terms of technology and knowledge (Auh & Menguc, 2005; March, 1991). Thus the results confirm a pro-cyclical investment in innovation as well as a reduction of the positive effect of product innovation outputs on firm performance. This does mean an invalidation of the Schumpeterian and Evolutionary perspective, but companies should: first, recalculate the opportunity cost of innovation; second, invest in projects which build on previous experience, or cooperate with companies experienced in innovation; and third, focus efforts on continuous R&D. All this helps companies in contractive periods to reduce risk and exploit positive externalities relating to innovation.

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Chapter 1. Effects of product and geographic diversification on company performance: Evidence during a period of economic crisis.

Abstract

Based on a novel and specialized sample of Spanish listed companies from non-financial sectors, I explore the nature and linked effects of product and geographic diversification on company performance during a period of economic downturn. The paper develops comprehensive models depicting the interactive effects of these strategies. I find a U-Shaped geographic diversification-performance relationship and lack of evidence of product diversification added value, unless combined with high levels of geographic diversification. Evidence shows that companies have achieved greater performance in a period of economic crisis by combining these strategies. The results are robust after controlling for the endogeneity of both types of diversification. The findings highlight the fact that geographic diversification is an effective and valuable strategy in economic downturns, but only if the company already has certain exposure to foreign markets. Furthermore, results provide a more effective understanding of the interaction of product and geographic diversification and its effects on performance.

Keywords: Product diversification, Geographic diversification, Company performance, Economic Crisis, Corporate diversification.

Introduction

The study of corporate diversification[1] remains important in business and economic literature, as it is a strategy widely used by companies to increase growth and competitiveness (Ahuja & Novelli, 2016). The relationship between product or geographic diversification and performance is a core factor in this analysis, offering an insightful understanding and broad diversity of results[2].

The majority of papers study the effect of product or geographic diversification on company performance separately (Kirca et al., 2011; Peng & Delios, 2006). However, companies seeking to expand the scope of their activities can do so by encompassing geographic dimensions as well as product markets (Bowen & Wiersema, 2009; Kumar, 2009; Mayer et al., 2015; Ref, 2015). Decisions on product segments can affect the geographic diversification-performance relationship and vice-versa. Theories such as the Resource-Based View (RBV) of the company and Transaction-Cost Economics (TCE) suggest that both types of diversification are driven by similar mechanisms to generate company performance, as synergies, building capabilities, or increases in coordination and governance cost (Bowen & Wiersema, 2009; Hitt et al., 1997; Hitt et al., 2006; David J. Teece, Pisano, & Shuen, 1997). Consequently, analysing both strategies together provides a more effective understanding of the product and geographic diversification-performance relationship.

Similarly, expanding the evidence in different periods and home country environments also enriches the analysis of product and geographic diversification-performance relationships (Oh & Contractor, 2012; Wan & Hoskisson, 2003). Markets, companies and strategies evolve over time. In the same way, a period of economic recession requires different resources, capabilities, and strategies to lead to success (Kogut & Kulatilaka, 2001; S.-H. Lee & Makhija, 2009). For instance, Kuppuswamy and Villalonga (2015) and Hovakimian (2011) show that the effects of product diversification on performance increase during a period of financial crisis, which is explained by more funds and capital efficiency allocation of diversified companies. Likewise, S.-H. Lee and Makhija (2009) find a valuable flexibility of companies' international investments during an economic crisis. Furthermore, corporate diversification-performance relationships are also affected by home country factors (Kim, Hoskisson, & Lee, 2015). Largely, the work done so far has focused its attention on the USA, Japan and the UK, although for the last two decades, it has also been conducted in emerging countries (Y. Chen, Jiang, Wang, & Hsu, 2014; J. Li & Yue, 2008). Studies on product or geographic diversification-performance relationships in other economies, including European countries, are less frequent (Braakmann & Wagner, 2010; Wan & Hoskisson, 2003).

[1] I use the term corporate diversification to refer to product and geographic diversification. I consider horizontal non-related business segments as product diversification using the European Classification of Economic Activities code (NACE2009 rev.2). In this article, geographic diversification means a company's level of sales in different overseas geographic locations or markets.

[2] For a literature review, see Benito-Osorio et al. (2012) and .Wan, Hoskisson, Short, and Yiu (2011) for product diversification; Kirca et al. (2011) and Hitt et al. (2006) for international diversification.

I extend the evidence of corporate diversification-performance relationships to Spain, the sixth largest economy in Europe, which entered into a deep recession in 2008. Hence, I focused my analysis on this economy during a period of economic crisis, to determine whether the interaction between both types of diversification plays an important role in the corporate diversification-performance relationship. In this sense, geographic diversification can offset certain unanticipated –or anticipated- downward fluctuations in business segment demand by expanding the portfolio of international clients (Shaver, 2011). Therefore, it can be expected that the flexibility obtained by geographic diversification positively affects company performance (S.-H. Lee & Makhija, 2009) and even influences the relationship between product diversification and performance.

To address the analysis of corporate diversification-performance relationships in this country, I built a novel database with raw corporate diversification data on independent Spanish listed companies in 2006-2011 that did not belong to the financial sector. This database allowed us to select companies with decision-making freedom in product and geographic diversification strategies and to collect consistent data on the degree of geographic and product diversification based on the International Financial Reporting Standards Operating Segments (IFRS 8). This database enabled us to include market and accounting-based performance measures to provide a broader diversification analysis. Specifically, I used Economic Value Added (EVA), as a market performance measure[3] and Earnings Before Interest and Taxes (EBIT) as an accounting-based measure. The main advantage of using EVA as a measure of performance is that it accounts for all costs, including the opportunity cost of equity capital, which complements accounting performance measures. Thus, EVA is the amount of real value created for the company by management, which is also described as the value added to shareholders. To my knowledge, EVA has not been used in the analysis of corporate diversification-performance.

To perform this analysis, I developed 6 different models focusing on the effect of product and geographic diversification as well as their interaction on company performance. The models also include accounting and governance measures as control variables, which may influence the performance measures used. I used a fixed effect to control from omitted company-specific characteristics or capabilities (Abdallah, Goergen, & O'Sullivan, 2015). Additionally, I addressed the potential endogeneity of the level of product and geographic diversification (Çolak, 2010; Dastidar, 2009; Villalonga, 2004) using a Two-Stage least squares regression (2SLS).

The paper is structured as follows. Section 2 reviews theoretical and empirical literature and presents the hypothesis proposed in this study for a period of economic crisis. Section 3 describes the data and the sample selection criteria. Section 4 defines the modelling procedure, the estimation method and variables. The results are presented in section 5 and the robustness check is reported in section 6; I finish with conclusions and a discussion of the research in Section 7.

[3] EVA is a trademark of Stern Stewart Management Services.

Literature background and hypotheses.

In this section, I review the main theoretical domains and empirical studies to identify the benefits and costs of product and geographic diversification, as well as their interaction, focusing on a period of economic crisis.

1. Product diversification and performance

Literature provides powerful reasons to justify product diversification. According to the internal market efficiency perspective, Transition Cost Economics (TCE) and Industrial Organization Economic Theory (IO), product diversification offers organizations substantial advantages in terms of lower transaction costs inside the company and healthier internal markets (Scharfstein & Stein, 2000; Williamson, 1981). Product diversification allows companies access to lower costs of capital, better allocation, risk reduction and tax advantages through intra-company transactions (Berger & Ofek, 1995; Schmid & Walter, 2009).

In a period of economic crisis, external financial markets suffer constraints that increase companies' external financing costs. Thus, the internal capital market of product diversified companies is able to allocate their capital resources more efficiently and provide more funds, resources, assets and technology than non-diversified companies. In a recent work, Kuppuswamy and Villalonga (2015) show that company value increased in 2007-2009 because product diversification generated "more money", as well as more efficient allocation of capital amongst segments. Similarly, Hovakimian (2011) finds that companies improve the efficiency of internal capital markets by increasing the allocation of funds to high performance instead of low performance segments.

However, managers are "boundedly rational" and limited in their cognitive capacities, and hence unable to absorb all the information from their environment (Ciabuschi, Forsgren, & Martin, 2011; Zahra & George, 2002). In a period of crisis, managers have to face unpredictable and uncertain new scenarios, which may hinder the decision-making process and jeopardize the ability to properly assign resources and investments. Companies may invest inefficiently to keep some of their business lines, spending too little on profitable segments and too much on less profitable segments (Denis, Denis, & Yost, 2002; Lamont & Polk, 2002; Rajan, Servaes, & Zingales, 2000; Scharfstein & Stein, 2000).

In an attempt to decrease this uncertainty, managers demand more information, increasing internal control mechanisms and administrative and coordination costs (Zhou, 2011). Managers need to spend much more time and effort on coordinating segment activities in such periods.

Furthermore, the capacity to restructure product diversification strategy and take advantage of the benefits described above is limited and costly in an economic recession. A necessary decision taken in a product segment may be counter-productive for other segments, which may limit the efficiency of the corporation. For instance, the bankruptcy of a subsidiary can influence the solvency and financing of the rest of the corporation. Hence, managers also have incentives to postpone and limit their decisions to avoid excessively damaging a particular segment, which may reduce overall company performance.

On the whole, I hypothesize that product diversification may be negative in periods of crisis because corporations may prioritize certain product segments over others and invest (or disinvest) inefficiently due to short term company needs in an uncertain new environment. Although in a period of economic crisis, product diversified companies can take advantage of their internal markets, product diversification strategy adapts poorly to sudden changes in an environment in which the transfer of technology, resources or assets is not immediate. Accordingly, I propose the following hypothesis: in periods of economic crisis, the costs of product diversification exceed the benefits.

Hypothesis 1. Product diversification decreases company performance in a period of economic crisis.

2. Geographic diversification and performance

Companies decide to diversify geographically seeking potential competitive advantages. The benefits of geographic diversification arise from the possibility of achieving economies of scale and scope by sharing and exploiting parent company resources (Chakrabarti, Singh, & Mahmood, 2007; S. B. Tallman, Geringer, & Olsen, 2004). In addition, geographic diversification can help to reduce the costs of access to new inputs (Hennart, 2007), increase the market power of the company (J. Li & Yue, 2008; Lu & Beamish, 2004) and transfer knowledge more efficiently than non-geographically diversified companies (Hitt et al., 1997; Vega-Jurado, Gutiérrez-Gracia, & Fernández-de-Lucio, 2008; Vermeulen & Barkema, 2001; Zahra & George, 2002). Geographic diversification therefore increases the number of potential clients, suppliers and access to resources and promotes more stable cash flows, thus reducing the overall risks (Rugman & Verbeke, 2004).

These potential advantages can be relevant in periods of crisis, in which geographic diversification may offer a flexible strategy for companies. Shaver (2011) found that geographic diversification mitigates investment liquidity constraints in periods of crisis. Furthermore, exporting activities are significantly oriented towards enhancing relations with overseas distributors and partners. If conditions in a foreign country become adverse during a downturn, companies can redefine their investments with lower sunk costs than when the investment involves a substantial amount of fix assets. Companies can respond rapidly to unanticipated –and anticipated- downward changes in domestic or international demand, shifting sales and investments in markets where they expect to obtain greater profits (S.-H. Lee & Makhija, 2009; Shaver, 2011).

Nevertheless, there are also disadvantages associated with geographic diversification. Initially, companies have to deal with different environments – different cultures, labour conditions, legislation, capital markets or products to suit their international markets- which may increase administrative and coordination costs (Hennart, 2007). Similarly, companies have to ensure export infrastructure and implement governance operations and, in many cases, the task of supervision and decision is complex and difficult to manage in international corporations (Ciabuschi et al., 2011; Contractor, Kumar, & Kundu, 2007; Gomes & Ramaswamy, 1999). This trade-off between the cost and benefits of geographic diversification is considered by some authors as a U shaped geographic diversification-performance relationship (Capar & Kotabe, 2003; Contractor et al., 2007; J. Li & Yue, 2008; Lu & Beamish, 2004; Ruigrok & Wagner, 2003). This U-Shaped relationship implies that with a low level of geographic diversification, the technology and knowledge

transfer, as well as the bureaucratic costs are higher than the potential benefits, which may limit profitability. However, after learning processes and establishing suitable management channels, companies may reduce entry barriers and expand foreign sales and profitability (Lu & Beamish, 2004).

I propose that during an economic crisis, companies need to quickly readapt production to the downturn in demand. As mentioned above, geographic diversification involves further investment, such as foreign market research, export licenses, distribution and production networks, which are costly and time consuming. Companies that enter new overseas markets may suffer more from a downturn of this kind because they do not know as much about the markets as local competitors. However, companies that have already invested in such processes may have greater opportunities to achieve the benefits of geographical diversification.

In short, I propose that increasing geographic diversification may offset downturn effects in an economic recession, but only if the company has enough exporting knowledge and infrastructure to compete in foreign markets. Therefore, I propose the hypothesis of a U-Shape relationship between geographic diversification and performance, the costs being higher than the profits with low levels of diversification and profits higher than costs in high levels of diversification:

Hypothesis 2. Geographic diversification has a U-shape relationship with performance in periods of economic crisis.

3. The interaction effect between the two types of diversification and performance

Companies are dynamic organizations in which the effects on performance of a particular strategy are determined by other strategies. This may be the case of product and geographic diversification strategies, which are interdependent, since both require investment commitments to leverage resources, technology and capabilities into geographic and product markets (Bowen & Wiersema, 2009; David J. Teece, 1982; David J Teece, 2014).

On the positive side, from an RBV perspective, the opportunities to achieve synergies are higher when both strategies are combined. Using common distribution channels, brand names, networks, production facilities and marketing strategies, companies may enhance efficiency and reach higher levels of scale and scope economies, as compared to others that are not diversified in both dimensions (S. Tallman & Li, 1996; Zahra, Ireland, & Hitt, 2000). In fact, the interaction between both strategies increases the firm's options of making an investment profitable by exploiting market imperfection (Porter, 1990), bargaining power (Kogut & Kulatilaka, 2001) and accessing new knowledge available in distant markets (Oh & Contractor, 2012). Additionally, managers learn from past experiences in diversification, applying more efficient mechanisms to facilitate transactions across markets and facilitating the decision-making process (Chang & Wang, 2007; David J. Teece et al., 1997). Thus, product diversification can have a positive impact on geographic diversification performance, due to the skills acquired by managers dealing with several product segments and uncertainty (Hitt et al., 1997).

The potential benefits described above may be particularly important in a period of economic crisis. Geographic diversification can mitigate business segment constraints by expanding products and activities to

overseas markets, or enhancing efficiency in resources allocation by exploiting multinational networks for the different business lines (S.-H. Lee & Makhija, 2009; Shaver, 2011). During an economic downturn, uncertainty is higher and makes it difficult to structure investment in advance. In this situation, it could be advisable to wait and see how future conditions develop, instead of disinvesting or over-investing in certain company lines of business (Gaur & Kumar, 2009). Using geographic diversification, managers can mitigate the downturns and negative effects during such periods on company performance (Shaver, 2011), but acts as a positive moderator between product diversification and performance.

Moreover, the capacity to re-adapt to geographic diversification is generally achieved faster than in the case of product diversification strategies, which involve more fixed assets. Companies can also re-allocate idle assets in an economic crisis to other business lines, regions or a combination of both. In addition, managers learn from past experiences in diversification, reducing transaction costs and employing this useful knowledge to increase the efficiency of geographic and product diversification. Accordingly, geographic diversification can be expected to have a positive influence on the product diversification-performance relationship.

On the downside of running both strategies at the same time, TCE argues that companies need extra internal controls and to adjust internal settings to integrate different lines of business and overseas markets (Wiersema & Bowen, 2008; Zhou, 2011). This increases coordination and administrative costs and significantly reduces the potential benefits of the interaction. Furthermore, the supervisory capacity of managers may decrease when dealing with different environments. In a period of economic crisis, the capability of seeking and developing opportunities that involve several businesses and markets may be low. Uncertainty jeopardizes the decision-making process. Managers may attempt to remedy the situation by demanding more information, which may overwhelm their capabilities and damage the benefits of the interaction (Franko, 2004).

In the interaction analysis, I hypothesize that in an economic downturn, by combining product and geographic diversification, companies may achieve greater market power (J. Li & Yue, 2008) and a mechanism to reduce risk (Delios & Beamish, 1999). The flexibility achieved by geographic diversification (S.-H. Lee & Makhija, 2009) can be combined with additional potential benefits provided by product diversification, such as better internal capital market efficiency in an economic downturn (Hovakimian, 2011). In this case, the probability of synergies is higher, and companies also have more possibilities to readjust themselves to changing environments. Furthermore, the previous experience of managers in diversification activities can reduce the coordination and governance costs associated with more complex companies and apply more efficient mechanisms facilitating transactions across markets. I therefore expect a combination of product and geographic diversification will help companies reach greater performance in periods of economic crisis:

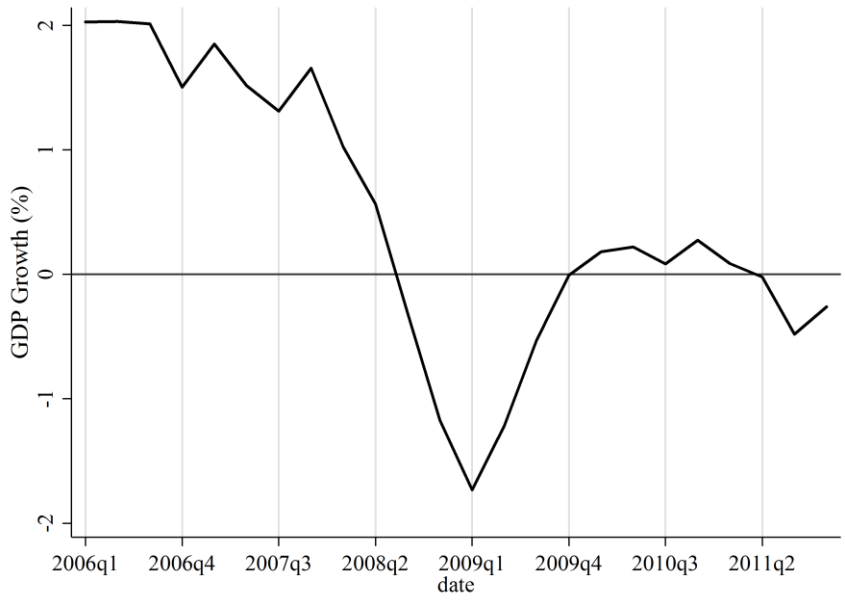
Hypothesis 3. The interaction of geographic and product diversification increases company performance in periods of economic crisis.

Data

In this paper I build a novel database with raw corporate diversification data. I gathered data on all independent Spanish listed companies[4] not belonging to the financial sector from 2006 to 2011 as corporate diversification information. I followed by extracting the segment data for each company and year from their consolidated accounting data in their annual financial statements. The same information was gathered on each of the firm's product segments and each reported geographic segment. Similarly to other databases, each of these product segments has an associated NACE2009 activity code. The information available in the annual financial statements of listed companies is based on the International Financial Reporting Standards Operating Segments (IFRS 8). Additionally, I expanded the database by obtaining data on company shares, market capitalization and Spanish ten-year bonds from using the Bloomberg database. I collected corporate governance information from the Companies' Annual Corporate Governance Reports and from the National Securities Commission ("*Comisión Nacional del Mercado de Valores - CNMV"*). My data includes 100 companies belonging to a wide variety of sectors. Most of the companies belong to the manufacturing sector (42) followed by the construction sector (22), energy and supplies (7) and information and communications (7). (See Appendix B of Chapter 2 for further information about the database elaborated).

The database enabled us: firstly, to expand the corporate diversification analysis to a broader sample of listed Spanish companies and not only to the IBEX35 group[5].

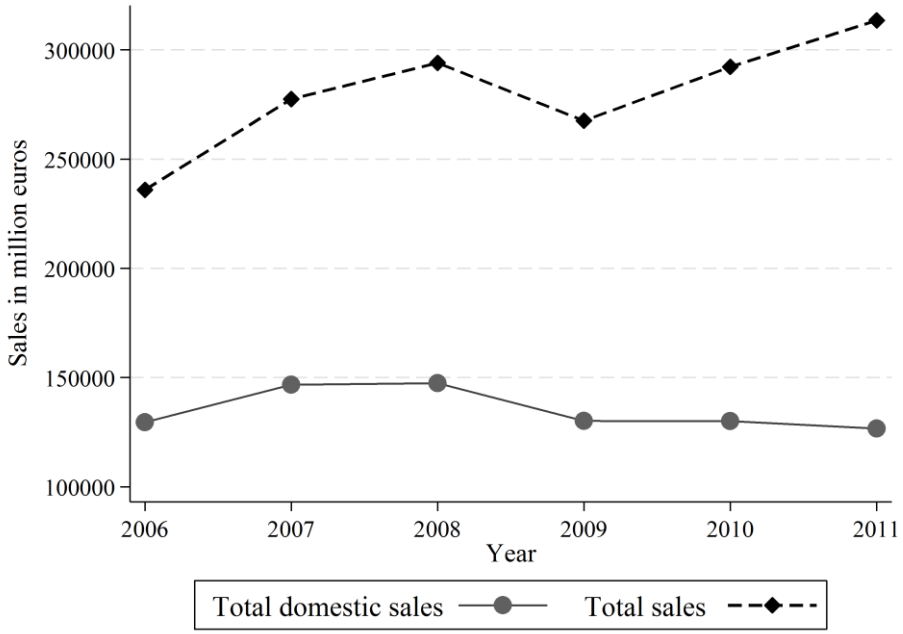
Figure 1. Spanish quarterly GDP Growth 2006-2011



[4] I considered that a company or corporation is independent when is not controlled for more than 25% of its capital by another company or corporation. Thus, I select Spanish parent companies which are autonomous in the decision making process.

[5] IBEX35: it is an index comprising the 35 most liquid Spanish stocks traded in the Spanish Stock Exchange.

Figure 2. Overall domestic sales and total sales of the companies in the sample



N=91 Companies that reported domestic sales for every year.

The database enabled us: firstly, to expand the corporate diversification analysis to a broader sample of listed Spanish companies and not only to the IBEX35 group[6]. Secondly, it enabled us to select companies with the freedom to define their product and geographic diversification strategies. Thirdly, I were able to collect consistent data on the degree of geographic and product diversification based on IFRS 8 and, finally, calculate accounting and market performance measures, thus broadening the interpretation of the performance of corporate diversification.

Spain provides an appropriate setting for an analysis of corporate diversification in a period of economic crisis. Spain is the sixth largest economy in Europe and entered into a deep recession in 2008, due to lack of liquidity, rising defaults and debt that caused a bank bailout, 22% unemployment rate in late 2011 and long and steady GDP constrictions from 2008 to 2011. Figure 1 shows quarterly gross domestic product (GDP) growth in Spain[7]. The financial crisis began in 2008, moving from a growth of 1.02% in the first quarter of such year to a decline of 1.73% in the first quarter of the following year. Although economic growth remained constant (0.2%) in 2010, it started to decline again in 2011. Table 1 shows company descriptive statistics on the size and degree of diversification. The database consists of medium and large companies[8].

[6] IBEX35: it is an index comprising the 35 most liquid Spanish stocks traded in the Spanish Stock Exchange.
[7] Source for the Spanish GDP: AMECO.
[8] A great number of studies were performed with samples of large and generally listed corporations such as (Y. Chen et al. (2014); Gaur and Kumar (2009); Graham, Lemmon, and Wolf (2002); or C.-F. Wang, Chen, and Chang (2011)).

In 2011, the mean assets per company amounted to 6,922.23 million euros and the mean net turnover per company was 3,324.78 million euros. Indeed, for the same year the sum of all company net turnover accounts for 31.14% of the Spanish GDP and their assets are equivalent to 64.83% of GDP. However, the difference in size is notable, the interquartile range in 2011 for assets being 3,251.37 million euros and net turnover 1,672.91 million euros. Similarly, product and geographic diversification were widely used strategies and only 3 companies did not undergo corporate diversification in that year. From a timing perspective, the number of non-product diversified companies decreased during the period of analysis from 31 in 2006 to 25 in 2011. In the same way, the number of non-geographically diversified companies' decreased from 24 in 2006 to 12 in 2011.

Table 1. Descriptive Statistics

	Year		
	2006	2008	2011
Assets mean (millions of euros)	5221.11	6235.36	6922.23
Assets median (millions of euros)	913.31	933.02	971.45
Assets interquartile range (millions of euros)	3417.95	3314.19	3251.37
Sales mean (millions of euros)	2530.94	3101.17	3324.78
Sales median (millions of euros)	509.55	664.21	585.42
Sales interquartile range (millions of euros)	1117.28	1330.03	1672.91
Product diversification			
Average number of segments (2dig NACE2009)	3.15	3.08	3.04
Median number of segments (2dig NACE2009)	3	3	3
No diversified companies	31	29	25
Refocus companies		37	34
Companies increase diversification		36	41
No diversified companies in any year			22
Geographic diversification			
No diversified companies	24	15	12
Refocus companies		30	38
Companies increase diversification		55	48
No diversified companies in any year			11
Ratio of foreign sales in percentage*	45.09	49.84	59.60
Without any type of diversification			
No corporate diversified companies	9	4	3
No corporate diversified companies in any year			3
Product but not geographic diversified companies	15	11	9
Geographic but not product diversified companies	22	25	22

N=100; *: 91 Companies that reported domestic sales for every year (2006-2011)

Finally, it is interesting to compare the companies' sales growth at home and in foreign countries (figure 2). The data shows that domestic demand decreased as of the beginning of the economic crisis in 2008, whereas total sales grew every year except in 2009. Although in 2008 companies exported 49.84% of their products and services on average, in 2011 exports grew to 59.60% of total sales. This is valuable information to

understand export growth and implies that companies adapted partly to the decline in domestic demand by increasing their overseas sales.

Econometric modelling and variables

To test the hypotheses on the possible effects of corporate diversification on performance during a period of crisis and in line with other studies, I considered company performance as dependent variables, which depend on corporate diversification and control variables. Specifically:

$$P_{it} = \boldsymbol{X_{it}}\beta + \alpha_k * D_{it} + \mu_{it} \quad [1]$$

Where P_{it} is performance for company *i* and year *t*, $\boldsymbol{X_{it}}$ is the matrix with the constant and control variables that may affect performance, D_{it} is the diversification specification and μ_{it} the disturbance term, where $\mu_{it} = u_i + e_{it}$ u_i being the individual effects and e_{it} the idiosyncratic error term.

In equation [1], the individual effects are modelled as fixed to include unobserved company characteristics and to control for heterogeneity between companies. I assumed that companies have different resources or capabilities, which may have effects on performance. They also belong to different sectors, which may affect the performance and the degree of diversification (C. Wang, Hong, Kafouros, & Boateng, 2012). The Hausman test confirmed the validity of fixed effects models[9]. Each model provides corrections for the presence of autocorrelation and heteroscedasticity. The dependent, exploratory and control variables were measured as natural logarithms to obtain elasticities from their coefficients. Diversification variables in model 2, 4 and 5 were centered to facilitate interpretation[10]. Table 2 summarizes the 6 models developed to define and understand the effects of both strategies synthesized in the 3 hypothesis.

The following is description of the dependent, exploratory and control variables[11]:

[9] I used a robust method suggested by Arellano (1993) and .Wooldridge (2010, p. 332) which is carried out by a "xtoverid" STATA command developed by Schaffer and Stillman (2010) to test fixed versus random effects. This test is highly appropriate for heteroscedastic - and cluster- robust standard error models, such as ours, in which the Durbin-Wu-Hausman test can fail. It was followed by a Wald test, based on a cluster-robust estimate of the variance matrix. For the 6 models proposed, using EVA/Assets and EBIT/Assets as performance variables, the test rejects the null hypothesis (P-value much lower than 0.1) accepting the fixed effect estimation.

[10] Mathematically:

$$lnY_{it} = \alpha_i + \beta_1 lnIEp_{it} + \beta_2 lnIEg_{it} + \beta_3(lnIEp_{it} - \overline{lnIEp})^2 + \beta_4(lnIEg_{it} - \overline{lnIEg})^2 + \beta_5\left(lnIEp_{it} - \overline{lnIEp}\right)\left(lnIEg_{it} - \overline{lnIEg}\right) + controls + \varepsilon_{it}$$

Where: lnY_{it} is the logarithm of EVA / Assets or EBIT / Assets; α_i company fixed-effects plus the constant; $lnIEp_{it}$ the logarithm of the Product entropy index; $lnIEg_{it}$ the logarithm of the Geographic entropy index; $\overline{lnIEp}$ the overall mean of the logarithm of the Product entropy index; and $\overline{lnIEg}$ the overall mean of the logarithm of the Geographic entropy Index.

[11] The descriptive statistics and correlation matrix are available in appendix 2, showing no high correlations between variables.

Table 2. Model specification

Model	$\alpha_k * D_{kit}$ is equal to	Definition	Testing
1	$\alpha_1 PD_{it}$	Product diversification.	Linear and non-linear product diversification. (Hypothesis 1)
2	$\alpha_1 PD_{it} + \alpha_2 {PD_{it}}^2$	Product diversification + squared of product diversification.	
3	$\alpha_3 GP_{it}$	Geographic diversification.	Linear and non-linear geographic diversification. (Hypothesis 2)
4	$\alpha_3 GD_{it} + \alpha_4 {GD_{it}}^2$	Geographic diversification + squared of geographic diversification.	
5	$\alpha_1 PD_{it} + \alpha_3 GD_{it} + \alpha_5 (PD_{it} * GD_{it})$	Product div. + geographic div. + Interaction between product and geographic diversification.	Interaction effects (Hypothesis 3)
6	$\alpha_1 PD_{it} + \alpha_2 {PD_{it}}^2 + \alpha_3 GD_{it} + \alpha_4 {GD_{it}}^2 + \alpha_5 (PD_{it} * GD_{it})$	Product div. + geographic div. + product div. squared + geographic div. square + Interaction between product and geographic diversification.	

Dependent variables. I used Economic Value Added to total assets (EVA/Assets) and Earnings Before Interest and Taxes to total assets (EBIT/Assets) as market and accounting performance measures respectively (see the Appendix A for more details). EVA expands other accounting as well as market performance measures, including the opportunity cost for shareholders, thus providing a fair measure of the real value created for the firm by management. I include both measures to guarantee a broader analysis of company performance.

Explanatory variables. The degree of product and geographic diversification was measured by the sale-based Entropy index[12]. This measure highlights sales distribution by segments, which is a valuable diversification indicator, giving information on whether the company is diversified or not, as well as the degree and growth of company diversification over time. I measured the product Entropy index using a two-digit NACE-2009 code[13]. The degree of geographic diversification was calculated assuming 7 different

[12] I used the Jacquemin and Berry (1979) Entropy measure definition. I also used the Herfindahl Index as a product and geographic diversification measure, with similar results.

[13] NACE: Statistical classification of economic activities in the European Community. It should be pointed out that this article does not measure "related product diversification" using the NACE code. These types of codes are widely used to measure product diversification, however have limitations (Villalonga, 2004). Companies exercise considerable discretion in disclosing segment–level information. The extent of disaggregation in segment reporting is much lower than the actual extent of a firm's product diversification. Companies tend to aggregate related product segments into a single segment report, resulting in bias in the measure of "related product diversification".

regions – Spain, Europe, Latin America, USA and Canada, Africa, Asia Pacific and a non-specified region[14]. The non-specified region included sales reported by the company that cannot be attributed to any of the other six regions. The Entropy index is consistent with the majority of previous studies, such as those by Colpan and Hikino (2005), Chang and Wang (2007), or K. Park and Jang (2012). In the two Entropy index variables created, a zero value means no diversification, whereas higher values mean higher levels of product or geographic diversification.

Control variables. I included accounting and corporate governance measures that are capable of affecting company performance and that have sufficient variability within the companies during the period of analysis. The inclusion of control variables reduces the possibility of spurious correlations between corporate diversification and performance due to omitted variable bias. In addition to the normal accounting variables, in this paper I incorporated variables relating to the quality of corporate governance and ownership structure that may influence company performance, as well as product and geographic diversification -performance (Gande, Schenzler, & Senbet, 2009; Hoechle, Schmid, Walter, & Yermack, 2012; Lins & Servaes, 1999).This provides extra information on company performance.

Specifically, I controlled for size, liquidity, long-term debt, intangible assets, executive directors on the board, directors who serve on multiple boards and significant non-director shareholders on the board. Finally, I also added a dummy variable to control for the decreasing part of the business cycle resulting from the period of economic and financial crisis that began in 2008 (Enqvist, Graham, & Nikkinen, 2014; Kuppuswamy & Villalonga, 2015), which has a value of 0 for years 2006 and 2007 and 1 for 2008-2011. Size was measured by total sales to test the significance of economies of scale and market power (Gomes & Ramaswamy, 1999; J. Li & Yue, 2008). Liquidity and debt, two variables that were highly affected in the last economic financial crisis, were measured by the current ratio defined as current assets vs. current liabilities; and by long-term debt vs. total assets, respectively. Intangible assets were measured by the amount of intangible assets vs. total assets. I try to control for the company asset structure, which may determine its ability to transfer and sell assets, knowledge, technology and resources. The percentage of non-director significant shareholders[15] attempts to measure the ownership structure and the trade-off between serving shareholders and manager's objectives (Demsetz & Villalonga, 2001; Gande et al., 2009). The percentage of executive directors on the board is a core feature of corporate governance that can affect company performance (Baysinger & Butler, 1985). Finally, the percentage of directors who serve on multiple boards –more than one- is a potential measure of a busy board and may be indicative of the structure of corporate governance (R. Chen, Dyball, & Wright, 2009; Fich & Shivdasani, 2006).

14 In most cases, companies report their geographic segment information by selecting large areas and not focusing on countries (e.g. European Union or South America). This makes it difficult to analyse geographic diversification per country and is the reason why I aggregated in 7 different regions.

15 Non-director significant shareholders are defined as the percentage of significant shareholdings, excluding directors, amounting directly or indirectly to three per cent or more of the share capital.

Results

Table 3 reports the fixed effect regression output, where EVA/Assets and EBIT/Assets are the dependent variables. I begin by analysing the effect of product and geographic diversification on company performance, according to the 6 models described above (table 2)[16]. Models 1 and 2 analyse product and product diversification squared respectively. The results show that product diversification has a negative but not significant effect on performance in model 1 and I did not observe non-linear effects for product diversification: the squared terms are not significant in model 2. These results show that there is no relationship between product diversification and company performance in a period of economic crisis, which does not support the hypothesis 1. This result is in line with that obtained by Çolak (2010) using a European company sample.

In the case of geographic diversification, model 3 includes the linear relationship between geographic diversification and performance, whereas model 4 includes the squared relationship. In model 3, the coefficient for geographic diversification is positive, but not significant in both specifications of company performance. In model 4, the coefficient of the squared parameter of geographic diversification is positive and significant (0.297 for EVA/Assets and 0.210 for EBIT/Assets). The positive value of the squared parameter in a centered model and the non-significance in linear terms of geographic diversification in model 3 indicates a U-Shape relationship[17]. In line with other previous studies, such us those of Capar and Kotabe (2003) or Ruigrok and Wagner (2003) on European companies, I find a U-Shape relationship between performance and the degree of geographic diversification, which holds for a period of economic crisis. This result indicates that a low level of geographic diversification may be linked to an early stage of overseas activities, in which company performance is reduced due to market unfamiliarity and insufficient market power. Meanwhile, with a medium level of geographic diversification, the know-how and market power enable companies to exploit economies of scope and scale, thus improving company performance. The inflexion point at which the marginal effect of geographic diversification becomes positive is close to 0.45, representing a medium level of diversification (the mean of geographic diversification is 0.47, see table 1 in appendix B). This supports hypothesis 2.

[16] I replicated the 6 models reported in table 3 without centering the diversification variables. The results do not change the main implications described in this article relating to product and geographic diversification

[17] In model 4, the slope of geographic diversification (GD) comes from the first derivate of performance with respect to geographic diversification: $\alpha_3 + 2 * \alpha_4 GD_{it}$. I performed a Wald test to check the joint significance of the geographic diversification coefficients through: Ho: $\alpha_3 + 2 * \alpha_4 = 0$. The results do not accept the null hypothesis ($F(1, 89) = 3.62$ with P-value= 0.06 in the EVA/Asset model and $F(1, 97) = 5.00$ with P-value= 0.0277 in the EBIT/Asset model).

Table 3. Fixed effect estimation (FE) of the effect of product and geographic diversification and their interaction on company performance.

	EVA/Assets						EBIT/Assets					
VARIABLES	Model 1 FE	Model 2 FE	Model 3 FE	Model 4 FE	Model 5 FE	Model 6 FE	Model 1 FE	Model 2 FE	Model 3 FE	Model 4 FE	Model 5 FE	Model 6 FE
Sales (size)	0.0707***	0.0711***	0.0673***	0.0692***	0.0736***	0.0748***	0.0320**	0.0323***	0.0326***	0.0346***	0.0349***	0.0361***
	(0.0248)	(0.0249)	(0.0260)	(0.0253)	(0.0247)	(0.0242)	(0.0124)	(0.0125)	(0.0126)	(0.0123)	(0.0122)	(0.0121)
LD	0.0326	0.0292	0.0238	0.0350	0.0303	0.0322	-0.0774	-0.0801	-0.0725	-0.0630	-0.0667	-0.0649
	(0.0771)	(0.0779)	(0.0797)	(0.0787)	(0.0753)	(0.0765)	(0.0556)	(0.0561)	(0.0548)	(0.0541)	(0.0550)	(0.0544)
Current ratio	0.0712**	0.0724**	0.0734**	0.0620**	0.0713**	0.0645**	0.0908***	0.0917***	0.0881***	0.0797***	0.0877***	0.0838***
	(0.0320)	(0.0313)	(0.0321)	(0.0310)	(0.0310)	(0.0294)	(0.0205)	(0.0201)	(0.0213)	(0.0215)	(0.0207)	(0.0203)
Dummy crisis	-0.0307***	-0.0305***	-0.0325***	-0.0350***	-0.0296***	-0.0318***	-0.0253***	-0.0251***	-0.0252***	-0.0268***	-0.0225***	-0.0235***
	(0.00955)	(0.00937)	(0.00947)	(0.00963)	(0.00952)	(0.00956)	(0.00557)	(0.00552)	(0.00620)	(0.00631)	(0.00574)	(0.00574)
Int. assets ratio	0.0217	0.0196	0.0347	0.0335	0.0291	0.0251	0.0447	0.0418	0.0480	0.0447	0.0425	0.0377
	(0.0680)	(0.0665)	(0.0718)	(0.0699)	(0.0689)	(0.0663)	(0.0401)	(0.0397)	(0.0436)	(0.0433)	(0.0435)	(0.0435)
ND	0.151*	0.151*	0.154*	0.144*	0.145*	0.137*	0.0643***	0.0644***	0.0666***	0.0609***	0.0628**	0.0595**
	(0.0786)	(0.0786)	(0.0795)	(0.0775)	(0.0789)	(0.0775)	(0.0242)	(0.0247)	(0.0243)	(0.0235)	(0.0248)	(0.0244)
EB	-0.0771	-0.0775	-0.0790	-0.0825	-0.0871	-0.0891	0.172**	0.172**	0.177**	0.173**	0.177**	0.176**
	(0.123)	(0.124)	(0.123)	(0.118)	(0.123)	(0.121)	(0.0790)	(0.0796)	(0.0795)	(0.0767)	(0.0777)	(0.0767)
ND	-0.165**	-0.165**	-0.162**	-0.156**	-0.164**	-0.159**	-0.0514	-0.0514	-0.0511	-0.0481	-0.0543*	-0.0520
	(0.0716)	(0.0701)	(0.0692)	(0.0706)	(0.0720)	(0.0700)	(0.0340)	(0.0337)	(0.0328)	(0.0330)	(0.0322)	(0.0318)
Pro. Div.	-0.0838	-0.0887			-0.0850	-0.0794	-0.0497	-0.0538			-0.0259	-0.0242
	(0.0808)	(0.0780)			(0.0819)	(0.0801)	(0.0384)	(0.0379)			(0.0368)	(0.0363)
Pro. Div. sq.		0.0798				0.129		0.0870				0.0920
		(0.248)				(0.243)		(0.0848)				(0.0840)
Geo. Div.			-0.0255	0.00775	-0.0354	-0.00670			-0.0252	0.00226	-0.0292	-0.0111
			(0.0431)	(0.0491)	(0.0430)	(0.0474)			(0.0308)	(0.0319)	(0.0271)	(0.0271)
Geo. Div. sq.				0.297**		0.242				0.210**		0.128
				(0.148)		(0.148)				(0.0887)		(0.0803)
Pro. X Geo.					0.227**	0.206*					0.355***	0.336***
					(0.115)	(0.113)					(0.0793)	(0.0811)
Observations	496	496	494	494	493	493	545	545	543	543	542	542
R-squared	0.130	0.131	0.130	0.140	0.139	0.146	0.227	0.228	0.222	0.236	0.273	0.280
F	4.897***	4.453***	3.661***	3.640***	4.982***	4.335***	7.971***	7.528***	7.819***	7.455***	7.343***	6.374***
Nº companies	89	89	89	89	89	89	98	98	98	98	98	98

Logarithmic transformation of all continuous variables. Coefficients represent elasticities. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

LD: Long-term debt ratio; Int. assets: Intangible assets ratio; ND: % Non-director significant shareholders; ED: % Executive directors; MB: % Members of the board on other boards;

Following with the interaction between both types of diversification, model 5 portrays a positive and significant value of the interaction coefficient for both performance variables. (0.227 for EVA/Assets and 0.355 for EBIT/Assets). This result implies that combining product and geographic diversification positively affects company performance. Knowing that geographic diversification exhibits a non-linear relationship with performance, as shown in model 4, I replicated model 5 in model 6, although including the quadratic consecutive terms of product and geographic diversification. The results confirm that the interaction affect positively company performance (0.206 for EVA/Assets and 0.336 for EBIT/Assets). As I discussed previously, during the crisis, companies can offset low domestic demand by expanding their sales into foreign markets in any of their business lines, while avoiding company restructuring costs. Thus, I find support for hypothesis 3, in that the interaction between both types of diversification shows a positive relationship with company performance in an economic downturn.

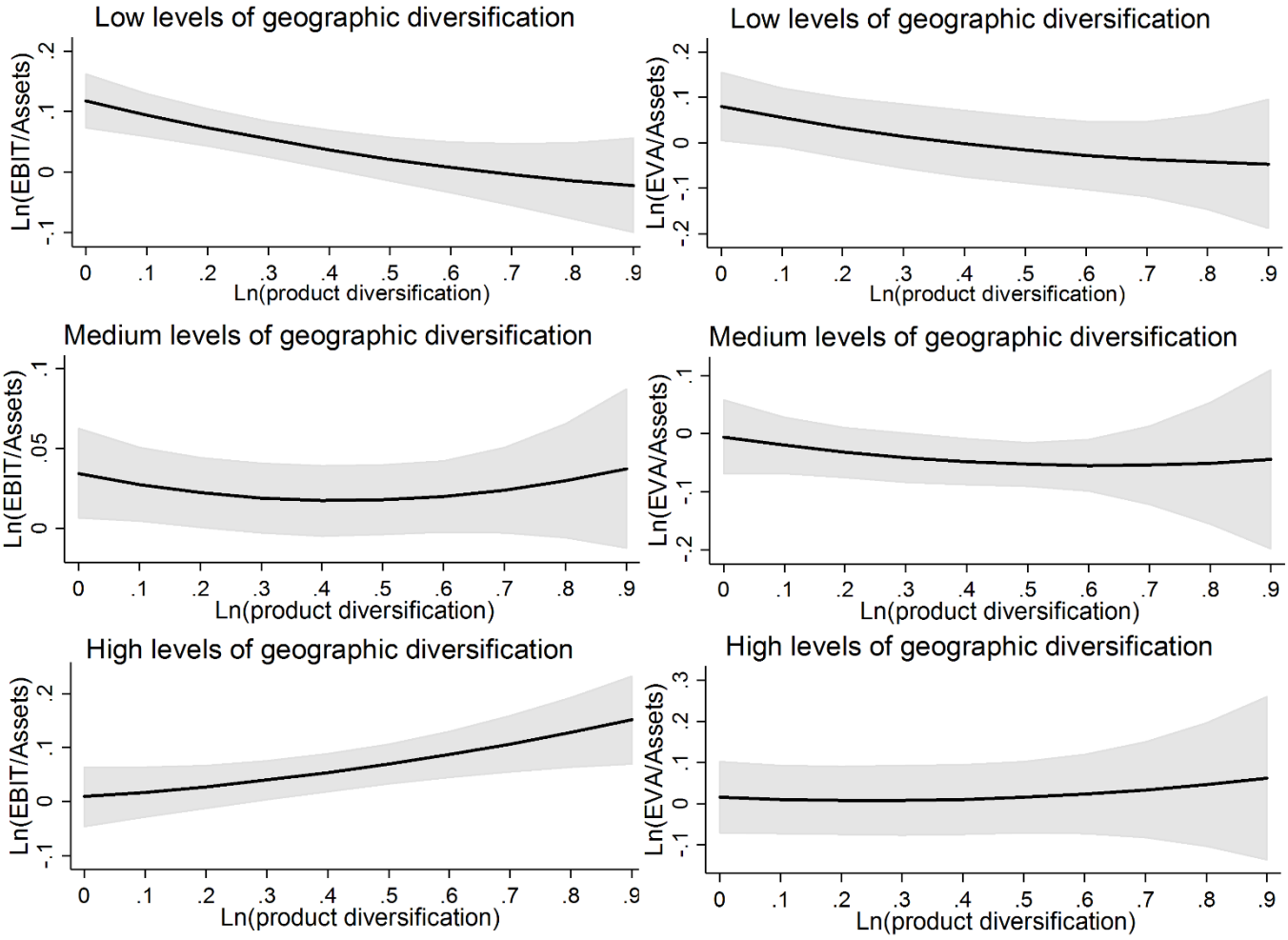
I delve deeper into the analysis of the interaction, by examining the marginal effects of product diversification on company performance according to different levels of geographical diversification. The figure 3 depicts the effect of product diversification on company performance in low, medium –average- and high levels of geographic diversification based on model 6 using EBIT/Assets and EVA/Assets as measures of company performance.

For low levels of geographic diversification, product diversification decreases company performance, whereas at medium levels of geographic diversification, product diversification keeps company performance constant. Finally, high levels of geographic diversification positively moderate the product diversification-performance relationship. These results suggest that geographic diversification enhances the benefits of product diversification, when the product diversification-performance relationship depends on the level of geographic diversification. The results portray a clear positive relationship between both types of diversification, clarifying the interpretation of model 1 and 2, where product diversification turns from negative into positive in a period of economic crisis, with high levels of geographic diversification.

Finally, I also find differences in the marginal effects by analysing the performance measured by EVA/Assets or EBIT/Assets. When I measure performance through EVA/Assets, I find a positive but not significant effect of the interaction. The figure confirms that the moderating effect of geographic diversification on product the diversification-performance relationship is not as enlightening as in the case of EBIT/Assets - predictions showing a great deal of dispersion and non-significance to 95%-. One explanation of these differences is that corporate diversification decisions are generally based on profitability according to financial statements, which is measured more accurately by accounting performance measures (Kim et al., 2015).

With respect to the control variables -accounting as well as corporate governance variables-, I find that company performance is positively related to its size, which confirms the potential advantages of market

Figure 3. Moderating effect of geographic diversification on the relationship between product diversification and company performance



power in periods of crisis. The coefficients of company size are double in EVA/Assets models than in EBIT/Assets, which shows the importance of the size of the company on market measures.

Besides, the current ratio is also positive with respect to performance for both estimates. Companies benefit from using internal liquidity as a resource in periods of economic crisis. On the other hand, the long-term debt ratio and proportion of intangible assets have no effect on performance. As far as the governance variables are concerned, the proportion of non-board member significant shareholders is an appropriate control mechanism of profitability positively affecting company performance (0.137 for EVA/Assets and 0.0595 for EBIT/Assets in model 6). Furthermore, the proportion of executives on the board is positive for EBIT/Assets (0.176), but not significant for EVA/Assets. These results show the positive influence of the management structure on the board in internal financial statements. Moreover, the proportion of directors who serve on multiple boards –usually called busy directors- negatively affects company performance using EVA/Assets (-0.241 in model 6), but it is not significant for EBIT/Assets. The negative effect reflects the potential agency problems (busyness effect) of directors on multiple boards, which is clearly shown when

performance is measured by EVA/Assets[18]. Finally, the period of economic crisis reduces company performance (-0.0318 for EVA/Assets and -0.0235 for EBIT/Assets in model 6).

Robustness check

To further understand and validate the results, I performed several additional analyses. Firstly, I addressed the potential endogeneity of the level of both types of diversification. Secondly, I analyse the possible spurious positive value of geographic diversification due to different areas economic growth. Third, I also ran the 6 models excluding the corporate governance variables. Fourth, I further analysed the relationship between geographic and product diversification by including interactions between the quadratic variables of both types of diversification. Finally, I used EBITDA, ROA and Q-Tobin as additional performance variables

4. Product and geographic diversification as endogenous variables.

A large number of authors analyse whether being diversified or not is a firm's endogenous choice (Campa & Kedia, 2002; Gande et al., 2009; Villalonga, 2004), but even the level of diversification can be decided by the company –e.g. to increase diversification, refocus or do nothing- (Çolak, 2010). Most of the companies in the sample chose to diversify in the late 90s, thus I checked the endogeneity of the degree of both types of diversification. I estimate model 1 to model 6 by applying instrumental variables fixed effect estimator (IV-FE) in order to validate the results. Each model provides corrections based on the presence of autocorrelation and heteroscedasticity. I included three additional instruments correlated with diversification variables, but not with the error of the main regression: lag of the diversification variable, lag of long-term debt ratio and the lag of current ratio. The previous diversification level is a good indicator of the following aspects: the main sector average diversification, company diversification strategy trend and the previous experience of managers in diversification strategy (Mayer et al., 2015; Ref, 2015; Wiersema & Bowen, 2008). Companies may also make their diversification choices depending on their previous liquidity and debt structure (Çolak, 2010; Gande et al., 2009). These two variables are relevant in the last financial and economic crisis. More liquidity means more opportunities to invest in product and geographic diversification strategies with less opportunity costs. Furthermore, companies with high levels of debt will generally be less inclined to increase any kind of diversification (O'Brien, David, Yoshikawa, & Delios, 2014; Yoshikawa & Phan, 2005).

In each of the models, the Kleibergen-Paap LM rk test shows that the instruments chosen are correlated with the endogenous regressors and the null hypothesis of under-identification is rejected. Similarly, the Sargan-Hansen J-Statistics over-identified test shows that the instruments are exogenous (or not over-identified) in all the models. Further, I also run 2 additional analysis accepting the exogeneity of each of the three extra instrument proposed (See appendix D for further details). For models 2, 4, 5 and 6 which include the squared

[18] See Fich and Shivdasani (2006), who address the intuition behind the negative effect of a "busy board" and its potential endogeneity.

diversification variables, I added the squared fitted values of the diversification variables as instruments, according to Wooldridge (2010).

Table 4 reports model 1 to model 6 using IV-FE. First stage regression is included in Appendix C. I did not find significant coefficients for product diversification in model 1 and 2, showing no relationship between product diversification and performance as in the previous model 1 and 2, shown in table 3. Geographic diversification yields a positive but not significant coefficient in model 3 and positive and significant coefficients for geographic diversification square in model 4 (0.825 in EVA/Assets and 0.634 in EBIT/Assets). These coefficients are higher than in the estimate by FE (0.297 in EVA/Assets and 0.210 in EBIT/Assets). This shows that the decreasing part of the U-Shaped curve is smaller after controlling for endogeneity. The inflexion point at which the marginal effect slope changes from negative to positive is now close to zero, showing low levels of geographic diversification. The reduction of the downside effects of both types of diversification after controlling for endogeneity has also been found in previous studies (Campa & Kedia, 2002; Gande et al., 2009; Kuppuswamy & Villalonga, 2015; Villalonga, 2004).

The interaction between product and geographic diversification is positive and significant for EBIT/Assets (0.545) and for EVA/Assets (0.663) in model 5, but not significant for EVA/Assets in model 6, when de quadratic consecutive terms are added. These coefficients are higher than the FE coefficient in table 3. In total, after controlling for the potential endogeneity of both types of diversification, the results yield a U-shaped relationship between geographic diversification and performance, in which the negative slope of the U-Shaped curve is small and the inflexion point remains at a low level of geographic diversification. Similarly, the positive interaction effects of geographic diversification on product diversification performance –and vice versa- is higher after controlling for endogeneity.

5. Controlling geographic diversification with the degree of internationalization.

There is a likelihood that geographic diversification can obtained simply by measuring sales in areas and countries that were less affected by the economic crisis than Spain. In these cases, it may be possible for a company to increase its level of geographic diversification only because its sales in Spain (home country) have decreased more than in foreign countries, according to the different economic growth between the areas. The objective in this section is to study how the geographic diversification-performance relationship changes after introducing the ratio of foreign sales. Introducing both variables together would reduce the potential spurious positive coefficient of geographic diversification, given that the period of the economic crisis was greater in Spain than in other areas.

Table 4. First robustness check: 2SLS fixed effect estimation (IV-FE) of the effect of product and geographic diversification and their interaction on company performance.

	EVA/Assets						EBIT/Assets					
VARIABLES	Model 1 FE	Model 2 FE	Model 3 FE	Model 4 FE	Model 5 FE	Model 6 FE	Model 1 FE	Model 2 FE	Model 3 FE	Model 4 FE	Model 5 FE	Model 6 FE
Sales (size)	0.0337	0.0346	0.0371	0.0405	0.0374	0.0398*	0.0348**	0.0345**	0.0314**	0.0345**	0.0294*	0.0312**
	(0.0218)	(0.0232)	(0.0236)	(0.0250)	(0.0229)	(0.0229)	(0.0142)	(0.0142)	(0.0145)	(0.0151)	(0.0153)	(0.0153)
LD	-0.0367	-0.0753	-0.0284	0.0107	-0.0729	-0.0468	-0.0808	-0.0755	-0.0782	-0.0517	-0.112*	-0.0785
	(0.0828)	(0.101)	(0.0807)	(0.0847)	(0.0829)	(0.0792)	(0.0628)	(0.0662)	(0.0580)	(0.0609)	(0.0587)	(0.0599)
Current ratio	0.0887***	0.103**	0.0806**	0.0527	0.109***	0.0822**	0.0913***	0.0896***	0.0853***	0.0642**	0.107***	0.0882***
	(0.0341)	(0.0477)	(0.0378)	(0.0383)	(0.0393)	(0.0367)	(0.0181)	(0.0180)	(0.0247)	(0.0251)	(0.0220)	(0.0222)
Dummy crisis	-0.0561***	-0.0566***	-0.0631***	-0.0691***	-0.0570***	-0.0666***	-0.0181***	-0.0181***	-0.0266***	-0.0302***	-0.0204***	-0.0228***
	(0.00975)	(0.00931)	(0.0115)	(0.0131)	(0.0122)	(0.0145)	(0.00521)	(0.00531)	(0.00804)	(0.00866)	(0.00759)	(0.00819)
Int. assets ratio	0.0443	0.0121	0.0877	0.0934	0.0397	0.0368	0.0417	0.0475	0.0670	0.0705	0.0339	0.0541
	(0.0689)	(0.0743)	(0.0697)	(0.0671)	(0.0684)	(0.0682)	(0.0453)	(0.0503)	(0.0470)	(0.0466)	(0.0452)	(0.0502)
ND	0.118	0.0903	0.115	0.0883	0.140	0.0898	0.0751**	0.0794***	0.0759**	0.0607**	0.101***	0.0978***
	(0.0881)	(0.0997)	(0.0895)	(0.0895)	(0.0859)	(0.0944)	(0.0297)	(0.0303)	(0.0321)	(0.0288)	(0.0323)	(0.0320)
ED	0.0120	0.0686	0.00116	-0.00608	0.00127	0.0288	0.197*	0.187*	0.212**	0.201**	0.196	0.169
	(0.167)	(0.202)	(0.145)	(0.132)	(0.183)	(0.185)	(0.102)	(0.102)	(0.105)	(0.0961)	(0.120)	(0.109)
MB	-0.263***	-0.262***	-0.247***	-0.232***	-0.265***	-0.243***	-0.0486	-0.0491	-0.0308	-0.0195	-0.0478	-0.0420
	(0.0767)	(0.0688)	(0.0794)	(0.0866)	(0.0811)	(0.0780)	(0.0391)	(0.0414)	(0.0374)	(0.0398)	(0.0360)	(0.0463)
Pro. Div.	0.0569	0.0908			0.0398	0.0616	-0.0574	-0.0621			-0.00442	-0.0280
	(0.220)	(0.225)			(0.228)	(0.218)	(0.0808)	(0.0848)			(0.0989)	(0.0954)
Pro. Div. square		1.073				0.599		-0.174				-0.433
		(1.179)				(1.031)		(0.338)				(0.334)
Geo. Div.			0.108	0.197	0.0750	0.202			0.101	0.168	0.0652	0.0987
			(0.0936)	(0.139)	(0.0925)	(0.146)			(0.0895)	(0.108)	(0.0814)	(0.0876)
Geo. Div. square				0.825**		0.919				0.634**		0.312
				(0.355)		(0.663)				(0.250)		(0.267)
Pro. X Geo. Div.					0.663**	0.492					0.545***	0.393**
					(0.316)	(0.340)					(0.207)	(0.190)
Observations	422	422	420	420	419	419	461	461	459	459	458	458
R-squared	0.192	0.074	0.188	0.157	0.160	0.096	0.214	0.201	0.175	0.154	0.215	0.164
F	8.057***	9.515***	7.108***	7.355***	6.295***	7.119***	7.042***	6.788***	5.213***	5.862***	5.858***	5.882***
Nº companies	89	89	89	89	89	89	98	98	98	98	98	98
Under text	14.5***	7.633*	11.47***	13.87***	12.64***	10.80**	19.37***	10.53**	11.51***	12.37***	16.20***	13.47***
Over text	0.475	0.449	1.154	0.714	2.113	1.086	0.486	0.404	0.054	0.067	0.656	0.218

Logarithmic transformation of all continuous variables. Coefficients represent elasticities. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
LD: Long-term debt ratio; Int. assets: Intangible assets ratio; ND: % Non-director significant shareholders; ED: % Executive directors; MB: % Members of the board on other boards; Under text: Under-identification Kleibergen-Paap rk LM; Over text: Over-identified Hansen J Statistic.

Table 5. Second robustness check: Regression of company performance on the degree of internationalization and geographic diversification.

	EVA/Assets				EBIT/Assets			
VARIABLES	Model 3	Model 4	Model 5	Model 6	Model 3	Model 4	Model 5	Model 6
Sales (size)	0.0856***	0.0878***	0.0934***	0.0947***	0.0426***	0.0453***	0.0435***	0.0452***
	(0.0258)	(0.0261)	(0.0236)	(0.0237)	(0.0133)	(0.0136)	(0.0131)	(0.0134)
Long-term debt ratio	-0.0240	-0.0194	-0.00742	-0.0187	-0.0642	-0.0573	-0.0518	-0.0558
	(0.0857)	(0.0845)	(0.0785)	(0.0800)	(0.0572)	(0.0570)	(0.0583)	(0.0579)
Current ratio	0.0675*	0.0615*	0.0644*	0.0650**	0.0719***	0.0660***	0.0704***	0.0690***
	(0.0359)	(0.0349)	(0.0332)	(0.0319)	(0.0210)	(0.0210)	(0.0206)	(0.0199)
Dummy crisis	-0.0408***	-0.0424***	-0.0372***	-0.0382***	-0.0232***	-0.0242***	-0.0210***	-0.0216***
	(0.00939)	(0.00950)	(0.00947)	(0.00944)	(0.00610)	(0.00618)	(0.00591)	(0.00591)
Intangible assets ratio	0.0123	0.0103	0.00764	0.000883	0.0155	0.0105	0.0121	0.00501
	(0.0755)	(0.0728)	(0.0696)	(0.0673)	(0.0381)	(0.0367)	(0.0342)	(0.0333)
% Non-director significant shareholders	0.123	0.115	0.112	0.108	0.0554**	0.0503**	0.0535**	0.0505**
	(0.0822)	(0.0806)	(0.0831)	(0.0815)	(0.0255)	(0.0246)	(0.0257)	(0.0252)
% Executive directors	-0.153	-0.158	-0.162	-0.164	0.138	0.132	0.142	0.141
	(0.149)	(0.147)	(0.146)	(0.149)	(0.0914)	(0.0905)	(0.0882)	(0.0892)
% Members of the board on other boards	-0.153**	-0.153**	-0.158*	-0.157**	-0.0239	-0.0254	-0.0280	-0.0275
	(0.0759)	(0.0769)	(0.0795)	(0.0747)	(0.0304)	(0.0306)	(0.0296)	(0.0289)
Pro. Div.			-0.0886	-0.0908			-0.0211	-0.0217
			(0.0844)	(0.0799)			(0.0405)	(0.0394)
Pro. Div. square				0.195				0.120
				(0.257)				(0.0833)
Geo. Div.	-0.134	-0.103	-0.139	-0.125	-0.0419	-0.00500	-0.0347	-0.0167
	(0.0965)	(0.101)	(0.0914)	(0.0922)	(0.0481)	(0.0443)	(0.0420)	(0.0393)
Geo. Div. square		0.282		0.157		0.250**		0.133
		(0.183)		(0.197)		(0.0961)		(0.0925)
Pro. X Geo. Div.			0.358***	0.321**			0.328***	0.286***
			(0.134)	(0.145)			(0.0860)	(0.0841)
Internationalization	0.149	0.149	0.121	0.133	-0.0266	-0.0308	-0.0413	-0.0376
	(0.121)	(0.122)	(0.113)	(0.115)	(0.0546)	(0.0541)	(0.0580)	(0.0569)
Observations	455	455	454	454	502	502	501	501
R-squared	0.173	0.181	0.189	0.194	0.231	0.250	0.272	0.280
F	3.946***	3.652***	4.703***	4.791***	5.723***	5.518***	5.887***	5.125***
Number of companies	86	86	86	86	94	94	94	94

Logarithmic transformation of all continuous variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5 shows geographic diversification and the degree of internationalization measured by the ratio of foreign sales in the models 3, 4, 5 and 6. The results confirm that the interaction between product and geographic diversification positively influences company performance as shown in the models appearing in table 3. Furthermore, geographic diversification has a U-Shaped relationship with performance when measured by EBIT/Assets (0.250) and the coefficient is close to being significant for EVA/Assets (p-value= 0.116). In short, I find that the degree of internationalization does not change the U-Shaped relationship between geographic diversification and performance and neither the positive effect of the interaction between product and geographic diversification on company performance.

It would have been very interesting to correct for the economic development of the destination area or country. However, as I said before, most of the companies report their geographic segment information by selecting large areas and not focusing on countries. Some focus on countries, some on broad geographic regions and others on economic regions, such as the European Union or MERCOSUR, as well as political or cultural regions: OECD, Latin America or Mediterranean countries. This makes it difficult to analyse geographic diversification per country. Due to the disparity of ways of reporting geographic sales, I grouped company sales into 7 major regions: Spain, Europe, Latin American Countries, USA and Canada, Africa, Asia and rest of the world. In regions such as Europe, the internal heterogeneity of each of these groups is large. For example, Germany grew by 4.1% in 2010 and France by 2%, while United Kingdom grew 1.5%, Norway 0.6%, Croatia -1.7%, and Greece -5.5%. All these areas are within the same region: Europe. The most extreme cases occur in Latin American and Asian countries with high within variations in GDP growth. Due to the different ways that companies report, in many cases I do not know either how much or in what countries they sell their products. All of this potentially bias the analysis of geographic diversification by regions. In any case appendix E include the regression output which geographic diversification representing different regions (See table E.1).

6. Analysis without corporate governance variables.

As I mentioned earlier, corporate governance might influence the performance of product and geographic diversification. Table 6 presents the six models described in table 2 where the corporate governance variables are not included as controls. Similar than the original models, product diversification exhibits no relationship with performance unless it is combined with geographic diversification (0.215 and 0.281 in the interaction term in model 6 for EVA/Assets and EBIT/Assets respectively). Geographic diversification yields a U-shaped relationship with performance as in the original models with similar coefficients. Thus, product and geographic diversification and its interaction keep the same relationship with performance when the corporate governance variables are not included.

Table 6. Fixed effect estimation (FE) of the effect of product and geographic diversification and their interaction on firm performance without corporate governance variables.

	EVA/Assets						EBIT/Assets					
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Sales (size)	0.0713***	0.0716***	0.0679**	0.0701***	0.0737***	0.0749***	0.0214	0.0215	0.0229	0.0270*	0.0247*	0.0274**
	(0.0245)	(0.0245)	(0.0259)	(0.0251)	(0.0245)	(0.0238)	(0.0142)	(0.0143)	(0.0141)	(0.0137)	(0.0140)	(0.0136)
LD	0.0387	0.0354	0.0314	0.0432	0.0344	0.0368	-0.0637	-0.0647	-0.0503	-0.0398	-0.0511	-0.0440
	(0.0780)	(0.0793)	(0.0815)	(0.0802)	(0.0763)	(0.0782)	(0.0526)	(0.0530)	(0.0522)	(0.0512)	(0.0505)	(0.0502)
Current ratio	0.0657**	0.0669**	0.0678**	0.0557*	0.0672**	0.0596**	0.0830***	0.0834***	0.0780***	0.0673***	0.0779***	0.0700***
	(0.0303)	(0.0297)	(0.0305)	(0.0294)	(0.0293)	(0.0278)	(0.0186)	(0.0183)	(0.0192)	(0.0193)	(0.0185)	(0.0186)
Dummy crisis	-0.0292***	-0.0290***	-0.0315***	-0.0343***	-0.0285***	-0.0311***	-0.0293***	-0.0292***	-0.0294***	-0.0314***	-0.0267***	-0.0287***
	(0.0100)	(0.00989)	(0.00951)	(0.00972)	(0.00974)	(0.00988)	(0.00551)	(0.00554)	(0.00600)	(0.00616)	(0.00558)	(0.00576)
Int. assets	0.00438	0.00235	0.0193	0.0171	0.0108	0.00632	0.0356	0.0346	0.0439	0.0387	0.0407	0.0364
	(0.0705)	(0.0685)	(0.0745)	(0.0721)	(0.0709)	(0.0677)	(0.0427)	(0.0434)	(0.0458)	(0.0439)	(0.0441)	(0.0442)
Pro. Div.	-0.0757	-0.0805			-0.0759	-0.0686	-0.0537	-0.0547			-0.0241	-0.0153
	(0.0870)	(0.0838)			(0.0879)	(0.0853)	(0.0380)	(0.0377)			(0.0370)	(0.0360)
Pro. Div. sq.		0.0781				0.130		0.0307				0.0205
		(0.260)				(0.256)		(0.115)				(0.114)
Geo. Div.			-0.0167	0.0215	-0.0268	0.00674			-0.0425	-1.76e-05	-0.0437	-0.0108
			(0.0436)	(0.0490)	(0.0424)	(0.0465)			(0.0408)	(0.0379)	(0.0361)	(0.0323)
Geo. Div. sq.				0.330**		0.274*				0.303***		0.233**
				(0.153)		(0.153)				(0.110)		(0.111)
Pro. X Geo. Div.					0.243**	0.215*					0.319***	0.281***
					(0.112)	(0.110)					(0.101)	(0.100)
Observations	499	499	497	497	496	496	566	566	562	562	561	561
R-squared	0.098	0.099	0.098	0.110	0.107	0.116	0.170	0.170	0.169	0.198	0.213	0.229
F	5.088***	4.776***	3.282***	3.509***	4.967***	4.466***	8.815***	7.651***	8.902***	7.957***	7.586***	6.270***
Nª of companies	90	90	90	90	90	90	99	99	99	99	99	99

Logarithmic transformation of all continuous variables. Coefficients represent elasticities. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. LD: Long-term debt ratio; Int. assets: Intangible assets ratio.

Table 7. Regression of company performance including other interactions between product and geographic diversification.

	EVA/Assets			EBIT/Assets		
VARIABLES	Model 7 FE	Model 8 FE	Model 9 FE	Model 7 FE	Model 8 FE	Model 9 FE
Sales	0.0752***	0.0754***	0.0760***	0.0359***	0.0361***	0.0363***
	(0.0248)	(0.0244)	(0.0247)	(0.0122)	(0.0123)	(0.0124)
Long debt ratio	0.0291	0.0319	0.0376	-0.0641	-0.0649	-0.0595
	(0.0781)	(0.0784)	(0.0794)	(0.0556)	(0.0553)	(0.0563)
Current ratio	0.0633**	0.0617**	0.0583*	0.0847***	0.0848***	0.0830***
	(0.0304)	(0.0306)	(0.0320)	(0.0205)	(0.0204)	(0.0204)
Dummy crisis	-0.0321***	-0.0316***	-0.0315***	-0.0234***	-0.0236***	-0.0234***
	(0.00981)	(0.00974)	(0.00979)	(0.00583)	(0.00585)	(0.00581)
Intangible assets ratio	0.0258	0.0281	0.0183	0.0377	0.0366	0.0298
	(0.0675)	(0.0689)	(0.0714)	(0.0443)	(0.0437)	(0.0426)
% Non-director significant shareholders	0.132*	0.140*	0.141*	0.0618**	0.0580**	0.0640**
	(0.0791)	(0.0776)	(0.0772)	(0.0252)	(0.0243)	(0.0249)
% Executive directors	-0.0945	-0.103	-0.0970	0.180**	0.181**	0.186**
	(0.128)	(0.129)	(0.130)	(0.0784)	(0.0788)	(0.0800)
% Members of the board in other boards	-0.157**	-0.160**	-0.158**	-0.0532	-0.0508	-0.0505
	(0.0729)	(0.0705)	(0.0708)	(0.0325)	(0.0328)	(0.0320)
Product diversification	-0.0847	-0.0570	-0.0666	-0.0227	-0.0358	-0.0345
	(0.0827)	(0.0974)	(0.1000)	(0.0372)	(0.0425)	(0.0449)
Pro. diversification square	0.127	0.132	0.236	0.101	0.0953	0.202*
	(0.250)	(0.250)	(0.300)	(0.0813)	(0.0861)	(0.109)
Geographic diversification	0.0201	-0.000698	0.0276	-0.0303	-0.0143	-0.0167
	(0.0665)	(0.0478)	(0.0694)	(0.0286)	(0.0280)	(0.0302)
Geo. diversification square	0.253*	0.271*	0.411**	0.124	0.119	0.242**
	(0.147)	(0.149)	(0.201)	(0.0833)	(0.0873)	(0.0968)
Pro. X Geo. Div.	0.240*	0.169	0.250	0.323***	0.362***	0.398***
	(0.135)	(0.124)	(0.172)	(0.0846)	(0.0780)	(0.0975)
Pro^2 X Geo. Div.	-0.391		-0.383	0.268		0.0788
	(0.583)		(0.613)	(0.243)		(0.272)
Pro X Geo^2. Div.		-0.441	-0.163		0.185	0.302
		(0.541)	(0.648)		(0.264)	(0.328)
Pro^2 X Geo^2. Div.			-1.858			-1.613
			(1.935)			(0.979)
Observations	494	494	494	542	542	542
R-squared	0.147	0.148	0.151	0.281	0.281	0.287
F	4.358	5.314	5.218	6.941	6.029	6.438
Number of firms	90	90	90	98	98	98

Logarithmic transformation of all continuous variables. Coefficients represent elasticities. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

7. Including other interactions between product and geographic diversification.

Now, I delve into the effect of the interaction between both types of diversification on performance. Specifically, I check the potential interaction using the square of each type of diversification. Table 7 reports three additional models with the same two dependent variables –EVA and EBIT over assets-. Model 7 introduces the interaction the product diversification squared and geographic diversification. In model 8 interacts product diversification and the square of geographic diversification, whereas in Model 9 presents the interaction between product and geographic diversification with quadratic terms of both variables. None

of the interaction coefficients are significant. Thus, although quadratic geographic diversification yields a significant positive coefficient –in models 4-, it does not affect the relationship between product diversification and performance.

8. Using different performance measures.

I did run additional regression using: EBITDA over assets, Q Tobin and ROA as performance measures. These are the most common measures of performance (including EBIT) in the corporate diversification field. The analyses output is included in appendix F. (See tables F1, F2 and F.3). The tables include fixed effects (FE) and 2SLS with a fixed effect (IV_FE), representing table 3 and 4 of the article. The main relationship between geographic diversification and performance, as well as the interaction, remains similar with these performance variables. The only exception is in the U-Shaped findings for ROA. In any case, net income is frequently criticized as a performance measure because, because it can be manipulated. This is why I chose EBIT instead.

Conclusions.

This paper extends previous analyses examining the interaction effect of product and geographic diversification on company performance in a period of economic crisis. With this objective, I built a novel database from segmentation data gathered directly from the annual financial statements of independent Spanish listed companies during the period 2006-2011.

The results confirm that the combination of product and geographic diversification increases company performance beyond what these strategies can contribute separately. The overall product and geographic diversification-performance relationship depends on the whole corporate diversification strategy pursued by the company. This result makes evidence the linked effects of product and geographic diversification on company performance and it expands previous research by showing that the combination of product and geographic diversification increases company performance in periods of economic crisis.

When I only consider product diversification in the model, I do not find a significant effect on company performance. This result is in line with Kuppuswamy and Villalonga (2015) who study the last financial crisis in the USA. Product diversification provides companies with both finance and investment advantages and it serves as an insurance risk reduction function for companies (Hovakimian, 2011). However, I also find that the product diversification is contingent upon the level of geographic diversification in a period of crisis. Particularly, the findings indicate a decrease in product diversification on company performance at low levels of geographic diversification, which change into an increase in high levels of geographic diversification. Thus, I expanded the intuition and results of S.-H. Lee and Makhija (2009), who found that geographic diversification is a flexible strategy in periods of economic crisis, with a positive side effect on product diversification performance as well. I debated whether in a period of economic downturn, the combination of both strategies is an efficient mechanism to resolve certain rigidities of product diversification. The re-defining of product diversification strategy may be slower than geographic diversification, in response to

short–term environmental changes. The transfer of technology, resources or assets between segments is not immediate and companies may find it easier and quicker to reorganize their geographic diversification strategy, rather than to adapt their product diversification strategy**.**

In the analysis, I obtained a U-Shaped relationship between geographic diversification and company performance. In line with other previous studies conducted in European countries (e.g. Capar & Kotabe, 2003; Ruigrok & Wagner, 2003), I found that geographic diversification is an effective strategy in economic downturns only if the company already has certain exposure to foreign markets. This result reinforces the idea of an initial foothold investment in geographic diversification strategy to generate net profits, as described in S.-H. Lee and Makhija (2009). Finally, the results are robust after controlling for the potential endogeneity of both types of diversification.

Two main implications arise from this article: Firstly, in a period of economic crisis, if companies wish to increase their performance by means of product diversification, they must seek potential international clients and overseas markets to compete. Geographic diversification reduces the downsides of product diversification in an economic crisis. When companies interact both strategies, they are less exposed to major environment fluctuations and downturn. Thus, managers should implement and develop routines to connect and integrate both types of diversification strategies. In other words, during a period of economic crisis, managers should determine if a new business of product sector is strong enough to compete in overseas market and whether the sector can be expanded geographically. Otherwise, product diversification can decrease company performance in an economic downturn. Secondly, the results highlight the importance of a joint analysis of both types of diversification to fully understand and determinate the performance of the company's actual level of corporate diversification. It has important implications for practitioners, who should check if the interaction of both strategies is significant when they are analysing the performance of product or geographic diversification.

Despite the interest of these results, it is important to mention that this study was subject to several limitations. Firstly, I used panel data from 100 independent Spanish listed companies, which may reduce the representation nature of other regions, specific sectors or another types of companies. Secondly, I cannot calculate the influence and weighting of the moderators that influence the product and geographic diversification-performance relationship. I also assume that each effect occurs independently to the others. This limitation opens the door for future research focusing on the effects of certain specific moderators on the performance resulting from the interaction of both strategies.

Appendix A

EVA is a company aggregate value measure that describes performance as the growth in company value. EVA is an indicator that subtracts the financial cost of capital employed in financing the company from its operating profit. Specifically, I defined EVA on assets ($EVAsAT_{it}$) in company *i* and year *t* to obtain a dimensionless measure of the value generated by the active unit:

$$EVAsAT_{it} = \frac{NOPAT_{it} - [(Liabilities + Equity)_{it} * WACC_{it}]}{TA_{it}}$$

NOPAT being the net operating profit after taxes and WACC the weighted average cost of capital. NOPAT was calculated as net profit plus financial expenses:

$$NOPAT = Net\ profit + financial\ expenses$$

I calculated WACC as the rate of return a company is expected to provide, on average, to all its shareholders in order to finance its assets. Mathematically, it is the sum of two parts expressed as a percentage: cost of debt (Kd) and cost of equity (RE), both weighted by their relative size in the sum of liabilities and equity[19] of the company.

$$WACC = \left[\frac{Liabilities}{Liabilities + Equity} * Kd\right] + \left[\frac{Equity}{Liabilities + Equity} * RE\right]$$

The cost of debt (Kd) is the amount of interest expense divided by total debt reported by the company. The return expected by the shareholder or cost of equity (RE) was calculated using an approximation of the Capital Asset Pricing Model (CAPM model). Specifically, I calculated:

$$R_{it} = \bar{R}_{ft} + \beta_{iM}\left(\bar{R}_{Mt} - \bar{R}_{ft}\right)$$

Where R_{it} is the cost of equity of Company i in year t; $\bar{R}_{ft}$ the expected risk-free return on the stock-market measured by the daily average of 10-year Spanish government bond yield for year; $\bar{R}_{Mt}$ being the average annual return of the stock market; and β_{iM} the sensitivity of company profitability *i* on market fluctuations. It can be interpreted as the risk associated to the company shares in relation to the Spanish stock market. β_{iM} was calculated using OLS regress as follow:

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}\left(R_{Mt} - R_{ft}\right) + \varepsilon_{it}$$

Where $\left(R_{Mt} - R_{ft}\right)$ is the daily stock-market premium and $R_{it} - R_{ft}$ the daily company share premium. The performance of the daily stock market has been calculated as the weighted arithmetic mean of the return of each company traded on such day. To calculate the average annual return of the stock market, I calculated the arithmetic mean of the daily company returns.

[19] The capital contributed by shareholders is approximate to company equity.

Appendix B

Table B. 1. Descriptive statistics and pairwise correlation.

	Mean	S.D	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11
1. EVA/Assets	-0.02	0.11	-0.49	0.21	1.00										
2. EBIT/Assets	0.04	0.08	-0.51	0.37	0.69	1.00									
3. Sales (size)	6.31	1.78	1.30	11.05	0.25	0.24	1.00								
4. Long-term debt ratio	0.25	0.14	0.00	0.88	-0.01	-0.04	0.40	1.00							
5. Current ratio	0.81	0.26	0.20	2.19	0.13	0.18	-0.24	-0.19	1.00						
6. Dummy crisis	0.50	0.50	0.00	1.00	-0.13	-0.18	0.00	0.07	-0.01	1.00					
7. Intangible assets ratio	0.11	0.13	0.00	0.58	0.05	0.02	0.16	0.27	-0.29	0.10	1.00				
8. Non-director significant shareholders	0.24	0.17	0.00	0.69	0.13	0.11	0.17	0.05	-0.08	0.01	-0.01	1.00			
9. Executive directors	0.18	0.11	0.00	0.47	0.03	0.10	-0.24	-0.14	0.19	-0.09	-0.05	-0.18	1.00		
10. Members of the board on other boards	0.19	0.14	0.00	0.61	0.06	0.09	0.47	0.10	-0.07	-0.03	0.05	0.03	-0.21	1.00	
11. Product diversification	0.31	0.28	0.00	0.89	-0.04	-0.12	0.20	0.19	-0.08	0.04	0.01	0.14	-0.09	0.14	1.00
12. Geographic diversification	0.47	0.28	0.00	0.93	0.09	0.08	0.48	0.17	0.07	0.11	0.12	-0.01	-0.10	0.25	0.13

Logarithmic transformation of all continuous variables.

Appendix C.

Table C. 1. First stage estimation results.

VARIABLES	Pro. Div. FE	Geo. Div. FE
Sales (size)	0.0269*	0.0245*
	(0.0138)	(0.0144)
Long-term debt ratio	0.104*	0.102
	(0.0604)	(0.0640)
Current ratio	-0.0191	-0.0580**
	(0.0272)	(0.0282)
Dummy crisis	0.00665	0.0273***
	(0.00770)	(0.00835)
Intangible assets ratio	0.0748	-0.00475
	(0.0672)	(0.0690)
% Non-director significant shareholders	0.0728	-0.0769
	(0.0593)	(0.0620)
% Executive directors	-0.218**	0.0224
	(0.0878)	(0.0913)
% Members of the board on other boards	0.0196	-0.0100
	(0.0549)	(0.0573)
Lag. Long-term debt ratio	-0.0658	-0.200***
	(0.0693)	(0.0714)
Lag. Current ratio	0.0261	0.00755
	(0.0217)	(0.0223)
Lag. Pro. Div.	0.418***	
	(0.0466)	
Lag. Geo. Div.		0.414***
		(0.0455)
Observations	461	459
Number of companies	98	98
R-squared within	0.249	0.313
R-squared between	0.729	0.926
R-squared overall	0.715	0.851
F	10.63***	14.52***

Logarithmic transformation of all continuous variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix D.

Although the selected instruments pass the statistical tests (overid-test and underid-test) a rational for the exogeneity of the instruments have to be provide, too. Not at least, since the overid-test assumes one instrument as exogenous for testing the second instrument for their validity (not correlated with the residuum). If all instruments are endogenous the overid test yields doubtful results. If the lagged instrument is correlated with the lagged error and if there is serial correlation. (Wooldridge, 2010)

I ran two additional analyses to check the exogeneity of the instrument proposed. Firstly, I calculated the C statistic (also known as a GMM distance or difference-in-Sargan statistic) discussed in Hayaski (2002). This technique allows testing of a subset of the orthogonality conditions; i.e., it is a test of the exogeneity of one or more instruments. It is defined as the difference between the Sargan-Hansen statistic of the equation with the smaller set of instruments (valid under both the null and alternative hypotheses) and the equation with the full set of instruments, i.e., including the instruments whose validity is suspect. Under the null hypothesis that both the smaller set of instruments and the additional one, suspect instruments are valid, the C statistic being distributed as chi-squared in the number of instruments tested. Failure to reject the null hypothesis requires the full set of orthogonality conditions to be valid.

Table D1 summarises the values of difference-in-Sargan statistics, where each instrument is tested one by one to check its exogeneity.

Endogenous variable on the right side	Product diversification					
Instrument tested	Lag of product diversification		Lag of long term debt		Lag of liquidity	
Performance variable	EVA/Assets	EBIT/Assets	EVA/Assets	EBIT/Assets	EVA/Assets	EBIT/Assets
Hansen J statistic (eqn. excluding suspect orthog. conditions):	0.158	0.215	0.366	0.052	0.108	0.305
Chi-sq(1) P-value	0.6907	0.6432	0.5454	0.819	0.7425	0.5805
C statistic (exogeneity/orthogonality of suspect instruments)	0.337	0.237	0.13	0.399	0.387	0.146
Chi-sq(1) P-value	0.5615	0.6265	0.7186	0.5276	0.5336	0.7024
Endogenous variable on the right side	Geographic diversification					
Instrument tested	Lag of geographic diversification		Lag of long term debt		Lag of liquidity	
Performance variable	EVA/Assets	EBIT/Assets	EVA/Assets	EBIT/Assets	EVA/Assets	EBIT/Assets
Hansen J statistic (eqn. excluding suspect orthog. conditions):	0.001	0.044	0.189	0.012	0.98	0.036
Chi-sq(1) P-value	0.9706	0.8347	0.6641	0.9141	0.3222	0.849
C statistic (exogeneity/orthogonality of suspect instruments)	1.32	0.011	1.132	0.043	0.341	0.019
Chi-sq(1) P-value	0.2506	0.9148	0.2872	0.8351	0.5593	0.8912

In all cases, I cannot reject the null hypothesis, meaning that each instrument selected is exogenous when I analyse them one by one.

This test is implemented in STATA command xtiveg2. To guarantee that the C statistic is not negative in finite samples, the estimated covariance matrix of the full set of orthogonality conditions is used to calculate both Sargan-Hansen statistics. Results are reported in the next table D1:

The second analysis ran the main regression (Equation 1 in the article, models 1 and 3, table 2) and then calculated the predicted error of the main regression. I then ran an auxiliary regression of the residues (predicted errors) over the instrument variables. If the coefficients of the instruments are not significant, it may mean that they are exogenous. Table D2 shows the predicted error of the main regression over the instruments:

Table D2. Predicted error of the main regression over the instruments.

	EVA/Assets				EBIT/Assets			
VARIABLES	Coef. (Std. Err.)	P-value	Coef. (Std. Err.)	P-value	Coef. (Std. Err.)	P-value	Coef. (Std. Err.)	P-value
Lag of long term debt	0.0119	0.924	0.0771	0.546	-0.0342	0.542	0.0117	0.849
	(0.125)		(0.127)		(0.0562)		(0.0611)	
Lag of liquidity ratio	0.0195	0.617	0.00899	0.842	0.00655	0.693	-0.00268	0.891
	(0.0388)		(0.0449)		(0.0166)		(0.0194)	
Lag of product div.	0.00317	0.968			-0.000108	0.997		
	(0.0789)				(0.0322)			
Lag of geographic div.			0.0138	0.758			0.000342	0.993
			(0.0447)				(0.0413)	
Firm fixed effects	Included		Included		Included		Included	
Observations	423		421		461		459	
R-squared	0.002		0.005		0.002		0.000	
Number of companies	90		90		98		98	
F	0.193	0.9007	0.316	0.8135	0.138	0.9368	0.0133	0.9979

Results confirm that the instruments are not related to the predicted errors of company performance (as Sargan Hansen suggests) and the coefficients of the instruments chosen are not significant.

Appendix E.

Table E1. Regression of firm value growth and firm performance on ratios of overseas sales.

	EVA/Assets		EBIT/Assets	
VARIABLES	FE	FE	FE	FE
Sales	0.0702***	0.0739***	0.0347***	0.0360***
	(0.0238)	(0.0227)	(0.0117)	(0.0117)
Long term debt	0.0317	0.0295	-0.0744	-0.0788
	(0.0771)	(0.0779)	(0.0556)	(0.0561)
Current ratio	0.0664**	0.0662**	0.0726***	0.0730***
	(0.0294)	(0.0286)	(0.0219)	(0.0210)
Dummy crisis	-0.0335***	-0.0317***	-0.0270***	-0.0255***
	(0.00873)	(0.00906)	(0.00579)	(0.00575)
% Non-director significant shareholders	0.130	0.123	0.0546*	0.0520*
	(0.0801)	(0.0792)	(0.0275)	(0.0274)
% Executive directors	-0.0693	-0.0822	0.163**	0.155*
	(0.123)	(0.122)	(0.0805)	(0.0787)
% Members of the board on other boards	-0.161**	-0.164**	-0.0415	-0.0441
	(0.0693)	(0.0717)	(0.0356)	(0.0370)
Product diversification		-0.0825		-0.0589
		(0.0849)		(0.0384)
Ratio sales to Europe	-0.0245	-0.0345	-0.0568	-0.0627
	(0.0632)	(0.0644)	(0.0384)	(0.0384)
Ratio sales to Latin America	0.0331	0.0417	0.0142	0.0199
	(0.0681)	(0.0729)	(0.0320)	(0.0339)
Ratio sales to USA and Canada	0.353*	0.345*	0.0647	0.0576
	(0.185)	(0.189)	(0.0622)	(0.0654)
Observations	499	498	553	552
R-squared	0.142	0.144	0.218	0.225
F	5.067***	5.109***	8.234***	8.892***
Number of companies	90	90	99	99

Logarithmic transformation of all continuous variables. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Appendix F.

Table F1 First robustness check: Regression of firm performance (EBITDA/Assets) on the degree of both types of diversification and their interaction.

	EBITDA/Assets											
VARIABLES	Model 1 FE	Model 2 FE	Model 3 FE	Model 4 FE	Model 5 FE	Model 6 FE	Model 1 IV_FE	Model 2 IV_FE	Model 3 IV_FE	Model 4 IV_FE	Model 5 IV_FE	Model 6 IV_FE
Sales (size)	0.0357***	0.0362***	0.0363***	0.0376***	0.0377***	0.0387***	0.0330***	0.0331***	0.0327***	0.0351***	0.0296***	0.0310***
	(0.0103)	(0.0102)	(0.0106)	(0.0108)	(0.0103)	(0.0104)	(0.00859)	(0.00858)	(0.00909)	(0.00913)	(0.00917)	(0.00951)
LD	-0.0560	-0.0597	-0.0517	-0.0449	-0.0481	-0.0489	-0.0722**	-0.0737**	-0.0606*	-0.0405	-0.0938**	-0.0713**
	(0.0362)	(0.0361)	(0.0354)	(0.0353)	(0.0355)	(0.0346)	(0.0345)	(0.0354)	(0.0344)	(0.0339)	(0.0365)	(0.0353)
Current ratio	0.0575***	0.0585***	0.0555***	0.0494***	0.0552***	0.0529***	0.0635***	0.0639***	0.0539***	0.0378**	0.0740***	0.0612***
	(0.0161)	(0.0155)	(0.0164)	(0.0170)	(0.0161)	(0.0156)	(0.0148)	(0.0146)	(0.0169)	(0.0181)	(0.0156)	(0.0166)
Dummy crisis	-0.0201***	-0.0197***	-0.0202***	-0.0213***	-0.0181***	-0.0187***	-0.0145***	-0.0145***	-0.0201***	-0.0228***	-0.0149***	-0.0170***
	(0.00479)	(0.00472)	(0.00534)	(0.00535)	(0.00494)	(0.00480)	(0.00343)	(0.00342)	(0.00470)	(0.00492)	(0.00464)	(0.00494)
Int. assets ratio	-0.00668	-0.0107	-0.00373	-0.00608	-0.00872	-0.0141	-0.0252	-0.0268	0.00206	0.00479	-0.0321	-0.0199
	(0.0324)	(0.0311)	(0.0354)	(0.0344)	(0.0317)	(0.0305)	(0.0295)	(0.0313)	(0.0322)	(0.0306)	(0.0251)	(0.0282)
ND	0.0372*	0.0376*	0.0398*	0.0357*	0.0365*	0.0345	0.0506*	0.0494*	0.0514**	0.0398*	0.0724***	0.0672**
	(0.0211)	(0.0211)	(0.0205)	(0.0203)	(0.0219)	(0.0213)	(0.0258)	(0.0270)	(0.0257)	(0.0238)	(0.0265)	(0.0263)
ED	0.110*	0.111*	0.115*	0.112*	0.115*	0.115*	0.125**	0.128**	0.125**	0.117**	0.122*	0.106*
	(0.0599)	(0.0607)	(0.0616)	(0.0608)	(0.0600)	(0.0604)	(0.0572)	(0.0571)	(0.0603)	(0.0537)	(0.0657)	(0.0558)
MB	-0.0255	-0.0259	-0.0250	-0.0229	-0.0277	-0.0264	-0.0217	-0.0217	-0.00726	0.00129	-0.0223	-0.0164
	(0.0280)	(0.0274)	(0.0272)	(0.0275)	(0.0265)	(0.0258)	(0.0263)	(0.0262)	(0.0272)	(0.0287)	(0.0258)	(0.0286)
Pro. Div.	-0.0406	-0.0480			-0.0245	-0.0276	-0.0121	-0.0121			0.0275	0.0177
	(0.0362)	(0.0352)			(0.0353)	(0.0337)	(0.0641)	(0.0637)			(0.0694)	(0.0663)
Pro. Div. square		0.127*				0.131*		0.0556				-0.258
		(0.0753)				(0.0724)		(0.270)				(0.230)
Geo. Div.			-0.0153	0.00452	-0.0185	-0.00502			0.0612	0.113**	0.0284	0.0600
			(0.0254)	(0.0240)	(0.0221)	(0.0195)			(0.0561)	(0.0562)	(0.0574)	(0.0573)
Geo. Div. square				0.151*		0.0905				0.482**		0.248
				(0.0808)		(0.0756)				(0.190)		(0.198)
Pro. X Geo. Div.					0.244***	0.232***					0.474***	0.357**
					(0.0664)	(0.0676)					(0.153)	(0.141)
Observations	544	544	542	542	541	541	460	460	458	458	457	457
R-squared	0.242	0.248	0.236	0.249	0.279	0.290	0.238	0.240	0.196	0.186	0.236	0.209
F	98	98	98	98	98	98	98	98	98	98	98	98
Nº companies	8.546***	8.270***	8.372***	7.877***	8.028***	7.327***	7.491***	6.678***	7.738***	7.364***	7.526***	6.911***
Under text							18.45***	11.53***	15.13***	21.60***	16.76***	15.24***
Over text							2.137	2.016	3.710	4.341	3.980	4.547

Logarithmic transformation of all continuous variables. Coefficients represent elasticities. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 LD: Long-term debt ratio; Int. assets: Intangible assets ratio; ND: % Non-director significant shareholders; ED: % Executive directors; MB: % Members of the board on other boards; Under text: Under-identification Kleibergen-Paap rk LM; Over text: Over-identified Hansen J Statistic.

Table F2. First robustness check: Regression of firm performance (ROA) on the degree of both types of diversification and their interaction.

	ROA											
VARIABLES	Model 1 FE	Model 2 FE	Model 3 FE	Model 4 FE	Model 5 FE	Model 6 FE	Model 1 IV_FE	Model 2 IV_FE	Model 3 IV_FE	Model 4 IV_FE	Model 5 IV_FE	Model 6 IV_FE
Sales (size)	0.0194	0.0202	0.0219	0.0229	0.0242*	0.0250*	0.0169	0.0176	0.0194	0.0218	0.0158	0.0181
	(0.0136)	(0.0135)	(0.0149)	(0.0149)	(0.0140)	(0.0140)	(0.0145)	(0.0143)	(0.0158)	(0.0165)	(0.0143)	(0.0146)
LD	-0.0820	-0.0886	-0.0643	-0.0597	-0.0638	-0.0704	-0.106	-0.119	-0.0750	-0.0547	-0.115	-0.0986
	(0.0772)	(0.0789)	(0.0820)	(0.0822)	(0.0783)	(0.0799)	(0.0761)	(0.0778)	(0.0793)	(0.0801)	(0.0747)	(0.0749)
Current ratio	0.104***	0.106***	0.0958***	0.0917***	0.0975***	0.0992***	0.110***	0.114***	0.0914***	0.0751**	0.117***	0.103***
	(0.0325)	(0.0324)	(0.0338)	(0.0345)	(0.0319)	(0.0320)	(0.0291)	(0.0318)	(0.0323)	(0.0331)	(0.0302)	(0.0298)
Dummy crisis	-0.0238***	-0.0232***	-0.0236***	-0.0243***	-0.0195**	-0.0192**	-0.0159**	-0.0158**	-0.0197**	-0.0226**	-0.0136	-0.0169
	(0.00785)	(0.00739)	(0.00839)	(0.00852)	(0.00777)	(0.00747)	(0.00704)	(0.00699)	(0.00959)	(0.0103)	(0.0101)	(0.0110)
Int. assets ratio	0.0998*	0.0928*	0.114*	0.112*	0.0995*	0.0924*	0.101*	0.0863	0.143**	0.145**	0.0940*	0.0961
	(0.0526)	(0.0516)	(0.0650)	(0.0647)	(0.0567)	(0.0556)	(0.0547)	(0.0620)	(0.0626)	(0.0620)	(0.0553)	(0.0594)
ND	0.0750	0.0752	0.0839	0.0811	0.0735	0.0732	0.108	0.0971	0.103	0.0909	0.120*	0.104
	(0.0571)	(0.0562)	(0.0564)	(0.0558)	(0.0573)	(0.0562)	(0.0708)	(0.0772)	(0.0688)	(0.0686)	(0.0692)	(0.0769)
ED	0.113	0.115	0.122	0.119	0.116	0.117	0.148	0.171	0.145	0.136	0.146	0.147
	(0.106)	(0.107)	(0.106)	(0.104)	(0.104)	(0.105)	(0.145)	(0.161)	(0.128)	(0.121)	(0.150)	(0.150)
MB	-0.108*	-0.108*	-0.110*	-0.108*	-0.113*	-0.113*	-0.135**	-0.134**	-0.121**	-0.112*	-0.141**	-0.131**
	(0.0650)	(0.0617)	(0.0625)	(0.0634)	(0.0645)	(0.0616)	(0.0549)	(0.0530)	(0.0567)	(0.0594)	(0.0569)	(0.0588)
Pro. Div.	-0.0891	-0.0991			-0.0741	-0.0829	-0.00869	0.00259			0.0176	0.0186
	(0.0705)	(0.0660)			(0.0721)	(0.0673)	(0.147)	(0.150)			(0.162)	(0.158)
Pro. Div. square		0.211				0.208		0.432				0.105
		(0.185)				(0.186)		(0.731)				(0.621)
Geo. Div.			-0.0591*	-0.0457	-0.0638**	-0.0591*			0.00865	0.0622	-0.0220	0.0315
			(0.0322)	(0.0357)	(0.0318)	(0.0335)			(0.110)	(0.126)	(0.109)	(0.125)
Geo. Div. square				0.102		0.0173				0.491		0.402
				(0.0938)		(0.0864)				(0.321)		(0.332)
Pro. X Geo. Div.					0.218**	0.219**					0.351	0.264
					(0.0858)	(0.0863)					(0.227)	(0.250)
Observations	545	545	543	543	542	542	461	461	459	459	458	458
R-squared	0.142	0.148	0.137	0.139	0.158	0.164	0.122	0.102	0.108	0.083	0.125	0.106
F	98	98	98	98	98	98	98	98	98	98	98	98
Nº companies	5.596***	4.724***	5.787***	5.514***	5.294***	4.323***	4.589***	4.326***	4.402***	4.109***	4.029***	3.634***
Under text							18.17***	10.92**	15.14***	19.57***	17.75***	14.43***
Over text							1.322	1.180	2.400	2.106	2.492	1.915

Logarithmic transformation of all continuous variables. Coefficients represent elasticities. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
LD: Long-term debt ratio; Int. assets: Intangible assets ratio; ND: % Non-director significant shareholders; ED: % Executive directors; MB: % Members of the board on other boards; Under text: Under-identification Kleibergen-Paap rk LM; Over text: Over-identified Hansen J Statistic.

Table F3. Regression of firm performance (Q Tobin/Assets) on the degree of both types of diversification and their interaction.

	Q Tobin/Assets											
VARIABLES	Model 1 FE	Model 2 FE	Model 3 FE	Model 4 FE	Model 5 FE	Model 6 FE	Model 1 IV_FE	Model 2 IV_FE	Model 3 IV_FE	Model 4 IV_FE	Model 5 IV_FE	Model 6 IV_FE
Sales (size)	-0.107***	-0.105***	-0.102***	-0.0963***	-0.0919***	-0.0880***	-0.0656**	-0.0607*	-0.0736**	-0.0586*	-0.0481	-0.0376
	(0.0270)	(0.0273)	(0.0267)	(0.0273)	(0.0290)	(0.0296)	(0.0319)	(0.0363)	(0.0296)	(0.0337)	(0.0402)	(0.0410)
LD	-0.0910	-0.103	-0.0342	4.03e-05	-0.0516	-0.0427	-0.152	-0.218	-0.0754	0.0986	-0.177	-0.00723
	(0.142)	(0.143)	(0.146)	(0.146)	(0.142)	(0.144)	(0.126)	(0.151)	(0.122)	(0.147)	(0.143)	(0.140)
Current ratio	0.0284	0.0326	0.00711	-0.0274	0.0126	-0.0101	0.0504	0.0759	0.00156	-0.122	0.0712	-0.0517
	(0.0729)	(0.0725)	(0.0742)	(0.0748)	(0.0728)	(0.0712)	(0.0735)	(0.0803)	(0.0732)	(0.0785)	(0.0760)	(0.0705)
Dummy crisis	-0.144***	-0.143***	-0.142***	-0.150***	-0.133***	-0.140***	-0.0964***	-0.0963***	-0.107***	-0.133***	-0.0802***	-0.109***
	(0.0149)	(0.0145)	(0.0192)	(0.0193)	(0.0154)	(0.0151)	(0.0148)	(0.0155)	(0.0191)	(0.0221)	(0.0210)	(0.0217)
Int. assets ratio	0.212	0.204	0.249	0.245	0.209	0.196	0.193*	0.128	0.271**	0.296**	0.155	0.191
	(0.144)	(0.143)	(0.168)	(0.165)	(0.138)	(0.140)	(0.116)	(0.134)	(0.131)	(0.138)	(0.109)	(0.126)
ND	0.110	0.110	0.139	0.108	0.0925	0.0691	0.186*	0.132	0.168*	0.0481	0.237**	0.0806
	(0.0960)	(0.0942)	(0.0942)	(0.0978)	(0.0915)	(0.0911)	(0.103)	(0.115)	(0.0970)	(0.135)	(0.0964)	(0.130)
ED	0.562***	0.560***	0.588***	0.577***	0.591***	0.584***	0.467**	0.576**	0.533**	0.501**	0.440*	0.459**
	(0.178)	(0.181)	(0.172)	(0.172)	(0.186)	(0.188)	(0.209)	(0.250)	(0.207)	(0.203)	(0.227)	(0.227)
MB	-0.106	-0.106	-0.117	-0.0998	-0.112	-0.0952	-0.0703	-0.0675	-0.0305	0.0362	-0.0942	-0.0220
	(0.113)	(0.112)	(0.110)	(0.108)	(0.107)	(0.103)	(0.104)	(0.118)	(0.108)	(0.116)	(0.1000)	(0.108)
Pro. Div.	-0.130	-0.150			-0.118	-0.100	-0.302	-0.254			-0.227	-0.266
	(0.139)	(0.142)			(0.143)	(0.149)	(0.251)	(0.299)			(0.263)	(0.282)
Pro. Div. square		0.304				0.397		2.118				0.778
		(0.357)				(0.369)		(1.423)				(1.083)
Geo. Div.			-0.110	-0.00898	-0.147	-0.0559			-0.0662	0.325	-0.235	0.154
			(0.116)	(0.0962)	(0.116)	(0.0953)			(0.241)	(0.243)	(0.290)	(0.258)
Geo. Div. square				0.899**		0.774**				3.654***		3.117***
				(0.394)		(0.388)				(1.154)		(1.197)
Pro. X Geo. Div.					0.744**	0.681*					2.122**	1.014
					(0.366)	(0.355)					(0.911)	(0.659)
Observations	499	499	497	497	496	496	424	424	422	422	421	421
R-squared	0.300	0.302	0.296	0.320	0.316	0.337	0.206	0.076	0.214	0.016	0.188	0.070
F	90	90	90	90	90	90	90	90	90	90	90	90
Nº companies	14.65***	15.94***	14.87***	12.45***	11.86***	11.90***	6.719***	5.439***	7.132***	5.397***	5.264***	4.423***
Under text							14.54***	6.270*	15.17***	28.10***	17.60***	8.918**
Over text							2.708	2.298	4.560	5.805*	2.378	3.639

Logarithmic transformation of all continuous variables. Coefficients represent elasticities. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
LD: Long-term debt ratio; Int. assets: Intangible assets ratio; ND: % Non-director significant shareholders; ED: % Executive directors; MB: % Members of the board on other boards; Under text: Under-identification Kleibergen-Paap rk LM; Over text: Over-identified Hansen J Statistic

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Chapter 2. A deeper look into the geographic and product diversification-performance relationship.

Abstract

This chapter extends previous empirical studies developing separate hypotheses in which each type of diversification may moderate the performance of the other type differently. It also expands previous results exploring the side effect of product and geographic diversification on relationship between company performance and other firm characteristics. For this propose, I used a novel panel data set comprising 85 Spanish listed companies from non–financial sectors during 2006–2011 and I conducted a Structural Threshold Regression correcting for the endogeneity of both types of diversification and firm specific characteristics. The results reveal that geographic diversification positively influences the product diversification–performance relationship. But product diversification has no clear impact on geographic diversification-performance relationship. Further, results portray that a minimal upfront investment in geographic diversification strategy is needed to generate a positive effect on product diversification performance. Finally, product diversification has a significant positive side effect on liquidity performance and geographic diversification shapes the long-term debt performance. The findings imply that the combination of both, product and geographic strategies, are needed to fully determinate diversification performance. Further, this paper offers guideline for managers to improve firm performance by combining both strategies.

Keywords - Geographic diversification, Product diversification, Firm performance, Spanish firms, Structural Threshold Regression.

Introduction

An increasing number of companies are diversified in products and foreign markets at the same time. Nowadays, it is difficult to find listed companies not diversified in product or geographic diversification. Firms seeking to expand the scope of their activities can do so by encompassing in dimensions of geographic as well as product markets (Bowen & Wiersema, 2009; Kumar, 2009; Mayer et al., 2015; Ref, 2015). Theories as resource-based and transaction-cost describe similar mechanisms through which product and geographic diversification can impact firm performance, as synergies, building capabilities, or increases in coordination and governance cost (Bowen & Wiersema, 2009; Hitt et al., 1997; Hitt et al., 2006; David J. Teece et al., 1997). However, product and geographic diversification are usually analysed as different corporate diversification strategies with their own effects on firm performance (Kirca et al., 2011; Peng & Delios, 2006)[20]. Firms involved in both types of diversification can generate additional costs and benefits which cannot be taken into account analysing only product or geographic diversification. Consequently, analysing both strategies together provide a more effective understanding of product and geographic diversification-performance relationship.

Although there are a few studies that have tried to examine the interaction between the two strategies, they provide mixed evidence. Whereas Geringer, Tallman, and Olsen (2000) and S. Tallman and Li (1996) did not find significant effects of the interaction on firm performance, Garrido-Prada, Delgado-Rodriguez, and Romero-Jordán (2016) and Hitt et al. (1997) found positive relationship. Further, Chang and Wang (2007) and Y. Chen et al. (2014) showed that while related product diversification positively influences the performance of multinational firms, unrelated product diversification negatively moderates the geographic diversification–performance relationship. And finally, Oh and Contractor (2012) portrayed that product diversification moderate positively geographic diversification in distant regions but negatively in proximate regions.

One possible explanation of the mixed results is the causality assumptions. Previous studies assume and justify that product diversification strategy influences the geographic diversification–performance relationship. However, Hitt et al. (1997) or Hitt, Hoskisson, and Ireland (1994) have found more complex relationship between both strategies, suggesting that geographic diversification is also a moderator of the product diversification–performance relationship and that product and geographic diversification also can affect other key variables of the firm**.** Thus, on the one hand, the direction of the influence can go from geographic diversification to product diversification performance, upside down, or be mutual. And on the other hand, both strategies may also influence some control variables generally used in models of corporate diversification which may change the net impact of product and geographic diversification on firm performance. For instance, Kuppuswamy and Villalonga (2015) and Hovakimian (2011) found that product

[20] Some studies use alternatives terms for geographic diversification such as global diversification, degree of internationalization or multinationality. In this article, geographic diversification means a firm's sales level of international expansion into different geographic locations, or markets, measure through Entropy and Herfindahl index.

diversification generates financing and investment advantages in the last period of financial crisis. Hence, the relationship between both strategies and their potential effect on some control variables need to be analyzed and controlled to fully understand how both strategies influence firm performance.

Further, previous studies are kindle aware to address whether be diversified is a firm's endogenous choice. But it is also important to address endogeneity bias from omitted firm specific characteristics or capabilities (Abdallah et al., 2015; Bowen & Wiersema, 2009). Firms can generate sustainable competitive advantage through resources and capabilities unobservable in the dataset, but that determine the performance of the firm. Therefore, failure to correct for any type of endogeneity may led to the wrong causal inference (Abdallah et al., 2015).

Finally, another reason is the bias that can occur when measuring related product diversification through the NACE code, or other similar as NAICS code[21]. These types of codes are widely used to measure product diversification but they have limitations (Villalonga, 2004). Firms exercise considerable discretion in disclosing segment–level information. The extent of disaggregation in segment reporting is much lower than the true extent of a firm's product diversification. Firms tend to aggregate related product segment into a single segment report, causing a bias in the measure of "related product diversification". This potential bias has serious implications for the statistical validity of prior findings.

This paper addresses these concerns by adopting an integrative framework that allows us to contribute toward understanding the complex interdependences between product and geographic diversification strategies on firm performance. Particularly, I theorize how geographic diversification may influences product diversification-performance relationship. This expand previous studies focus mainly on the effect of product diversification on the performance of geographic diversification. I examine the bidirectional influences between both types of diversification on firm performance. I developed separate hypotheses in which each type of diversification may moderate the performance of the other type differently. To enlarge the evidence of interaction, which symmetrically relates the influence of one type of diversification to the performance of the other type (Brambor, Clark, & Golder, 2006). I used a fixed–effect threshold regression model following the method proposed by Kourtellos et al. (2015). This technique is appropriate for several reasons. Firstly, to capture whether the product diversification–performance relationship changes due to the level of geographic diversification and vice versa. Secondly, to let product and geographic diversification influence the control variables and to detect the threshold, rather than selecting it arbitrarily. Thirdly, to calculate the effect of both types of diversification on firm performance under and above the threshold. And additionally, to control for the potential endogeneity of both types of diversification and firm unobserved characteristic. Finally, I measure product diversification as "*unrelated product diversification*" to avoid bias measuring this strategy.

[21] NACE: European Classification of Economic Activities; NAICS: North American Industry Classification System.

The remainder of this paper is organized as follow: section 2 provides the theoretical background and the hypotheses. After that, I explain the data, method and variables in section 3. I report the results in section 4 and finish with a discussion and the conclusion of this research.

Theoretical background and hypotheses

In this section, I review the main theoretical domains to identify how the combination of product and geographic diversification determines firm performance and how product diversification–performance relationship is influenced by geographic diversification, and vice versa. Firms are dynamic organizations where the effects on firm performance of a strategy are determined by other strategies. Product and geographic diversification strategies are interdependent since both require investment commitments to leverage resources, technology, or capabilities into geographic and product markets (Bowen & Wiersema, 2009; David J. Teece, 1982). These interconnections between both strategies not only affect the degree of product and geographic diversification if not the performance of each strategies.

Starting by the mutual effects, when the company is involved in both types of diversification, there are greater opportunities for synergies. From the resource-based view, using common distribution channels, brand names, networks, production facilities, or marketing strategies, firms may enhance efficiency and reach higher levels of economies of scale and scope compared with other firms undiversified in both dimensions (Chang & Wang, 2007; Zahra et al., 2000; Zhou, 2011). Furthermore, the Industrial Organization theory advocates that by gathering different product segments and overseas market, the firm can achieve greater market power in relation to suppliers, customers and competitors (Palich, Cardinal, & Miller, 2000). However, the combination and expansion of product and geographic diversification requires substantial amounts of managerial time and effort and may erode the benefit of synergies (David J. Teece, 1982; Vermeulen & Barkema, 2002; Zhou, 2011). According to the transaction cost theory, firms are pushed to markedly increase coordination and administrative costs to integrate their business and overseas segments (Wiersema & Bowen, 2008).

Following by the effect of geographic diversification on the product diversification-performance relationship, geographic diversification offers the possibility of increasing the potential markets, customers, suppliers and investors for each of the firm's product segments (S.-H. Lee & Makhija, 2009). On the one hand, based on the real option perspective, when firms are involved only in home country markets for their business lines, they are subject to the characteristics and boundaries of those markets. So far, when firms are also present in international markets, this increases their options and the likelihood of accessing in advance to foreign technology, extra information for any firm's business lines or take advantage of market inefficiencies (Williamson, 1981). Further, the possibilities for optimizing investment through preferential access to information are much higher when the company is also geographically diversified. For instance, through being present in international regions, changes in customer preferences, the cost of resources or regulation policies may be anticipated. Thus, managers can readapt more efficiently to the new scenario, taking

advantage of the information gathered in international markets to improve the performance of any of their product segments.

On the other hand, geographic diversification may provide a flexible strategy for managers, enhancing their potential to adapt to changes in the environment and to invest efficiently (Kogut & Kulatilaka, 2001; S.-H. Lee & Makhija, 2009). Managers can mitigate product segments constraints –and rigidities– by expanding their activities overseas enhancing efficiency in resources allocation. Firms may find it easier to transfer intangible assets and tacit knowledge to various overseas markets rather than to other dissimilar product segments. Thus, companies can respond rapidly to unanticipated –and anticipated– downward changes in domestic or international demand, shifting sales and investment to other markets and segments by exploiting multinational networks for their different business lines (S.-H. Lee & Makhija, 2009; Shaver, 2011). This flexibility provided by geographic diversification may be even higher having an established exporting infrastructure. Geographic diversification expansion is usually developed on business lines already known to the company (Ref, 2015), and in similar cultural markets (Gomes & Ramaswamy, 1999), which may help reduce the costs of entry barriers and increases the adaptability of the company to the new market. This enables managers to implement more expeditiously the necessary adjustments to generate sustainability as a competitive advantage and fix imbalances in the firm's product segments. Hence, flexibility is an important moderator that positively impacts the product diversification–performance relationship.

Finally, geographic diversification also strengthens the dominant position in a negotiation (J. Li & Yue, 2008). Geographically diversified firms have greater access to resources, information and flexibility, which afford a better position in negotiations with groups (e.g. employees, suppliers or institutional agencies). In companies that are only product–diversified, the negotiation power depends on the ability to transfer technology and resources among their different business lines (Bowman & Helfat, 2001). However, when companies are also involved in geographic diversification, with similar technology and resources, they have extra alternatives in a failed negotiation, reducing potential losses and improving their dominant position. Similarly, firms that are able to internationalize and increase their geographic diversification send signals to the market regarding their competitiveness. These signals may attract customers and investors, to any product segments who otherwise would not have been part of the range of possibilities, to their business lines. For instance, using a successful and well know brand to any of the product or geographic segment.

In the opposite direction, product diversification may also positively influence the geographic diversification–performance relationship. Apart from the benefit of synergies, a company's capability to generate economies of scale and scope depends on the ability to transfer knowledge, technology and shared resources to their different business and geographic segments. In this sense, managers learn from past experience of product diversification, applying more efficient mechanisms to facilitate transactions across overseas markets and facilitating the decision making process (Chang & Wang, 2007; Hitt et al., 1997; Mayer et al., 2015; David J. Teece et al., 1997). Thus, the lessons learned from product diversification assist managers to increase geographic diversification performance by reducing transaction costs for implementing and sharing new processes, knowledge or technology.

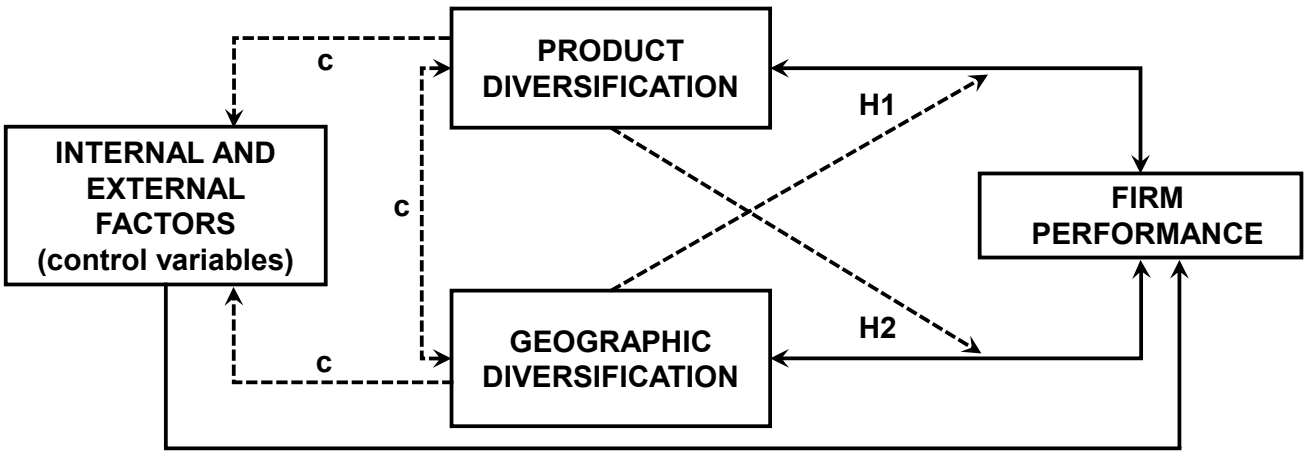
Further, through product diversification companies can achieve higher levels of internal capital market efficiency (Hovakimian, 2011; Kuppuswamy & Villalonga, 2015). This internal capital market can give the firm the chance to invest in product and geographic segments that would otherwise not be possible. For instance, firms can stop investments for a particular segment by transferring these funds to another more profitable segment or to an international market.

The intensity of the moderating effect of product and geographic diversification on the other type of diversification may differ depending on the firm's background, as well as other internal and external factors. I have controlled this fact using firm fixed effects and assuming that product and geographic diversification are endogenous variables in my model. But the data includes the recent economic crisis period (2008–2011). A period of economic crisis requires resources, capabilities, and strategies that are fundamentally different from those that are likely to lead to success in more stable markets (Kogut & Kulatilaka, 2001; S.-H. Lee & Makhija, 2009). Thus, although the channels through which geographic (product) diversification influences the product (geographic) diversification–performance relationship are the same as explained above, their intensity and weight may differ. Under this circumstances, I suggest that the potential benefits of flexibility, negotiation power, access to information and synergies can surpass the costs of dealing with firms' more complex environmental and internal structures. Additionally, product diversification can improve geographic diversification performance through managers' experience, potential synergies and the promotion of the internal capital market. Thus, I propose the following hypotheses:

Hypothesis 1. Increased geographic diversification positively moderates the product–diversification performance relationship.

Hypothesis 2. Increased product diversification positively moderates the geographic diversification–performance relationship.

Figure 1. Research Model.



A solid line arrow means direct relationship whereas a dotted (dashed) arrow implies moderation effect. *C* means relationship controlled in the model using Structural Threshold Regression.

The above hypotheses are sketched out in my research framework. Figure 1 shows that the effect of product and geographic diversification on firm performance is moderated by the other type of diversification. Firm

performance is also affected by internal and external factors which are included as control variables. Finally, the level of geographic and product diversification is determined endogenously depending on the other type of diversification. See section 3 for a full understanding of the research model.

Data, method and variables

I built a balance panel database of independent Spanish listed companies from 2006 through 2011, not belonging to the financial sector[22](See Appendix B in chapter 2 for further information about the database used in this chapter and chapter 1). I gathered raw corporate diversification data extracting the product and geographic segments information for each company and year directly from their annual reports, which follow the International Financial Reporting Standards Operating Segments (IFRS 8). Each of the product segments has an associated NACE2009 activity code. This database allows, first, to select companies with autonomous decision in product and geographic diversification strategies, in a European country generally less analysed than other regions as USA, Japan, UK, or same emerging countries. And second, to collect homogeneous data of the degree of geographic and product diversification, available freely, that is a good alternative to increase analysis of corporate diversification in European firms. The final sample includes 85 firms, the broadest balance database I can gather from the most comprehensive sample of Spanish listed firms not limited to the IBEX35 group[23].

I tested whether firm performance depends on product and geographic diversification, but I allowed for a structural break where the slope of product diversification can be moderated by geographic diversification (table 2) and vice versa (table 3). For this propose, I used the Structural Threshold Regression model described in Kourtellos et al. (2015)[24] (See Appendix A for further information). I addressed endogeneity bias from omitted firm specific characteristics or capabilities through fixed effects, assuming that firms have different resources or capabilities and belong to different sectors, which may impact performance. Further, I considered the potential endogeneity of the degree of both types of diversification, and I included control variables which can be also affected by product and geographic diversification. This model expands previous studies elaborating a joint analysis between both strategies and their direct and indirect effect on firm performance and control variables. Concretely, I fit the following regression:

$$y_{it} = \beta_1' x_{it} I(q_{it} \leq \theta) + \beta_2' x_{it} I(q_{it} > \theta) + \eta_i + e_{it} \quad (1)$$

Subscript i indexes firms (85 companies) and the subscript t indexes time (6 years). The dependent variable y_{it} is performance, while q_{it} is an observed threshold variable that splits the sample into two regimes. In this article, q_{it} is product or geographic diversification, which are treated as endogenous variables. The matrix

[22] I consider that a company or corporation is independent when not more than 25% of its capital is controlled by another company or corporation. Thus, I have selected Spanish parent companies that have autonomy over their decision-making process.

[23] IBEX35: it is an index comprising the 35 most liquid Spanish stocks traded in the Spanish Stock Exchange.

[24] I used the MATLAB code provided by the authors in:
https://sites.google.com/site/kourtellos/resear/research

x_{it} includes control variables and product or geographic diversification variables. The idiosyncratic error term is represented as e_{it} and η_i is the individual effects. Finally, θ is an unknown threshold parameter which determines the indicator $I(\cdot)$. The indicator values are one and zero if θ is under or above the threshold variable q_{it} respectively. The individual effects are modelled as fixed to include unobserved firm characteristics in the models controlling for heterogeneity among firms. I removed individual specific means to eliminate the individual weight η_i. Each model provides corrections for the presence of heteroskedasticity in each regime. Finally, I calculated regression slopes, under and above the threshold value, using GMM estimation controlling for the endogeneity of product and geographic diversification.

One advantage of this model is that the value θ is estimated instead of chosen arbitrarily. Concretely, threshold θ is estimated by using a two-step concentrated least squares, minimizing the concentrated sum of squared error and assuming that the threshold variable is endogenous. Following Kourtellos et al. (2015) inverse Mill ratio is introduced to ensure bias correction term in each regime. I inverted the likelihood ratio (LR) statistic to construct the confidence interval of the threshold estimator following Hansen (2000) suggestion.

I used Earnings Before Interest and Taxes to total assets (EBIT/Assets) as the measure of firm performance. The degree of product and geographic diversification was measured by the sales–based Entropy index[25]. This measure highlights sales distribution by segments, giving information on whether the company is diversified as well as the level and evolution over time of firm diversification. The degree of geographic diversification was calculated assuming 7 different regions, namely, Spain, Europe, Latin America, USA and Canada, Africa, Asia and Pacific, and a non–specified region. The non–specified region included sales reported by the firm which cannot be attributed to any of the six regions described previously. I measured the product Entropy index using a two–digit NACE–2009 code. The Entropy index is widely used to measure diversification, as in K. Park and Jang (2012), Chang and Wang (2007) or Colpan and Hikino (2005).

I controlled for variables that may affect firm performance and are widely used in similar research. Concretely, I used size, liquidity, long–term debt, intangible assets, and a dummy for the period of economic crisis started in 2008. Size is measured by total sales to test the significance of economies of scale and market power (Gomes & Ramaswamy, 1999; J. Li & Yue, 2008). Liquidity and debts, two variables highly affected in this period of economic crisis, are measured by the current ratio defined as current assets to current liabilities, and by long–term debt to total liabilities, respectively. In the case of intangible assets, these are measured as the ratio of intangible assets to fixed assets to control for the firm's fixed assets structure. Finally, a dummy variable was used to control for the period of economic crisis started in late 2008. I also include the square of each control variable, except the dummy variable, to reduce the possibility of spurious correlation due to omitted variables bias.

[25] I used Jacquemin and Berry's (1979) definition of Entropy measure.

1. Endogeneity of product and geographic diversification.

I considered the potential endogeneity of the degree of both types of diversification. A large group of authors analyse whether being diversified is a firm's endogenous choice (e.g. Campa & Kedia, 2002; Gande et al., 2009; Villalonga, 2004), but even the level of diversification can be decided by the corporation, e.g. increase diversification, refocus, or do nothing (Çolak, 2010). Therefore, I checked instead the endogeneity of the degree of both types of diversification. I included four additional instruments for geographic diversification: the lag of geographic diversification variable, the lag of the number of operational segments, the lag of the ratio of long–term debts and the lag of the current ratio.

The previous geographic diversification level, and previous number of operational segments are good indicators of the diversification evolution and the previous experience of managers in corporate diversification strategy (Kumar, 2009; Mayer et al., 2015; Ref, 2015; Wiersema & Bowen, 2008). The number of operational segments is based on the International Financial Reporting Standards, Operating Segments (IFRS 8), which is included in the annual reports of listed companies[26]. Managers may also make their choices depending on previous performance (C. Park, 2003; Villalonga, 2004). Previous liquidity and debt structure were two variables highly affected by the crisis, and that were taken into account by managers before making their choices. The long–term debt ratio lag, the current ratio lag, and the lag of the number of operational segments are also used as instruments for product diversification, but I have included two additional variables: product diversification variable lag and the lag of the number of regions where the company is present in each year. For models that include the diversification variables squared, I added the squared fitted values of the diversification as instruments following Wooldridge (2010). I tested the validity of the instrument selected with the Kleibergen–Paap LM rk test (under–identifying restrictions) and the Sargan–Hansen test (over–identifying restrictions), respectively. The Kleibergen–Paap LM rk test reveals that the instruments chosen correlate with the endogenous regressor, and the null hypothesis of under identification is rejected. Similarly, the Hansen J–Statistics test reveals that the instruments are exogenous (or not over–identified)[27].

Results

I started analysing the moderating effect of both types of diversification as shown in tables 2 and 3. This was followed by the robustness check. Table 1 reports the correlation matrix as well as the minimum, mean and maximum values for the variables included in the model after subtracting individual means.

[26] Operating segments differ from product diversification segments of the firm. The former is based on the internal structure of the firm whereas the second is associated to the NACE code. For instance, *Adolfo Dominguez*, a clothing retailer, reports 3 different operating segments based on the potential clients for its products. However, these 3 segments belong to one product diversification segment with NACE–2009 rev2.code: 4771, "Retail sale of clothing in specialised stores".

[27] Results of these tests are included in tables 2 and 3.

Tables 2 and 3 report the regression output by GMM with geographic diversification and product diversification, as the threshold variable respectively. Regimes 1 and 2, respectively, present the results under and above the threshold point. The Inverse Mill's ratio is included to correct the potential endogeneity of the threshold variable. Firms' fixed effects were also added to the threshold estimation and in the main regression, correcting for unobserved firm characteristics. Positive values for the threshold point indicate an increase in the level of geographic (or product) diversification, whereas a negative value signals a decrease in the firm's geographic (product) diversification level.

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Table 1. Variables correlation

	Min.	Max.	Mean	S.d.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)EBIT/assets	-0.41	0.34	0.04	0.08	1.00										
(2)Geo. Div	0.00	1.54	0.70	0.44	-0.01	1.00									
(3)Pro. Div	0.00	1.43	0.45	0.43	-0.10	0.00	1.00								
(4)Sales (ln)	1.70	11.05	6.38	1.85	0.25	0.09	-0.05	1.00							
(5)Sales sq (ln)	2.89	122.06	44.12	25.01	-0.02	-0.03	0.05	0.05	1.00						
(6)Liquidity	0.22	7.91	1.36	0.91	0.16	-0.08	-0.06	-0.11	0.02	1.00					
(7)Liquidity sq	0.05	62.55	2.67	5.96	0.07	-0.05	-0.06	-0.11	0.00	0.82	1.00				
(8)Long debt	0.00	0.93	0.43	0.21	0.12	0.07	0.05	0.02	0.07	0.46	0.08	1.00			
(9)Long debt sq	0.00	0.87	0.23	0.19	-0.09	-0.05	-0.02	-0.07	-0.01	0.17	0.03	0.09	1.00		
(10)Intangibles	0.00	0.80	0.22	0.23	0.06	0.07	0.03	0.15	-0.05	-0.07	-0.08	0.08	0.06	1.00	
(11)Intangibles sq	0.00	0.64	0.10	0.15	-0.01	-0.02	-0.04	0.05	-0.00	-0.05	-0.10	0.05	0.11	0.70	1.00
Dummy crisis	--	--	--		-0.28	0.29	0.10	-0.15	-0.03	-0.00	-0.02	0.12	0.03	0.09	0.09

N=425. Pearson correlation partialled for fixed firm-effect

Starting with the model in table 2, the threshold point of 0.037 represents low–medium increases in geographic diversification. The findings show that product diversification variables yield a negative coefficient (–0.1383) in regime 1, but positive (0.0323), although not significant, in regime 2. The two–tailed test of difference between two beta coefficients confirms that, in the sample, the product diversification coefficients in regime 2 are significantly higher than in regime 1 (p–value = 0.0137). This result means that geographic diversification moderates the product diversification–performance relationship. Specifically, an increase in the level of geographic diversification decreases the product diversification discount. The above results support the Hypothesis 1, that an increase in the level of geographic diversification positively moderates the product diversification performance.

Analysing the control variables, performance is positively related to company size and negatively with the period of economic crisis in both regimes. The liquidity ratio and the ratio of intangible assets are positive related to firm performance, decreasing in regime 1 but not significant in regime 2. By contrast, the long–term debt ratio reveals an inverted U–shaped relation to performance in regime 1 and significantly positive in regime 2. This result means that debt composition has an important role in the geographic diversification expansion of firms. Increasing the level of geographic diversification also means generating more benefits from the establishment of a long–term liabilities structure.

Table 3 reports the regression output allowing that geographic diversification may be determined by product diversification. The threshold point (–0.0384) is negative, representing decreasing levels of product diversification. I find that geographic diversification is significantly positive in relation to firm performance below (0.1266) and above (0.1189) the threshold. The test of difference between two beta coefficients does not reject that both coefficients are the same (p–value = 0.9247). Thus, product diversification does not alter geographic diversification performance. I could not confirm that product diversification positively moderates the geographic diversification-performance relationship, rejecting the hypothesis 2.

Table 2. Structural Threshold Regression. Geographic diversification as threshold variable.

	Regime 1 (beta1)			Regime 2 (beta2)			Diff. betas
Variables	Coefficient	Std. Error	P-value	Coefficient	Std. Error	P-value	P-value
Sales (size)	0.024	0.0124	0.0534	0.0569	0.0191	0.0029	
Sales Square	0.0072	0.0154	0.6397	-0.1283	0.0454	0.0048	
Liquidity	0.0473	0.0125	0.0002	-0.0064	0.0131	0.6281	
Liquidity Square	-0.0075	0.0024	0.0021	0.0006	0.0019	0.7597	
Long debt ratio	-0.0143	0.0441	0.7455	0.1085	0.0446	0.0149	
Long debt ratio Square	-0.3125	0.1299	0.0161	-0.0835	0.1303	0.5217	
Intangibles ratio	0.1071	0.0428	0.0125	-0.0127	0.0526	0.8084	
Intangibles ratio square	-0.2850	0.1459	0.0507	0.0088	0.126	0.9444	
Crisis	-0.0235	0.0051	0.0000	-0.0144	0.0062	0.0197	
Product diversification	-0.1383	0.0493	0.0051	0.0323	0.0484	0.5050	0.0137
Inverse Mill Ratio	0.0032	0.0029	0.2743				
Firms fixed effects	Included						
Threshold (1)	0.0370						
Threshold Interval	[0.0060; 0.0464]						
Nº obs. under/above	280/145						
Observations	425						
Firms	85						
R-squared adjusted	0.3712						
F	28.8166		0.0000				
Sargan-Hansen J test	5.4039		0.2483				
Kleibergen-Paap test	38.404		0.0000				

Dependent variable: EBIT/Assets. GMM estimation with product and geographic diversification as endogenous variables. Robust standard errors. Two-tailed p-values

Further, the wide confidence interval of the threshold point [–0.044, 0.056] confirms the absence of a strong moderating effect of product diversification on geographic diversification performance.

These results expand the knowledge of how both types of variables interact, because I find a unidirectional effect of geographic diversification on the performance of product diversification, but I cannot establish that product diversification moderates the performance of geographic diversification with our data.

Likewise, the results in table 2 show that firm size is positively related to firm performance, whereas the period of economic crisis has caused it to decrease. It is important to note that liquidity is not clearly

related to firm performance under the threshold, but it is decreasingly positive above the product diversification threshold. Thus, product diversification expansion produces positive side effects on liquidity performance. Similarly, the long–term debt ratio portrays an inverted U–Shaped relationship with performance in regime 2. These results evidence the potential positive side effects of product diversification in the firm's internal capital market (Hovakimian, 2011; Kuppuswamy & Villalonga, 2015).

Table 3. Structural Threshold Regression. Product diversification as threshold variable.

	Regime 1 (beta1)			Regime 2 (beta2)			Diff. betas
Variables	Coefficient	Std. Error	P-value	Coefficient	Std. Error	P-value	P-value
Sales (size)	0.0246	0.0137	0.0715	0.0242	0.0157	0.1220	
Sales Square	0.0061	0.0135	0.6517	-0.0109	0.0195	0.5751	
Liquidity	0.0034	0.0156	0.8300	0.0472	0.0124	0.0001	
Liquidity Square	0.0007	0.0038	0.8535	-0.0059	0.0019	0.0022	
Long debt ratio	-0.0215	0.0409	0.5990	0.0061	0.0350	0.8608	
Long debt ratio Square	-0.1315	0.1443	0.3620	-0.2808	0.1247	0.0243	
Intangibles ratio	0.0662	0.0509	0.1939	0.0067	0.0427	0.8759	
Intangibles ratio square	-0.1031	0.1445	0.4757	0.0054	0.1219	0.9646	
Crisis	-0.0390	0.0087	0.0000	-0.0298	0.0064	0.0000	
Geographic diversification	0.1266	0.061	0.0380	0.1189	0.0544	0.0290	0.9247
Inverse Mill Ratio	-0.0052	0.0029	0.076				
Firms fixed effects	Included						
Threshold (1)	-0.0384						
Threshold Interval	[-0.0444; 0.0564]						
Nº obs. under/above	93/332						
Observations	425						
Firms	85						
R-squared adjusted	0.3349						
F	24.7285						
Sargan-Hansen test	4.5112		0.2113				
Kleibergen-Paap test	20.611		0.0004				

Dependent variable: EBIT/Assets. GMM estimation with product and geographic diversification as endogenous variables. Robust standard errors. Two-tailed p-values.

Robustness Check

In order to validate the previous results, I conducted three additional analyses. First, I allowed that product and geographic diversification can be nonlinear in each of the two regimes, including the square term of both types of diversification. Second, I reduced the control variables eliminating their square terms to check how product and geographic diversification coefficients change in each regime. Finally, I replicated the model using the Herfindahl Index as product and geographic diversification measure. Concretely, as in other

previous studies such as Y. Chen et al. (2014), or Oh and Contractor (2014; 2012), I defined the Adjusted Herfindahl Index: $AH = 1 - \sum_i^n p_i^2$, p_i being the proportion of the sales revenue from the i_{th} sector to total sales, and *n* the number of sectors (defined in the same way as for the Entropy Index).

Table 4. STR including the square variable of diversification under and above the threshold point.

	Regime 1			Regime2		
Variables	Coefficient	Std. Error	P-value	Coefficient	Std. Error	P-value
Controls	*Included*			*Included*		
Firms FE and Inverse Mill	*Included*			*Included*		
Product diversification	-0.1405	0.0569	0.0136	0.0196	0.0628	0.7547
Prod. diversification squared	-0.2708	0.2001	0.1761	0.1859	0.1612	0.2489
Threshold	0.0370					
Threshold Interval	[0.0368; 0.0370]					
Controls	*Included*			*Included*		
Firms FE and Inverse Mill	*Included*			*Included*		
Geographic diversification	0.0729	0.0434	0.0929	0.1283	0.0788	0.1035
Geo. diversification squared	0.0087	0.093	0.9256	-0.6498	0.5121	0.2045
Threshold	-0.0188					
Threshold Interval	[-0.0444; 0.0564]					

N=425. Dependent variable: EBIT/Assets. GMM estimation with product and geographic diversification as endogenous variables. Robust standard errors. Two-tailed p-values.

Table 5. STR excluding the squared control variables.

	Regime 1			Regime2			
Variable	Coefficient	Std. Error	P-value	Coefficient	Std. Error	P-value	Diff. betas P-value
Controls	*Reduced*			*Reduced*			
Firms FE and Inverse Mill	*Included*			*Included*			
Product diversification	-0.1448	0.0574	0.0116	0.0026	0.0402	0.9476	0.0335
Threshold	0.0060						
Threshold Interval	[-0.0603; 0.0795]						
Controls	*Reduced*			*Reduced*			
Firms FE and Inverse Mill	*Included*			*Included*			
Geographic diversification	0.1008	0.0483	0.0367	0.1377	0.0773	0.0749	0.6826
Threshold	0.0032						
Threshold Interval	[-0.0444; 0.0564]						

N=425. Dependent variable: EBIT/Assets. GMM estimation with product and geographic diversification as endogenous variables. Robust standard errors. Two-tailed p-values.

The adjustment of the Herfindahl Index allowed a similar interpretation as for the Entropy Index used before to be maintained. Thus, the higher the index, the higher the firm's level of product or geographic diversification.

Tables 4, 5 and 6, respectively, report the slope of product and geographic diversification of the three additional analyses described above. In table 4, product and geographic diversification exhibit a linear relationship with performance within each of the regimes (under and above the threshold point). The product

diversification squared coefficient is negative in regime 1 and positive in regime 2, but they are not significant. Similarly, geographic diversification slopes in the squared variables are not significant in either regime. Increased geographic diversification positively influences firm performance, which is not clearly affected by product diversification. Thus, geographic diversification reduces the downside of product diversification on performance but is not enough to generate direct net benefits from product diversification.

Table 6. STR using Adjusted Herfindahl (AH) as diversification measure.

	Regime 1			Regime2			
Variable	Coefficient	Std. Error	P-value	Coefficient	Std. Error	P-value	Diff. betas P-value
Controls	*Included*			*Included*			
Firms FE and Inverse Mill	*Included*			*Included*			
Product diversification (AH)	-0.3628	0.149	0.0149	0.0894	0.1449	0.5373	0.0284
Threshold	0.0014						
Threshold Interval	[0.0007; 0.0194]						
Controls	*Included*			*Included*			
Firms FE and Inverse Mill	*Included*			*Included*			
Geographic diversification (AH)	0.2078	0.1504	0.1671	0.3833	0.1478	0.0095	0.3989
Threshold	-0.0189						
Threshold Interval	[-0.0189; 0.0256]						

N=425. Dependent variable: EBIT/Assets. GMM estimation with product and geographic diversification as endogenous variables. Robust standard errors. Two-tailed p-values.

In table 5, I reduce the control variables to check how the slopes of product and geographic diversification change. I do not consider the squared control variables. Product diversification coefficients are similar to those in table 2. The conclusion reached is the same as before: Increased geographic diversification increases product diversification performance, but not enough to generate a direct net benefit from product diversification. However, the value of the threshold parameter is closer to zero and is wider, representing loss of model accuracy by eliminating variables that can affect firm performance.

Moreover, geographic diversification coefficients exhibit similar values to those in table 3. This is an additional sign that product diversification has no influence on geographic diversification performance, which is also refuted by the non–significance of the difference between two beta coefficients test over the geographic coefficients (p–value = 0.6826). Furthermore, as in the original model, the broad threshold interval again suggests that product diversification does not influence geographic diversification performance.

Finally, table 6 shows the analysis of product and geographic diversification using the Adjusted Herfindahl Index. Just as in the original model, product diversification is negative in regime 1 (–0.3628) and positive but not significant in regime 2 (0.0894). The estimated threshold point is close to zero (0.0014) indicating that an increase in geographic diversification has a positive effect on the performance of product diversification, whereas in the original model the threshold point (0.037) represented low–medium levels of

increase in geographic diversification. Similar to the original model, increased geographic diversification enhanced firm performance in both regimes, but product diversification did not significantly change this relationship (p–value = 0.3989).

Discussion and conclusions

I developed separate hypotheses in which each type of diversification may moderate the performance of the other type differently. I used Structural Threshold Regression as described in Kourtellos et al. (2015). This econometric technique allows us not only to capture the intensity of the moderating effect of geographic diversification on the performance of product diversification and vice versa, but also to correct for the potential endogeneity of both types of diversification.

The results reveal that geographic diversification positively influences the product diversification–performance relationship. Specifically, increasing the level of geographic diversification decreases the product diversification discount. However, increased product diversification has no clear impact on the geographic diversification–performance relationship. These results (1) confirm that geographic diversification may moderate the performance of product diversification, expanding previous studies mainly focus on the effect of product diversification on geographic diversification performance; and (2) show that each type of diversification may exerts different moderating effects on the performance of the other type. Managers should be kindle aware than both strategies should be defined simultaneously taking into account the interrelationship that both strategies generate on firm performance. Further, researchers in product or geographic diversification should control in their model by the other type of diversification to fully determinate corporate diversification performance.

I suggest that product diversification strategy may be slower to redefine than geographic diversification, in response to short–run environmental changes. The transfer of technology, resources or assets between segments is not immediate, and companies may find it easier and quicker reorganize their geographic diversification strategy rather than adapt their product diversification strategy (S.-H. Lee & Makhija, 2009; Shaver, 2011). Therefore, the flexibility obtained by geographic diversification positively affects performance, and positively influences product diversification performance.

Additionally, results reveal that geographic diversification, after a minimal upfront investment, generates positive effect on product diversification performance. When firms have the appropriate overseas distribution channels, network and knowledge, geographic diversification may be a good strategy to fix imbalances in the demand for some of the firm's business lines. This result reinforces the idea of an initial foothold investment in geographic diversification strategy to generate net benefits, described in S.-H. Lee and Makhija (2009), and it also expands the value of geographic diversification with positive side effects on product diversification performance. From a real option perspective, it is important to keep an investment in geographic diversification to, at least, let the company to shift easily product and services if needed.

In a related vein, as in previous studies as Braakmann and Wagner (2010) or Çolak (2010), the results show that geographic diversification is a necessary condition but not enough to generate a product diversification premium. I find a negative relationship between product diversification and performance. Product diversification does not improve firm performance in any of the models used in this research. Additionally, product diversification does not moderate the geographic diversification–performance relationship. Managers use product diversification strategy is a risk reduction mechanism and as a guarantee of firm survival, but may jeopardize firm performance.

I must point out that these results hold for a period of economic crisis. Although a period of economic crisis may limit the number of opportunities firms can exploit along both dimensions of diversification (Gaur & Kumar, 2009), it can also increase or decrease the influence of the aforementioned moderators. Similarly than Kuppuswamy and Villalonga (2015) and Hovakimian (2011), who have shown that product diversification generates financing and investment advantages during a period of financial constraints because, I find that product diversification has a significant positive effect on liquidity performance. Liquidity is an internal resource for firms' investment capacity. The recent period of economic crisis was also characterized by huge financial constraints. This reflect the positive side effect of product diversification on the internal investment firm capacity.

Additionally, I find that companies which increase their level of geographic diversification gather greater returns from having a large long–term debt liability composition. Shaver (2011) finds that, in a period of economic crisis, geographic diversification mitigates investment liquidity constraints, which may enhance firm performance. Firms that expand their level of geographic diversification also gather greater benefits from having a long–term debt ratio.

To further examine the robustness of my findings, I ran models with nonlinear product or geographic diversification under and above the estimated threshold point. I also excluded the control variables squared to check how the slope coefficients changed. Finally, I used an alternative measure for product and geographic diversification (Adjusted Herfindahl Index). In all cases, the results were similar to the findings given above.

This study has several limitations. First, I use a panel data of 85 independent Spanish listed companies, which may reduce representability of other regions or specifics sectors. Second, I cannot calculate the influence and weight of each mentioned effect (flexibility, information, governance costs etc.) on the performance of the interaction. I also assume that each effect occurs independently of the others. Thus, I have only been able to explain which factor is more influential than others through understanding the context dependency of the data. This limitation also open the door for future research focus on the effects of some specific moderators on the performance of the interaction between both strategies. Finally, the influence of both types of diversification on firm performance may differ depending on which type of diversification was implemented first. For future research, it might be interesting to test whether these results are the same in companies that face geographic diversification first and subsequently diversify into products, a pattern followed by many firms in emerging countries.

Appendix A. Summarize of Structural Threshold Regression model for our model.

These four pages summarize the model described in Kourtellos et al. (2015). I use the structural threshold regression model (STR), which is a threshold regression that allows for endogeneity in the threshold variable as well as in the slope regressors. I consider the balanced panel data where i and t are indexes for individual –firms- and time –years- respectively:

$$y_{it} = \beta_1' x_{it} I(q_{it} \leq \theta) + \beta_2' x_{it} I(q_{it} > \theta) + \eta_i + e_{it} \quad (1)$$

$$q_{it} = \pi' z_{it} + \eta_i + v_{it} \quad (2)$$

Where y_{it} is the dependent variable –performance-, q_{it} is an observed threshold variable that splits the sample into two regimes. In this article, q_{it} is product or geographic diversification. z_{it} is a vector of instruments plus the exogenous variables included in x_{it}. The idiosyncratic error is denoted by e_{it} and η_i is the individual effects term. Finally, θ is an unknown threshold parameter which determine the indicator $I(\cdot)$ with values are one and cero if θ is under of above the threshold variable q_{it} respectively. The individual effects is modeled as fixed to include unobserved firm characteristics in the models controlling for heterogeneity between firms. For obtaining the consistent coefficient estimators, individual effects η_i must cancel out before using STR. Thus, I eliminate individual effect η_i removing individual-specific mean (Hansen, 1999). We can rewrite the equation (1) and (2) as:

$$y_{it}^* = \beta_1' x_{it}^* I(q_{it}^* \leq \theta) + \beta_2' x_{it}^* I(q_{it}^* > \theta) + e_{it}^* \quad (3)$$

$$q_{it}^* = \pi' z_{it}^* + v_{it}^* \quad (4)$$

Where $y_{it}^* = y_{it} - \bar{y}_i$; $x_{it}^* = x_{it} - \bar{x}_i$; $e_{it}^* = e_{it} - \bar{e}_i$; $q_{it}^* = q_{it} - \bar{q}_i$; $z_{it}^* = z_{it} - \bar{z}_i$; $v_{it}^* = v_{it} - \bar{v}_i$ being $\bar{y}_i$, $\bar{x}_i$, $\bar{e}_i$, $\bar{q}_i$, $\bar{z}_i$ and $\bar{v}_i$ the firm individual mean for each of these variables.

The indicators with respect to the threshold variables q_{it}^* is defined as:

$$I(q_{it}^* \leq \theta) \begin{cases} 1 \text{ iff } q_{it}^* \leq \theta \iff v_{it}^* \leq \theta - z_{it}^{*\prime}\pi : \text{Regime 1} \\ 0 \text{ iff } q_{it}^* > \theta \iff v_{it}^* > \theta - z_{it}^{*\prime}\pi : \text{Regime 2} \end{cases}$$

And $I(q_{it}^* > \theta) = 1 - I(q_{it}^* \leq \theta)$.

One of the advantages of this model is that individual observations can be divided into classed based on the value of an observed variable. Instead of choose the threshold value by ourselves, the model estimates it using appropriated econometric techniques. As Kourtellos et al. (2015) discuss, equation (2) is analogous to a selection equation that appears in the literature on limited dependent variable models (Heckman, 1979a), but treating the sample split as an unknown parameter to estimate. They proceed to account for the "selection" bias by making the following assumptions.

$E[e_{it}^* | z_{it}^*] = 0$

$E[v_{it}^*|z_{it}^*] = 0$

$E[e_{it}^*|z_{it}^*, v_{it}^*] = E[e_{it}^*|v_{it}^*]$

$E[e_{it}^*|v_{it}^*] = kv_{it}^*$ Linear conditional expectation between the errors of the structural and the reduced form equations.

$v_{it}^* \sim N(0,1)$

Using this assumption is possible to calculate inverse Mill ratio terms as:

$\lambda_1(\theta - z_{it}^{*\prime}\pi) = -\frac{\phi(\theta - z_{it}^{*\prime}\pi)}{\Phi(\theta - z_{it}^{*\prime}\pi)}$ and $\lambda_2(\theta - z_{it}^{*\prime}\pi) = \frac{\phi(\theta - z_{it}^{*\prime}\pi)}{1 - \Phi(\theta - z_{it}^{*\prime}\pi)}$ being $\phi(\cdot)$ and $\Phi(\cdot)$ the normal pdf and cdf, respectively. I denote $\lambda_{1it}(\theta) = \lambda_1(\theta - z_{it}^{*\prime}\pi_0)$ and $\lambda_{2it}(\theta) = \lambda_2(\theta - z_{it}^{*\prime}\pi_0)$ when π is know or we can consider it as true (π_0). The Mill ratio bias correction term is required to restore conditional mean zero assumption of the error. Thus, to overcome the problem that the model cannot be analyzed regime-by-regime, I explore the relationship between the constrained and unconstrained sum of squared errors, forming the Mill ratio.

Due to the model allows for the endogeneity of product and geographic diversification when they are including as regressor in equation (3), the reduced form model for x_{it}^* is given by:

$$x_{it}^* = \Pi' z_{it}^* + v_{xit}^* \tag{5}$$

Where $E[v_{xit}^*|z_{it}^*] = 0$ with $v_{xit}^* \perp I(v_{it}^* \leq \theta - z_{it}^{*\prime}\pi_0)|z_{it}^*$. Assuming Π_0 as true values the conditional expectation: $x_{it}^* = g_{xit}^* = E[x_{it}^*|z_{it}^*] = \Pi_0' z_{it}^*$

Thus, the STR that allows for endogeneity in both, the threshold and slope variables, and the presence of regime-specific heteroscedasticity, can be written as follows:

$$y_{it}^* = \beta_1' g_{xit}^* I(q_{it}^* \leq \theta) + \beta_2' g_{xit}^* I(q_{it}^* > \theta) + k\Lambda_{it}(\theta) + u_{it}^* \tag{6}$$

Where $\Lambda_{it}(\theta) = \lambda_{1it}(\theta) I(q_{it}^* \leq \theta) + \lambda_{2it}(\theta) I(q_{it}^* > \theta)$; $u_{it}^* = \beta_1' v_{it}^* I(q_{it}^* \leq \theta) + \beta_2' v_{it}^* I(q_{it}^* > \theta) + \varepsilon_{it}^*$ and $\varepsilon_{it}^* = \varepsilon_{1it}^* I(q_{it}^* \leq \theta) + \varepsilon_{2it}^* I(q_{it}^* > \theta)$,with $E[u_{it}^*|z_{it}^*] = 0$

Model estimation.

After removing the individual effect, I estimate the reduced form parameter π and Π by OLS in equations 4 and 5, obtaining the consistent fitted values of q_{it}^*, $x_{it}^* = g_{xit}^*$ and v_{it}^*, respectively. For any θ, I define the predicted inverse Mill ratio term as:

$$\widehat{\Lambda}_{it}(\theta) = \hat{\lambda}_{1it}(\theta) I(q_{it}^* \leq \theta) + \hat{\lambda}_{2it}(\theta) I(q_{it}^* > \theta)$$

$$\hat{\lambda}_{1it}(\theta) = \lambda_1(\theta - z_{it}^{*\prime}\hat{\pi})$$

$$\hat{\lambda}_{2it}(\theta) = \lambda_2(\theta - z_{it}^{*\prime}\hat{\pi})$$

Then, I estimate the threshold parameter theta ($\hat{\theta}$) by minimizing a concentrated least square criterion (S_n^{CLS}), using the predicted values of the endogenous regressors ($\hat{g}_{xit}^*$) and the Mill inverse ratio ($\widehat{\Lambda}_{it}$) as follow:

$$S_n^{CLS}(\theta) = (y_{it}^* - \hat{\beta}_1' \hat{g}_{xit}^* I(q_{it}^* \leq \theta) - \hat{\beta}_2' \hat{g}_{xit}^* I(q_{it}^* > \theta) - \hat{k}\hat{\Lambda}_{it}(\theta))^2$$

$$\hat{\theta} = \arg \min_{\theta \in [\underline{\theta}, \bar{\theta}]} S_n^{CLS}(\theta) \quad (7)$$

Where $\hat{g}_{xit}^*$ includes the exogenous variables and the endogenous ones calculated with $\hat{\Pi}$. STR technique produces consistent $\hat{\theta}$ from equation 7. To avoid select one regime with too few observation, I restrict the search to values of theta that have at least 10% of the observation in each regime.

The confidence intervals for the threshold parameter is the likelihood ratio test statistic inverted (*LRn*). This approach follows Hansen (2000) who argues that under certain conditions *LRn* yields an asymptotically valid confidence region. Concretely, *LRn* is defined as:

$$LR_n = n \frac{S_n^{CLS}(\theta) - S_n^{CLS}(\hat{\theta})}{S_n^{CLS}(\hat{\theta})}$$

The confidence intervals are asymptotically valid under the assumption that the threshold effects diminishes as the sample size increases. This suggests that the confidential interval may be wider than the desired level for large values of the threshold effect and large degrees of endogeneity of the threshold variable. Follow (Kourtellos et al. (2015)) I use a regime specific heteroskedastic correction using an Epanechnikov kernel with automatic bandwidth to correct the size of the confidential interval.

Once I obtain the threshold estimate ($\hat{\theta}$) by two-stage concentrated least squares method that involves an inverse Mills ratio bias correction term in each regime, I proceed with estimation of the slope parameters betas by GMM, which produce consistent and asymptotically efficient regressors.

In sum, for getting consistent estimators, I follow STR technique, and first, I remove individual-specific mean eliminating individual effect. Second, I use LS to estimate π and Π in equation 4 and 5. Third, I estimate the threshold parameter theta by minimizing a two-step concentrated least squared criterion with the estimates from second stage. Fourth, when $\hat{\theta}$ is acquitted by concentrated least square, I use it to split data set and use GMM to estimate coefficient parameters ($\widehat{\beta_1'}$ and $\widehat{\beta_2'}$) and include inverse Mills ratio bias correction term.

Appendix B Database information.

This appendix describes further information about the database used in chapter 1 and 2. I defined "segment" using the definition from the International Financial Reporting Standard IFRS 8 "Operating Segments". It defines the segments or segments of operations, as "*components of a company, for which separate financial information is available, and it is regularly evaluated by the highest decision-making authority of the company*". These segments should be used to: decide how to allocate resources and evaluate their performance.

According to this standard, companies must provide financial and descriptive information on their operating or business segments, and must include the financial statements of each segment (consolidated and non-consolidated financial statements). In this way, in the Annual Accounts (AA) of each company, I can find the segments in which the company is organized. Thus, follow the same criteria to define segments led me reduce the bias and gather reliable data which makes it a unique base and of great gross value.

Furthermore, for Spanish companies, there are not database that reports business and geographical segments of the companies according to IFRS8. Currently, platforms like ORBIS or its subsidiary for data in Spain (SABI), have just started to incorporate some of this information; The THOMSON ONE platform is one of the most complete, as is Bloomberg or Compustat, but such data hardly cover Spanish IBEX35 companies. Something similar happens to the Factiva platform, whose data reported by segments do not agree with those reported in the companies' AA.

2. Company selection method

With the objective in mind of selecting Spanish companies, independently in decision making, with free access to their annual accounts, I have followed the following selection steps:

First, I selected all companies belonging to the Continuous Market in the period 2006-2011. This information has been obtained from the annual reports prepared by the Spanish National Securities Market Commission (CNMV) on all the companies of the Continuous Market. This group of companies is obliged to make public the AA, whose validity and truthfulness is judged by the investors. This sample is used to calculate Beta risk needed for Economic Value Added measure used in Chapter 1. Table B.1 summarizes the companies selected in this first phase, and the period listed in the Spanish Stock Market.

Second, I discarded companies dedicated mainly to the financial sector (such as banks), since they have a different accounting and objectives to the rest of companies. I inspected description of activity reported by the company (Section K of NACE code 2009 rev.2, 64- 66).

Third, once selected the companies that make up the Spanish Continuous Market for all the years of the period 2006-2011, I obtained the Consolidated Annual Accounts (AA) of each firm and year. To find this information, both the corporate web pages of each of the companies or the website of the CNMV which contains a directory with relevant information of listed companies, were used.

Fourth, I ruled out companies with more than 25% of their own funds controlled by another company or corporation for the Year 2010 and 2011. This information is available in the AA, the Annual Reports and other external information bases such as the SABI and the Bloomberg Database- In this way, I gather a group of companies with autonomy in making decisions about their product and geographical segments. Table B.2 summarizes the excluded companies in the second, third and fourth steps of the selection process.

Finally, to validate the process, I randomly chose 10 out of the 100 companies finally selected, confirming that the requirements and conditions required in the previous 4 selection points were met. Table B.3 lists the companies included in the sample.

3. Database elaboration

I extracted all the available information about its business and geographic segments collected in its Consolidated AA based on the International Financial Reporting Standard IFRS 8 "Operating Segments". I built a panel database with was merged with extra information available in Bloomberg, CNMV and SABI.

The IFRS8 requires that the information available in the Annual Report or Annual Account is the same as which is reported to the company's decision-making bodies. This causes that the reporting of information by segment is different between companies. Although companies do not have incentives to disclose all the information by segment, they all indicate segment sales for each year. However, very few are those report a complete balance sheet or a breakdown of profit and loss statement. Table B.4 shows the variables obtained for each segments of activity, and for the overall company, as well as the availability of them. The information was taken from the consolidated annual report of each of the companies in the sample and year (2006 to 2011) including, the balance sheet, profit and loss, flow and investment statements for the overall firm and each of the segment reported.

Note that the net amount of turnover in the segments only reflects the company's sales to external customers, therefore it does not include sales or inter-segment sales (vertical integration). In the same way, the variable investment in the segments reflects the annual investment flows in assets of the company, generally fixed assets. As I said before, companies decide which items are relevant in their business segments. The table shows that although most companies give information on the main balance sheet items, such as total assets and total liabilities, as well as sales and results of the company; Very few report more detailed items. Only 28% of the companies disaggregate the accounts of assets or liabilities and less than 20% ventures to analyze the flow statements of the different segments of activity.

Table B.1. Listed firms in the Spanish Stock Market in the period 2006-2011

Name	Ticker	Bloomberg	Year					
			2006	2007	2008	2009	2010	2011
ABENGOA	ABG	ABG SM	x	x	x	x	x	x
ABERTIS A	ABE	ABE SM	x	x	x	x	x	x
ACCIONA	ANA	ANA SM	x	x	x	x	x	x
ACERINOX	ACX	ACX SM	x	x	x	x	x	x
ACS	ACS	ACS SM	x	x	x	x	x	x
ADOLFO DGUEZ	ADZ	ADZ SM	x	x	x	x	x	x
ADVEO	ADV	ADV SM	x	x	x	x	x	x
ALMIRALL	ALM	ALM SM		20/06/2007	x	x	x	x
ALTADIS		ALT SM	x	x	22/02/2008			
AMADEUS	AMS	AMS SM					29/04/2010	x
AMPER	AMP	AMP SM	x	x	x	x	x	x
ANTENA 3 TV	A3TV	A3TV SM	x	x	x	x	x	x
ARCELOR		LOR SM	x	12/11/2007				
ARCELORMITT.	MTS	MTS SM	x	x	x	x	x	27/01/2011
AZKOYEN	AZK	AZK SM	x	x	x	x	x	x
B.POPULAR	POP	POP SM	x	x	x	x	x	x
B.SABADELL	SAB	SAB SM	x	x	x	x	x	x
B.VALENCIA	BVA	BVA SM	x	x	x	x	x	x
BANCA CIVICA	BCIV	BCIV SM						22/07/2011
BANCO DE ANDALUCÍA		AND SM	x	x	x	07/08/2009		
BANCO DE CASTILLA		CAS SM	x	x	19/12/2008			
BANCO DE CRÉDITO BALEAR		CBL SM	x	x	19/12/2008			
BANCO DE GALICIA		GAL SM	x	x	19/12/2008			
BANCO DE VASCONIA		VAS SM	x	x	19/12/2008			
BANCO GUIPUZCUANO		GUI SM	x	x	x	x	25/11/2010	
BANESTO	BTO	BTO SM	x	x	x	x	x	x
BANKIA	BKIA	BKIA SM						20/07/2011
BANKINTER	BKT	BKT SM	x	x	x	x	x	x
BARON DE LEY	BDL	BDL SM	x	x	x	x	x	x
BAVIERA	CBAV	CBAV SM		03/04/2007	x	x	x	x
BBVA	BBVA	BBVA SM	x	x	x	x	x	x
BIOSEARCH	BIO	BIO SM	x	x	x	x	x	x
BME	BME	BME SM	14/07/2006	x	x	x	x	x
BO.RIOJANAS	RIO	RIO SM	x	x	x	x	x	x
C.A.F.	CAF	CAF SM	x	x	x	x	x	x
C.V.N.E.	CUN	CUN SM	x	x	x	x	x	x
CAIXABANK	CABK	CABK SM		10/10/2007	x	x	x	x
CAM	CAM	CAM SM			24/07/2008	x	x	x
CAMPOFRIO	CFG	CFG SM	x	x	x	x	x	x
CEM.PORT.VAL	CPL	CPL SM	x	x	x	x	x	x
CIE AUTOMOT.	CIE	CIE SM	x	x	x	x	x	x
CLEOP	CLEO	CLEO SM	21/02/2006	x	x	x	x	x
CODERE	CDR	CDR SM		19/10/2007	x	x	x	x
CORP.FI.ALBA	ALB	ALB SM	x	x	x	x	x	x
CORTEFIEL		CTF SM	24/03/2006					
D.FELGUERA	MDF	MDF SM	x	x	x	x	x	x
DEOLEO, S.A.	OLE	OLE SM	x	x	x	x	x	x
DERMOESTETI.	DERM	DERM SM	x	x	x	x	x	x
DIA	DIA	DIA SM						05/07/2011

DINAMIA	DIN	DIN SM	x	x	x	x	x	x
DISTRIBUCIÓN INTEGRAL LOGÍSTICA		LOG SM	x	x	13/06/2008			
DOGI	DGI	DGI SM	x	x	x	x	x	x
EADS	EAD	EAD SM	x	x	x	x	x	x
EBRO FOODS	EBRO	EBRO SM	x	x	x	x	x	x
ELECNOR	ENO	ENO SM	x	x	x	x	x	x
ENAGAS	ENG	ENG SM	x	x	x	x	x	x
ENCE	ENC	ENC SM	x	x	x	x	x	x
ENDESA	ELE	ELE SM	x	x	x	x	x	x
ERCROS	ECR	ECR SM	x	x	x	x	x	x
EUROPA & C	PAC	PAC SM	x	x	x	x	x	x
EXIDE TECHNOLOGIES		TUD SM	x	x	x	x	05/08/2010	
EZENTIS	EZE	EZE SM	x	x	x	x	x	x
FAES	FAE	FAE SM	x	x	x	x	x	x
FCC	FCC	FCC SM	x	x	x	x	x	x
FEDERICO PATERNINA		PAT SM	x	x	x	x	07/01/2010	
FERGO AISA	AISA	AISA SM	x	x	x	x	x	x
FERROVIAL	FER	FER SM	x	x	x	x	x	x
FERSA	FRS	FRS SM	14/11/2006	x	x	x	x	x
FLUIDRA	FDR	FDR SM		31/10/2007	x	x	x	x
FUNESPAÑA	FUN	FUN SM	x	x	x	x	x	x
GAM	GALQ	GALQ SM	13/06/2006	x	x	x	x	x
GAMESA	GAM	GAM SM	x	x	x	x	x	x
GAS NATURAL	GAS	GAS SM	x	x	x	x	x	x
GE.INVERSION	CGI	CGI SM	x	x	x	x	x	x
GR.C.OCCIDEN	GCO	GCO SM	x	x*	x	x	x	x
GRIFOLS	GRF	GRF SM	17/05/2006	x	x	x	x	x
GRUPO TAVEX	TVX	TVX SM	x	x	x	x	x	x
HULLAS DEL CORTO CORTÉS		HCC SM	x	x	13/06/2008			
IAG	IAG	IAG SM	x	x	x	x	x	24/01/2011
IBERDROLA	IBE	IBE SM	x	x	x	x	x	x
IBERIA	IB	IBLA SM	x	x	x	x	x	21/01/2011
IBERPAPEL	IBG	IBG SM	x	x	x	x	x	x
INDITEX	ITX	ITX SM	x	x	x	x	x	x
INDO	IDO	IDO SM	x	x	x	x	x	x
INDRA A	IDR	IDR SM	x	x	x	x	x	x
INM.COLONIAL	COL	COL SM	x	x	x	x	x	x
INM.DEL SUR	ISUR	ISUR SM			30/06/2008	x	x	x
INMOBILIARIA URBIS		URB SM	x	08/06/2007				
INYPSA	INY	INY SM	x	x	x	x	x	x
ITIRENE INFRAESTRUCTURAS	EUR SM	ITI SM	x	x	x	18/09/2009		
JAZZTEL	JAZ	JAZ SM	x	x	x	x	x	x
LA SEDA BAR.	SED	SED SM	x	x	x	x	x	x
LINGOTES	LGT	LGT SM	x	x	x	x	x	x
MAPFRE	MAP	MAP SM	x	x	x	x	x	x
MARTINSA-FAD	MTF	MTF SM		17/12/2007	x	x	x	x
MECALUX	MLX	MLX SM	x	x	x	x	07/07/2010	
MEDIASET	TL5	TL5 SM	x	x	x	x	x	x
MELIA HOTELS	MEL	MEL SM	x	x	x	x	x	x
METROVACESA	MVC	MVC SM	x	x	x	x	x	x
MIQUEL COSTA	MCM	MCM SM	x	x	x	x	x	x
MONTEBALITO	MTB	MTB SM	x	x	x	x	x	x
NATRA	NAT	NAT SM	x	x	x	x	x	x

NATRACEUTICA	NTC	NTC SM	x	x	x	x	x	x
NH HOTELES	NHH	NHH SM	x	x	x	x	x	x
NICOL.CORREA	NEA	NEA SM	x	x	x	x	x	x
NYESA	NYE	NYE SM	x	x	x	x	x	x
OHL	OHL	OHL SM	x	x	x	x	x	x
PESCANOVA	PVA	PVA SM	x	x	x	x	x	x
PRIM	PRM	PRM SM	x	x	x	x	x	x
PRISA	PRS	PRS SM	x	x	x	x	x	x
PRISA CONV.B	PRS/P	PRS/P SM					29/11/2010	x
PROSEGUR	PSG	PSG SM	x	x	x	x	x	x
QUABIT	QBT	QBT SM	29/05/2006	x	x	x	x	x
R.E.C.	REE	REE SM	x	x	x	x	x	x
REALIA	RLIA	RLIA SM		06/06/2007	x	x	x	x
RENO M.S/A	RDM	RDM SM	x	x	15/04/2008			
RENTA 4	R4	R4 SM		14/11/2007	x	x	x	x
RENTA CORP.	REN	REN SM	05/04/2006	x	x	x	x	x
REPSOL	REP	REP SM	x	x	x	x	x	x
REYAL URBIS	REY	REY SM		11/06/2007	x	x	x	x
ROVI	ROVI	ROVI SM		05/12/2007	x	x	x	x
SACYR VALLE.	SYV	SYV SM	x	x	x	x	x	x
SAN JOSE	GSJ	GSJ SM				20/07/2009	x	x
SANTANDER	SAN	SAN SM	x	x	x	x	x	x
SERVICE P.S.	SPS	SPS SM	x	x	x	x	x	x
SNIACE	SNC	SNC SM	x	x	x	x	x	x
SOCIEDAD GENERAL DE AGUAS DE BARCELONA		AGS SM	x	x	x	x	31/05/2010	
SOLARIA	SLR	SLR SM		19/06/2007	x	x	x	x
SOTOGRANDE	STG	STG SM	x	x	x	x	x	x
TABLEROS DE FIBRAS		TFI SM	x	31/05/2007				
TECNICAS REU	TRE	TRE SM	21/06/2006	x	x	x	x	x
TECNOCOM	TEC	TEC SM	x	x	x	x	x	x
TELEFONICA	TEF	TEF SM	x	x	x	x	x	x
TESTA INM.	TST	TST SM	x	x	x	x	x	x
TRANSPORTES AZKAR		TAZ SM	01/02/2006					
TUBACEX	TUB	TUB SM	x	x	x	x	x	x
TUBOS REUNI.	TRG	TRG SM	x	x	x	x	x	x
UNIÓN FENOSA		UNF SM	x	x	x	04/09/2009		
URALITA	URA	URA SM	x	x	x	x	x	x
URBAS	UBS	UBS SM	x	x	x	x	x	x
VERTICE 360	VER	VER SM		19/12/2007	x	x	x	x
VIDRALA	VID	VID SM	x	x	x	x	x	x
VISCOFAN	VIS	VIS SM	x	x	x	x	x	x
VOCENTO	VOC	VOC SM	08/11/2006	x	x	x	x	x
VUELING	VLG	VLG SM	01/12/2006	x	x	x	x	x
ZARDOYA OTIS	ZOT	ZOT SM	x	x	x	x	x	x
ZELTIA	ZEL	ZEL SM	x	x	x	x	x	x

Source: Own elaboration with the data collected from Bloomberg and the Annual Reports of the CNMV. The dates indicate the day the company started or finish public offering in the Spanish Continuous Market, the X indicates that the company was listed the entire year. Companies without access: Parquesol infrastructures; Flame EMT; Tele pizza; Itirene infrastructures; Mittal; Fedesa real estate.

Table B.2. Companies excluded and reason.

Company name	Reason
ENDESA	Not Spanish or independent throughout the period.
MEDIASET	Not Spanish or independent throughout the period.
JAZZTEL	Not Spanish or independent throughout the period.
MAPFRE	Financial-insurance sector.
GRUPO CATALANA OCCIDENTE	Financial-insurance sector.
COMPAÑÍA FINANCIERA ALBA	Financial sector.
BOLSA Y MERCADO DE ESPAÑA	Financial sector.
MECALUX. SA	No access in 2011
IBERIA	No independent throughout the period.
FERGO AISA	Bankruptcy in 2010
*Banks**	Financial sector.
Investment services. **	Financial sector.

*: Banca Cívica, Bankia, Bankinter, BBVA, Banco de Andalucía, Banco de Castilla, Banco de Crédito Balear, Banco de Galicia, Banco Guipuzcoano, Banco Popular, Banco Sabadell, Banco Santander, Banco Valencia, Banco Vasconia, Banesto, Caixabank. **: Renta 4, Renta Corporación, Reno M.S/A y GE.Inversión

Table B.3. Companies included in the database

Nº	Nombre	Nº	Nombre
1	ACS, ACTIVIDADES DE CONSTRUCCION Y SERVICIOS, SA	26	DURO FELGUERA, SA
2	ABERTIS INFRAESTRUCTURAS, SA	27	EBRO FOODS, SA
3	ABENGOA SA	28	SOCIEDAD ANONIMA DAMM
4	ACCIONA, SA	29	ELECNOR SA
5	ACERINOX, SA	30	ENAGAS SA
6	ADOLFO DOMINGUEZ SA	31	ERCROS, SA
7	AMPER SA	32	FAES FARMA, SA
8	ALMIRALL SA	33	FERGO AISA SA
9	AMADEUS IT HOLDING SA	34	FERROVIAL SA
10	ANTENA 3 DE TELEVISION SA	35	FOMENTO DE CONSTRUCCIONES Y CONTRATAS SA
11	BARON DE LEY, SA	36	GAMESA CORPORACION TECNOLOGICA SOCIEDAD ANONIMA
12	AZKOYEN, SA	37	GAS NATURAL SDG SA
13	CEMENTOS MOLINS SA	38	GENERAL DE ALQUILER DE MAQUINARIA SA
14	CEMENTOS PORTLAND VALDERRIVAS, SA	39	GRIFOLS SA
15	CIE AUTOMOTIVE, SA	40	ENCE ENERGIA Y CELULOSA SA.
16	CLINICA BAVIERA, SA	41	GRUPO TAVEX SA
17	CODERE, SA	42	IBERDROLA, SOCIEDAD ANONIMA
18	COMPANYIA D'AIGUES DE SABADELL, SA	43	INTERNATIONAL CONSOLIDATED AIRLINES GROUP SA
19	COMPAÑIA LEVANTINA DE EDIFICACION Y OBRAS PUBLICAS SA	44	INDRA SISTEMAS, SOCIEDAD ANONIMA
20	COMPAÑIA LOGISTICA DE HIDROCARBUROS CLH SA	45	INDUSTRIA DE DISEÑO TEXTIL SA
21	COMPAÑIA VINICOLA DEL NORTE DE ESPAÑA, SA	46	INMOBILIARIA COLONIAL, SA
22	CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES, SA	47	INMOBILIARIA DEL SUR SA
23	CORPORACION DERMOESTETICA SA	48	INYPSA INFORMES Y PROYECTOS SA
24	DEOLEO SA	49	LA SEDA DE BARCELONA SA
25	DOGI INTERNATIONAL FABRICS, SA	50	LABORATORIOS FARMACEUTICOS ROVI, SA

Nº	Nombre	Nº	Nombre

51	LINGOTES ESPECIALES, SOCIEDAD ANONIMA	76	VERTICE TRESCIENTOS SESENTA GRADOS, SA
52	LIWE ESPAÑOLA, SA	77	MINERALES Y PRODUCTOS DERIVADOS, SA
53	TELEFONICA, SA	78	FLUIDRA, SA
54	REPSOL SA.	79	NATRA SOCIEDAD ANONIMA
55	TECNICAS REUNIDAS, SOCIEDAD ANONIMA	80	MARTINSA-FADESA, SA
56	OBRASCON HUARTE LAIN SA	81	TECNOCOM TELECOMUNICACIONES Y ENERGIA SA
57	REYAL URBIS, SA	82	GRUPO EZENTIS, SA
58	PROSEGUR COMPAÑIA DE SEGURIDAD, SA	83	SERVICE POINT SOLUTIONS, SOCIEDAD ANONIMA
59	PESCANOVA SA	84	SA HULLERA VASCO LEONESA
60	MELIA HOTELS INTERNATIONAL SA.	85	ZELTIA, SA
61	VIDRALA, SA	86	INDO INTERNACIONAL, SA
62	RED ELECTRICA CORPORACION SA	87	FUNESPAÑA, SOCIEDAD ANONIMA
63	METROVACESA SA	88	CAMPOFRIO FOOD GROUP, SOCIEDAD ANONIMA
64	SOLARIA ENERGIA Y MEDIO AMBIENTE, SA	89	TUBOS REUNIDOS, SA
65	PAPELES Y CARTONES DE EUROPA, SA	90	NICOLAS CORREA, SA
66	VISCOFAN SA	91	FERSA ENERGIAS RENOVABLES SA
67	PROMOTORA DE INFORMACIONES SA	92	ALZA REAL ESTATE, SA
68	SACYR VALLEHERMOSO SA	93	LIBERTAS 7 SOCIEDAD ANONIMA
69	NH HOTELES, SA	94	URBAS GRUPO FINANCIERO SA.
70	URALITA, SA	95	NYESA VALORES CORPORACION, SA
71	VOCENTO, SOCIEDAD ANONIMA	96	GRUPO NOSTRUM RNL, SA
72	MIQUEL Y COSTAS & MIQUEL, SA	97	IBERPAPEL GESTION, SA
73	QUABIT INMOBILIARIA, SA	98	ADVEO GROUP INTERNATIONAL SA.
74	PRIM, SA	99	TUBACEX, SA
75	SNIACE, SA	100	GRUPO EMPRESARIAL SAN JOSE, SA

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Chapter 3. The impact of product innovation on firm growth using a multi-stage model: Evidence in a period of economic crisis

Abstract

The period of economic crisis started in late 2008 meant a change in the conditions of the environment, which reduced the number of innovative companies as well as investment in innovation. However, an adverse macroeconomic environment can also determine the outputs of innovation and its effect on firm growth. The objective of the article is therefore (i) to analyze the determinants of innovation output and (ii) to examine how these outputs impact the firm growth during a period of economic crisis of the economy. For this purpose, I used a panel of Spanish firms (one of the countries most affected during the crisis of 2008) during the period 2005-2013, employing a sequential a multi stage approach based on four phases: decision to innovate, how much innovate, innovation outputs and finally, the effect of these innovations on firm growth. The results confirm that for the period of economic crisis, investment in innovation remains to be decisive for generating the output of innovation, albeit with a slightly smaller effect. In contractive periods, both previous experience and continuous activities of intramural R&D are the two fundamental factors to generate outputs of innovations. In any case, the positive effect of innovation outputs on firm growth is reduced by half in times of crisis. The results imply that companies must recalculate the opportunity cost of innovation, given that both previous experience in innovation and a continued effort in R&D can reduce the negative effects of contractionary macroeconomic periods on innovation.

Keywords – Product innovation, economic crisis, firm's growth, multi-stage model.

Introduction

The relationship between innovation and firm growth (and productivity) has been widely studied for many decades, both at the macroeconomic and microeconomic levels (Audretsch, Coad, & Segarra, 2014). There is considerable support that innovation (leading to technological progress) is one of the main driving forces of economic growth (Romer, 1990), in which firms play a core role to introduce those innovations in the society and markets. However, the results about the relationship between innovation and firm growth is usually obtained, and theoretically discussed, on the background of period of macroeconomic expansion (Antonioli et al., 2013).

The global financial crisis, started in late 2008 hit many countries in the world, devastating their economies, nearly collapsing the banking systems and decimating the financial resources of their companies and citizens in their countries (Hausman & Johnston, 2014). The severity and pervasiveness of the economic recession stimulated the analysis of the relation between innovation and firm growth on the crisis challenges. (Antonioli et al., 2013). Develop successful innovations is a difficult task, which depend among other, on firm and market characteristics, time period and macroeconomic environment (Audretsch, Segarra, & Teruel, 2014). H. Li and Atuahene-Gima (2001) proved that the innovation effectiveness is to large extent determined by environmental factors and institutional support. Therefore, it is to be expected that during downturns, the challenge to innovate and gather benefit from them, is likely amplified given demand uncertainty, revenues decline, and financial constraints (Amore, 2015).

Previous studies found a sharp reduction in the number of innovative firms and in innovative investment during the last period of crisis for many develop countries (Archibugi, Filippetti, & Frenz, 2013b; Filippetti & Archibugi, 2011; OECD, 2009, 2012; Paunov, 2012). However, this study aims is to give a step further and analyse the determinant and consequences of innovation on firm growth in a period of economic crisis. What is the role of investment in innovation over innovation output during downturns? Does the outputs of innovation have the same effect on firm growth in periods of crisis as in expansive ones? Which other factors determine the innovation output and firm growth in period of crisis?

For this purpose, I have used a panel of Spanish firms from 2005-2013. Spain entered into a deep recession in 2008, due to lack of liquidity, rising defaults and debt that caused a bank bailout, 25,5% unemployment rate in late 2013 and long GDP constrictions from 2008 to 2013[28]. Thus, analyze Spanish firms provides an appropriate setting for an analysis of innovation in a period of economic crisis. I estimated a sequential model (generally called CDM models) based on four stages: innovation decision, innovation investment, the innovation outputs and finally the effect of innovation output on firm growth. The use of a panel of data allows us to solve some of the limitations of previous studies based on CIS. On the one hand, the innovation is carried out over several years and different costs are allocated depending on the development phase of the innovation. I correct for this fact imputing the average expenditure on innovation by firm in period t to t-2.

[28] Source for the Spanish GDP: AMECO.

On the other hand, the output of innovation is not immediate, so having a data panel allows us to introduce delays in the explanatory variables by increasing the robustness of our model. Finally, with this panel from 2005 to 2013 with the same companies I can capture the effect of the economic cycle.

The paper is structured as follows. Section 2 reviews the literature. Section 3 describes the data and the sample selection criteria. Section 4 defines the modelling procedure, and the estimation method followed by section 6 which describes the variables. The results are presented in section 7 and the robustness check is reported in section 8; I finish with conclusions and a discussion of the research in Section 7.

Literature review.

There is a large volume of published studies analyzing the impact of innovation on growth and company productivity since the work of Griliches (1986). The main indicator of innovation has been investment in R&D. However, the study of the effect of innovation on firm performance has evolved, from a perspective of the inputs of innovation to an output perspective (Crepon et al., 1998). The underlying idea is that investing in innovation is a necessary but not sufficient requirement for introducing successful new products, services, processes, organization and marketing methods for companies (Bessler & Bittelmeyer, 2008). Only those innovations implemented are those that have the capacity to modify the performance and growth of the firm. Thus, R&D spending may not be representative of total innovation effort (B. H. Hall & Sena, 2017; Hashi & Stojčić, 2013).

The initial work of Crepon et al. (1998) proposed a structural model, also called the CDM model, which connects the transformation of innovation inputs and outputs. The original model distinguishes two processes: (i) the generation of innovations through R&D expenditures and (ii) the impact of these innovations on company returns. Subsequently, other authors have adapted this model, flexibilizing some of the mathematical requirements (Hashi & Stojčić, 2013; Lööf & Heshmati, 2002, 2006). Thus, the current CDM models distinguish 3 stages mainly: decision to innovate and how much to invest, the performance of innovation (innovation output) and how these outputs affect growth of the firm.

I focus in this review in the three steps described above: the decision and investment in innovation, the performance of the innovations (outputs), and the effect on the firm growth of these innovations.

1. Innovation investment (innovation input)

Like any other type of investment, the decision to invest and how much invest in innovation depends on the estimated benefit as well as the relative benefit of this investing compared to other. Both the internal characteristics of the firm and the external factors can influence differently in periods of economic crisis in the decision and total expenditure on innovation. Two broad categories of theories linking innovation to the Business cycle are frequently discussed : countercyclical (R. E. Hall, 1991) and procyclical (Barlevy, 2007; Stiglitz, 1993a).

The Shumpeterian vision advocates a counter-cyclical relationship of investment in innovation. In expansive periods companies have less incentive to introduce new product or reorganize production processes since the potential benefits for the introduction of innovation may not surpass the benefit from the existing product and methods. However, in times of crisis, demand and profits are lower, so the opportunity cost of a reallocation of assets due to innovation is lower (Stiglitz, 1993b). This increase in innovation expenses in periods of crisis, allows to create new opportunities, technology and knowledge that lets to overcome the recessive period.

The opposite view is the pro-cyclical relationship, where investing in innovation depends on the rate of expected benefits. If demand is low, and benefits too, there are no incentives to invest in innovation. In addition, much of the innovation is financed by liquidity, domestic funds, and external capital markets, which are constrained in times of crisis (Rafferty & Funk, 2008). The last period of economic crisis has been characterized precisely by the lack of liquidity and the collapse of part of the financial sector. It is therefore expected that the size of the company can be a relevant variable to determine the expenditure and the probability of innovating in crisis. If the company does not have the capacity to self-finance, this will deplete short-term investment capacity by reducing its total investment in innovation (Barley, 2005; Antoniolly, 2013).

Previous studies show that investment in innovation declined during the last economic crisis (Filippetti & Archibugi, 2011). Similarly, Barlevy (2007) finds that investment in R&D has a cyclical behavior, resulting in an inefficient investment in R&D in periods of crisis. In line, Aghion, Askenazy, Berman, Cette, and Eymard (2012) and Bovha Padilla, Damijan, and Konings (2009) find evidence that credit constrained reduce the investment of R&D. Nevertheless, Ouyang (2011) examines the opportunity cost hypothesis and finds an asymmetric response of R&D to demand shocks. A positive demand shock causes R&D expenditures to decrease due to rising opportunity costs while a negative demand shock decreases R&D investment due to liquidity constraints. Thus, further investigation is needed to determine the effect of the crisis in the innovation investment.

2. Innovation output determinants

Innovation output means the company's ability to introduce new or significantly improved products, services, processes, methods of organization and distribution for the company or market (Oslo Manual, 2005).

According to the Shumpeterian theory, innovation allows to overcome the equilibrium, gaining profits through a more dominant position in the market (Arrow, 1962). The innovation expands not only the limits of knowledge, but the market, and replaces the current technology. Thus, through investment in innovation, the company can generate outputs of innovation as new products, processes, methods of organization or distribution. This helps to produce at lower cost and open new markets that end up having a positive impact on the productivity and growth of the firm (Bayus, Erickson, & Jacobson, 2003). The accumulation of technology, both tangible and intangible, is difficult to replicate by the firm's competitors in the short term (Freeman, 1994), and it creates new opportunities that non-innovative firms cannot achieve (Breschi, Malerba, & Orsenigo, 2000).

In this way, the innovation is divided in innovation input (investment) and innovation output, which can influence both productivity and firm growth. In many cases, investment in innovation ends up in abandoned or unsuccessful innovations, which usually are not able to influence the growth of the firm. Yet, it is expected that the greater innovation input, the company will be able to generate greater outputs of innovation. Yet, not many studies have found this positive relationship (Klomp & Van Leeuwen, 2001). This is due to the fact that the innovation performance depends not only on investment in innovation, but also the objectives of that innovation, the type of innovation, the sources of information, cooperation, public aid, the sector to which it belongs, the internal characteristics of the company itself, and the macroeconomic environment. The sum of investment in innovation plus all factors determine the ability to introduce new products, services, processes, organization and distribution (Hashi & Stojčić, 2013).

As any other investment, innovation is not risk free. In times of economic crisis, uncertainty about the macroeconomic environment coupled with the complexity of technology may undermine and underestimate the potential benefits of innovation (Miller, 2006). As I said in the previous section, firms (and financial markets) are more reluctant to invest in innovations when the risks of such innovation are higher because of uncertainty. This may lead companies to simply defend their position in the market (Auh & Menguc, 2005) and prefer to exploit existing technology and knowledge (March, 1991). If the company does not have a clear commitment to innovation, new knowledge may not be enough to radically challenge the existing knowledge base and the technology driving sales (Choi & Williams, 2014). This implies that the new knowledge generated is not sufficient to sustain sales growth, or to taking advantage of the economies of scale of learning that stem from innovations. In this way investment in innovation may not increase the outputs of innovation in times of crisis in comparison with the expansion periods.

3. Innovation output and productivity.

The companies innovate seeking the outputs of the innovation that may lead to a competitive advantage. New products or services imply new markets, which can increase sales (Bayus et al., 2003). Innovation output can also improve productivity and growth by increasing the ability to use the company's assets, and by promoting technological changes. In addition, the innovations allow to develop and update routines, which favors the adaptability and use of company resources. These routines help the spread of new knowledge to any company activity increasing economies of scale (Choi & Williams, 2014). Thus innovation can affect the productivity, growth and survival of the company. Although the innovation of a new product, service or process, cannibalizes old products, services and manufacturing methods which can reduce productivity and growth. It is also an evolutionary method that allows to generate sustainable competitive advantage against its competitors, and generate market power through sales increases, and cost reduction.

Previous studies have found a positive relationship between innovation output and firm growth, both in sales (e.g. Coad & Rao, 2010) and in employment (e.g. Dachs & Peters, 2014; Harrison, Jaumandreu, Mairesse, & Peters, 2014). There is also an extensive literature that also finds a positive relationship between innovation output and productivity (see B. H. Hall, Mairesse, & Mohnen, 2010; Mohnen & Hall, 2013).

Both, the Shumpeterian and the evolutionist theory advocate innovation as the engine to overcome the economic crisis. For the Shumpeterian, radical innovations leads the company to give a qualitative leap which generates new demand, reduction cost, extra profits and investment. These radical innovations impact positively the macroeconomic as well helping to overcome the constraints that occur in contractionary periods. In the same way, evolutionists suggest that innovations allow the updating of technologies, routines and processes, which improve the benefit of the company. Only the best adapted survive and allow the economy to evolve to overcome the economic crisis.

Apart from the internal factor, external environment can moderate the effect of innovation output on firm growth. In periods of crisis, the company has to face higher levels of uncertainty, lack of financing and lower demand, which can break the positive relationship between innovation performance and growth. From the supply perspective, the economic crisis can lead the firm to invest inefficiently in innovation, due to lack of resources or information. This can undermine the ability to introduce radical innovations in both the company and the market. If these innovations are not differentiated enough, it can reduce the potential performance of innovation, which directly affects the sales of that good or service. From the perspective of demand, in times of crisis, when consumer disposable income is lower, preferences vary focusing on covering basic needs at the lowest possible price. This can affect sales of innovative products, which usually have a higher manufacturing cost in the early stages of the product. Also, the crisis can make process, organization or marketing innovations less effective, which again affect the cost of the product or service and their sales. Altogether, the benefits of innovation can be affected in times of crisis. As discussed earlier, investing in innovation is not synonymous with obtaining innovation output in crisis, and likewise, being able to produce innovation output may not ensure an increase in sales, employment or productivity of the firm before under macroeconomic conditions.

The database

The Technological Innovation Panel (PITEC) is a panel survey to study the innovation activity of Spanish firms over time. PITEC consists of repeated observations on the same firms over time, with annual statistical information on their innovation activities. It follows the guidelines in Oslo Manual (OECD, 2005) and Frascati Manual (OECD, 2015) using a standardized questionnaire. The data base is based on the Spanish Innovation Survey which in turn is based on the Community Innovation Survey (CIS). PITEC is carried out by the INE (The National Statistics Institute), which counts on advice from a group of university researchers and the sponsorship of FECYT and Cotec[29].

Specifically, PITEC provides detailed information on the innovation activities of Spanish firms for the period 2003-2014. For instance, it offers information on different types of innovation, R&D expenditures, R&D

[29] FECYT: Spanish Foundation for Science and Technology.
COTEC: Spanish Foundation for innovation.
PITEC web page: https://icono.fecyt.es/PITEC/Paginas/por_que.aspx

employees characteristic, innovation outputs, cooperation, or funding to undertake innovation activities. For reasons of opportunity and viability, PITEC started with two samples with data from 2003: a sample of firms with 200 or more employees (sample of large firms, which represented 73% of all firms with 200 or more employees according to data from the DIRCE), and a sample of firms with intramural R&D expenditures. Given the improvements made by the INE in information on firms undertaking R&D activities, there were enlargements of the second sample in 2004 and 2005. Thus, in 2004, the data base was expanded with a sample of firms with fewer than 200 employees, external R&D expenditure and no intramural R&D expenditure; and in 2005 with a representative sample of firms with fewer than 200 employees and no innovation expenditure. This database has been used for several articles (e.g. Coad, Segarra, & Teruel, 2016; Segarra & Teruel, 2014).

Our sample contains information for the period 2005-2013, since information in 2003 and 2004 is limited. In the pre-crisis period the annual GDP growth rate was 3.5%. The financial crisis began in 2008, moving from a Spanish GDP growth of 1.02% in the first quarter of such year to a decline of 1.73% in the first quarter of the following year. Although economic growth remained constant (0.2%) in 2010, it started to decline again in 2011 until the end of 2013 with an annual GDP growth rate of -1.7%. In 2013 was the last year of the Spanish economic recession.

The initial sample contains 8492 firms (76428 observations), but I eliminate observations that included some kind of incident (problems of confidentiality, sales or employees variation due to takeovers, mergers, or bankruptcy, etc.) and those with an obvious anomaly variable (such as null or below to 10000 euros sales). However, I did not drop outliers' observation that had been winsorized to avoid estimation bias. Finally, I keep those firms that remain with information in the whole period 2005-2013. Thus, the final sample consisted of a balanced panel of 6661 firms (59,949 observations). Our final sample include firms from all sector.

Table 1 and 2 summarize some descriptive statistics about innovation. Table 3 inspects the average and mean firm's sale growth (in percentage) in different groups of firms. Starting by table 1, I find that the proportion of innovative firms, follow Manual Oslo (2005) definition, decreased during the period of crisis especially for technological innovations (product and process). Since the definition of innovative firm refers to the period t to t-2, in year 2011, there was a clear decline in the proportion of innovative firms. This year includes innovative companies in the period 2009, to 2011. The decline was keeping up until the end of the crisis. It also highlights that the decline was stronger in technological innovations (product or process) which is usually associated with greater expenses.

Nevertheless, the incidence of the crisis was uneven depending on the size of the company. In micro and small enterprises, the proportion of firms that stopped their innovation process was larger than in medium and large companies. In this way, the size of the company has been fundamental for the decision and capacity of the company to embark on innovative activities. So it remains to ask: is innovation spending also contingent on the size of the company?

Table 1. Descriptive statistics on the decision to innovate during the period 2005 to 2013.

	Pre-crisis				Crisis				
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Percentage of innovative firms in:									
Product	55.16	54.30	52.15	53.63	55.58	56.31	44.12	39.38	37.71
Process	55.01	56.37	53.24	55.41	57.68	58.88	45.97	39.63	36.63
Organization and marketing	n.a	n.a	n.a	50.82	49.38	47.46	46.16	46.18	44.41
Total	72.51	72.51	70.45	76.49	77.74	78.56	68.34	65.35	63.31
Percentage of innovative firms by size:									
Micro firms	74.81	70.19	69.72	73.13	71.73	71.32	55.79	52.20	47.42
Small firms	79.49	79.04	75.19	80.65	83.03	82.99	71.34	67.16	65.06
Medium firms	76.75	78.06	75.21	81.18	82.81	83.99	75.84	73.83	73.39
Large firms	55.66	60.00	59.32	69.06	71.47	74.63	70.43	69.27	69.94

N.a: Not available;

Table 2. Descriptive statistics of innovation expenditure and output during the period 2005 to 2013.

	Pre-crisis				Crisis				
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Average and median expenses in innovation (in logarithms) of the innovative firms:									
Micro firms	10.33	9.32	9.06	8.41	7.86	7.26	7.78	7.45	7.16
	11.27	11.11	11.10	10.98	10.60	10.41	10.57	10.34	10.21
Small firms	10.83	10.26	10.06	9.59	9.13	8.71	9.00	8.96	8.93
	11.70	11.67	11.72	11.55	11.43	11.38	11.45	11.42	11.50
Medium firms	11.55	11.06	10.84	10.36	10.39	10.03	10.52	10.10	10.00
	12.37	12.34	12.44	12.39	12.37	12.32	12.49	12.43	12.44
Large firms	11.54	11.27	11.38	10.66	10.29	9.96	10.36	10.21	9.88
	13.37	13.21	13.35	13.05	13.04	12.88	12.94	12.88	12.77
Percentage of expenditure on innovation for the acquisition of machines, equipment and software.									
Micro firms	18.59	19.40	17.70	15.26	15.92	14.00	14.52	9.36	10.11
Small firms	22.40	18.40	19.02	17.59	15.62	13.65	12.84	11.68	12.31
Medium firms	22.84	21.12	19.27	18.11	16.77	15.06	15.27	12.91	11.83
Large firms	28.54	24.96	24.37	23.21	27.15	22.49	21.48	19.71	18.06
Percentage of firm's turnover in year t coming from goods or services that were new to market or to enterprise (only for companies that report product innovation):									
Micro firms	48.28	45.96	46.58	48.62	46.80	44.61	44.60	39.91	39.26
Small firms	41.60	41.57	40.87	44.47	41.62	41.85	41.72	39.64	40.50
Medium firms	38.75	38.27	36.43	37.74	37.16	36.64	39.52	38.84	39.31
Large firms	34.19	31.02	34.20	35.22	35.63	35.62	37.89	36.25	37.15

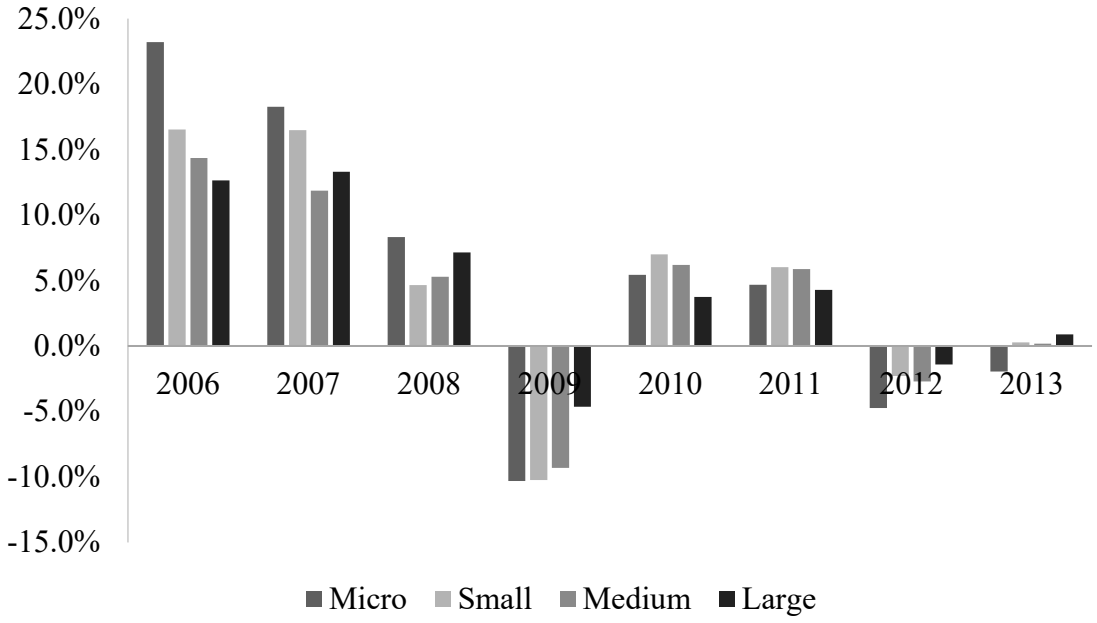
As can be seen in table 2, innovation spending on innovative firms also declined during the economic crisis, being more marked in micro and small firms. Yet, spending on medium and large companies, although slightly lower, remained. This may mean that innovative firms, especially larger ones, keep their spending on innovation even in times of economic crisis. One of the items of expenditure that represents greater outlay for the companies is the acquisition of machines, equipment and software for innovation. Again, I found that large companies expend more in this item than smaller ones. However, the decreasing during the crisis was similar and not clearly associated with company size. Finally, the percentage of sales of new products for the company or the market due to product innovation also remained constant throughout the period, except for micro and small firms in which there was a slighting tendency to a decrease.

Analysing our second variable of interest in Table 3, I see that innovative firms had a slightly higher level of firm's sale growth than non-innovative firms. These differences remained constant for the period analysed. Likewise, companies with export capacity maintained a higher level of firm's sales growth during the period of crisis –not in macroeconomic expansion period- compared to the rest for the whole period analysed. Focusing on size, figure 1 portrays the sales variation by size and year. In year 2008, there was a big decline in the firm growth (but still positive) coinciding with the beginning of the crisis in late 2008. The firm´s growth turned to negative in 2009 and kept lower level of variation since them.

Table 3. Average and median firm growth (percentage) in different groups of firms in the database.

	Pre-crisis				Crisis			
2005	2006	2007	2008	2009	2010	2011	2012	2013
Innovative firm vs non innovative firm. (Average and median)								
Non-Innovative	16.02	11.91	2.98	-8.79	3.16	3.32	-3.77	-1.88
	6.89	6.87	0.01	-10.15	0.18	0.08	-4.71	-2.97
Innovative	17.03	16.14	7.27	-8.85	6.40	6.19	-2.48	0.64
	8.77	8.58	1.59	-11.12	2.30	2.57	-3.71	-1.06
Exporter abroad UE vs non-exporter								
Non exporter	18.13	16.34	7.15	-7.11	2.86	3.69	-4.37	-2.36
	8.14	8.18	2.05	-8.23	0.18	0.14	-4.73	-3.52
Exporter	14.75	12.67	4.77	-11.56	9.75	7.42	-1.14	2.23
	8.18	7.72	-0.18	-14.66	5.01	3.76	-2.95	0.29

Figure 1. Average firm's sales growth by size.



Model specification

The analysis in this paper is based on a structural model (often called CDM) consisting of four stages (Crepon et al., 1998): the decision of firms to innovate; their decision about the amount of innovation expenditure; the production of innovation output; and, the impact of innovation output on productivity (or growth). The model is calculated sequentially, assuming causality between the decision to innovate and the firm growth, but also allowing the inverse causality. Each of these stages includes determinant factors, such as include firm's characteristics as well as, environmental and institutional characteristics.

Similarly to the studies such as Hashi and Stojčić (2013) and Lööf & Heshmati, 2002, 2006), the decision to innovate and the decision on how much to invest in innovation are linked to their determinants in the first two stages of the innovation process. Then, the third stage is a knowledge production function linking innovation input and output. Thus, the innovation output, included in the third equation depend on the decision to innovate (first) and how much to invest in innovation (second equation). Finally, in the fourth stage the productivity of a firm is related to the innovation output.

The literature on innovation and firm performance identifies two major problems with the econometric specification of this relationship, namely simultaneity and selectivity biases (Hashi & Stojčić, 2013; Mairesse & Robin, 2017). The first one arises because some factors influence in chorus firm's decision to innovate, how much spent, and its final performance. Selectivity bias arises from the fact that not all firms are engaged in innovation and some innovations are not successful.

This sequential structural model approach includes the predicted value of one endogenous variable that enters in the estimation of the next equation. The inclusion of a correction factor for potential selection bias relaxes the original CDM model assumption that errors should not be correlated.

1. General Specification of the Model

I will now introduce the basic model used in our sensitivity analysis. Similar to the CDM, I use a four-equation structural model:

Let i=1,…N index firms, and t=1…9 index year time from 2005 to 2013. The first equation account for firms' decision to innovate in the period t to t-2; the second one account for firms' innovate effort in the period t to t-2. Being $d^*_{i(t;t-2)}$ and $k^*_{i(t;t-2)}$ two unobserved (latent) variables of the decision to innovate and of the level of the firm's investment in innovation respectively, we can define:

$$d_{i(t;t-2)} = \beta_0 x^0_{i(t;t-2)} + u^0_{i(t;t-2)} \quad (1)$$

$d_{i(t;t-2)} = 1$ if $d^*_{i(t;t-2)} > 0$, otherwise $d_{i(t;t-2)} = 0$

And

$$g_{i(t;t-2)} \mid d_{i(t;t-2)} = \beta_1 x^1_{i(t;t-2)} + u^1_{i(t;t-2)} \quad (2)$$

$g_{i(t;t-2)} = g_{i(t;t-2)}$ if $g^*_{i(t;t-2)} > 0$, otherwise $g_{i(t;t-2)} = 0$

Where $d_{i(t;t-2)}$ is an observable variable of firm's decision to innovate in t to t-2 and $g_{i(t;t-2)}$ is the observable level of the average firm's investment in innovation in the period t to t-2. Then, x^0_{it}, x^1_{it}, β_0, β_1 are independent variables and their corresponding parameters which reflect the impact of different determinants on the firm's decision to invest in innovation and on the level of expenditure on innovation. u^0_{it}, u^1_{it} are random error terms with zero mean, constant variances and not correlated with the explanatory variables.

The third equation are the innovation production function (innovation output) presented as follow:

$$k_{it} = a^2_g \hat{g}_{i(t;t-2)} + \beta_2 x^2_{it^*} + u^2_{it} \quad (3)$$

Where k_{it} represents the innovation output of firm in year t, $\hat{g}_{i(t;t-2)}$ represents estimates of innovation input from Equation (2) and a^2_g is the corresponding vector of unknown parameters. x^2_{it} is the vector of other explanatory variables which includes among others inverse Mill's ratio estimates from Eq. (1) and performance from the fourth stage to control for selection bias and feedback effect. Finally, β_2, are the coefficients of the explanatory variables while u^2_{it} is the random error term with mean zero and constant variance not correlated with explanatory variables. By using its predicted value, I also instrument the innovative effort $d^*_{i(t;t-2)}$ and take care that it is possibly endogenous to the innovation production function (Griffith et al, 2006).

Finally, the last equation of the model relates the innovation output and other factors with the firm's performance (growth). I used a log transformed function similar than a Cobb-Douglas production function as follow:

$$q_{it} = \alpha \hat{k}_{it} + \beta_3 x^3_{it^*} + u^3_{it} \quad (4)$$

with q_{it} as the dependent variable indicating the firm's rate of productivity in year t, $\hat{k}_{it}$ representing estimates of innovation output from Eq. (3), where α the elasticity of production with respect to changes in innovation output; $x^3_{it^*}$ is a vector of input variables with include among other one lag of the dependent variable, β_3 is the correspondent unknown parameters and u^3_{it} being the error term which is assumed to be uncorrelated with explanatory variables.

2. Econometric technique

As I said before, the first two equations are estimated jointly through a double hurdle model (Cragg, 1971) where observations on both innovative and non-innovative firms are included. This methodology separates the decision to innovate in two process. The first hurdle corresponds to factors affecting the decision to innovate (participation) and the second to the decision of level of expenditure. A different latent variable is used to model each decision process. This model is closer to the firm reality where some companies do not want to innovate, and some other, do not have the enough resources and capabilities to do it. Thus, the first hurdle needs to be crossed to be a potential innovator. Given that the firm is a potential innovator, it current circumstances dictate whether innovate—this is the second hurdle (Engel & Moffatt, 2014).

Two main advantage emerges using a double hurdle model: First, the probability of a positive value (first stage) and the actual value, given that it is positive (second stage), can be determined by different underlying process (i.e., different parameters) overcoming the limitations of the Tobit model (Burke, 2009; Engel & Moffatt, 2014). Second, the double hurdle model can be thought of as a flexible version of the Heckman model. In the Heckman model, zero observations arise due to nonparticipation solely whereas the double hurdle model relaxes this assumption and allows zero observations to arise in both the participation hurdle and expenditure hurdle. (Eakins, 2016). The double hurdle model therefore features both the selection mechanism of the Heckman model (which is not a feature of the Tobit model) and the censoring mechanism of the Tobit model -which is not a feature of the Heckman model- (Eakins, 2016).

However, is reasonable to think that the decision to innovate (participation) and how much to spent (expenditure) are related decisions, but it may be driven by different variables. The Double Hurdle model assumes that there is no correlation between the error terms in the two hurdles (Cragg, 1971), so I relaxed this assumption included the inverse Mills ratio from the first component as explanatory for the second component (Burke, 2009; Heckman, 1979b; Wooldridge, 2010). Thus, I assumed that there is a correlation between the decision to innovate (participation), and how much to spend in innovation (expenditure). Finally, I correct for autocorrelation using cluster- robust standard error.

The third and fourth stages are estimated as a system in a 3SLS simultaneous equation where the endogenous innovation output variable is limited only to strictly positive values in the last step. In the production function model illustrated by equations (2) to (4), the innovation input g in equation (2) is an explanatory variable in the innovation output equation (3), and innovation output, k, is an explanatory variable in the productivity equation (4). Because of the endogeneity of these variables, I cannot assume that the explanatory variables

and the disturbances are uncorrelated. Thus, similarly than Lööf and Heshmati (2002 , 2006) , van Van Leeuwen and Klomp (2006) and Hashi and Stojčić (2013) I relaxed the full correlation between the error terms of the fourth equations with one of partial correlation between disturbance terms, in which it is assumed that the disturbance terms from the first two stages of the innovation process are correlated with each other on the basis of unobservable characteristics of firms. As noted by Griffith, Huergo, Mairesse, and Peters (2006) such procedure controls for the possibility of potential endogeneity of innovation input to the innovation output. Similarly, the third and fourth stages are estimated jointly as a system in a reduced form of the model.

3. Definition of variables.

Decision to innovate

A firm decision to innovate is considered (dependent variable in Equation 1) as long as it reported a positive value for innovation expenditure in the period t to t-2. Similar that Hashi and Stojčić (2013) or Peters, Roberts, and Vuong (2017), I broader the innovation definition included R&D expenditure and expenditure on machinery, equipment, software, patents, know-how and training of staff for innovation activities (Oslo Manual, 2005). Most studies have adopted the practice of including the same variables as determinants of the decision to innovate and how much invest in innovation. But in the explanatory variables of Equation (1) I included only variable available for the whole sample (innovative and not innovative firms) to avoid spurious correlations. Variables such us organizational and marketing innovations, objectives of innovations should be avoided since this variables are only answers by innovative firms.

Among the factors that are usually included in the decision to innovate as well as how much to spend on innovation are: the size of the company, the export capacity, types of cooperation, source of financing, company structure, sector and experience previous.

I divided the exploratory variables in firms' characteristics, and market characteristics. Firms characteristics included the size of firm measured by logarithms of firm's employees; two dummy variable for firms that belong to a group of enterprises being the parent or subsidiary; dummy variable if firm is private and with foreign participation; the firm age (in logarithm); a proxy of the market pressure through a categorical variable of the firm degree of internationalization (abroad UE border) in the year t-2; a proxy of the firms capacity of investment measured by the logarithm of the firm average gross investment in tangible assets in the period t to t-2; a dummy if the firm is established in an technological park; and a dummy variable if the firm was able to introduce a successful innovation previously (in t-3), or in the first year that the firm was included in the sample. In relation with the market characteristics, I included: factors hampering innovation (cost, knowledge and market); Spanish representative sector dummies; and finally a dummy variable of the economic crisis period started in 2009 (in the late 2008).

Innovation investment

The second stage: Innovation input was defined as the natural logarithm of the average amount spent per year in the period t to t-2 on innovations divided by the average employees per year in the same period. This definition measures the innovation expenditure intensity and it is widely used in the field. However, imputed the value of three years represents a huge advantage with respect other research. One of the limitations of analysis based on CIS databases is that it can only allocate the expenditure on innovation of year t. Yet, just as the process of innovation takes place over several years, innovation expenditures are also imputed over more than one period or year. In many cases, innovation expenses are paid in several years, (e.g. through a financial agreement), or the innovation process has different phases that require diverse levels of expenditure. Impute only the year t may bias the innovation input data and its effect on innovation output (Archibugi, Filippetti, & Frenz, 2013a). Further, defined this way, the variable encompasses spending on all innovation activities mentioned earlier (intramural and extramural R&D expenditure, investment in machinery, equipment and software and other acquisitions of external knowledge).

The exploratory variables of Equation (2) includes the same exploratory variables of Equation (1) except the dummy variable if the firm was able to introduce a successful innovation previously. Further, I also included variables that may affect the investment in innovation as dummies variable identifying highly important sources of information about innovation (internal sources, market sources, institutional sources); firm access to subsidies thought a dummy if the firm receives any public financial support from national or EU institutions; a dummy variable if the firm is involved in continuous activities of intramural R&D; a dummy variable if the firm invest in external R&D; breakdown of expenditure on innovation as percentage of total innovation expenditure in the period t to t-2 on acquisition of machines, equipment and software; three dummies variable if the firm cooperate on innovations with: (1) other abroad enterprises or institutions, (2) public institutions and research centre (3) competitors and other firms in the same main market segment (coopetition) in the period t to t-2.

Innovation output

In Equation (3) innovation output is measured by the natural logarithm of the share of sales of new products and services (new to a firm and new to the firm's market) of the firm. As Oslo Manual (2005), I considered "new" as entirely new, or substantially improved good of service. Thus it is the percentage in logarithm of total sales in year t that is due to products or services launched in the period t to t-2. Unfortunately, for the other types of innovation – process, organizational and marketing- the only innovation measures available are dichotomous measures. The sale of new products is considered as the most robust measure since the introduction of new products or services includes the whole process of innovation and allows quantifying the commercial success of innovation (Mohnen & Hall, 2013).

The explanatory variables in this equation are: innovation investment intensity measured by innovation input from the second stage; a dummy variable if the firm was able to introduce a successful innovation previously

(in t-3); a dummy variable if the firm is involved in continuous activities of intramural R&D in the previous year; a dummy variable if the firm invest in external R&D in the previous year; two dummies if the firm was able to introduce process or non-technological innovation (organizational and marketing) in the same period (t to t-2) respectively. I included two dummies representing firms whose objective is explorative or accumulative innovation (see appendix); three dummies for cooperation with abroad firm or institutions, public institution, or with competitors respectively in the period t to t-2; two dummies if the firm received any public financial support from national or EU institutions, etc. in the previous year; the natural logarithm of firm growth from the Equation (4); firm size; a proxy of the firm environment though a dummy if the firm is established in an technological park; the percentage of employees with high education; two dummies variable if the firm operates in high manufacture or high services sector; and finally, to correct the sample selection of select only companies with positive values of innovation output, I included two inverse Mills ratio: one from the first stage controlling selection bias of the decision to innovate, and another one controlling for the fact that firms may introduce other types of innovations that do not change the dependent variable of the Equation (3). In other words, companies can innovate with goals far from the introduction of new products for the market or the company. For example, innovations aimed at adapting to new regulations, those that seek to improve the quality and welfare of employees, process innovations that reduce the environmental impact of a particular product or process, non-technological innovations[30].

Firm growth

Finally, I defined the dependent variables of four stage in Equation (4) as firm growth measured through the variation of turnover. Since this variable is in logarithms, I built an index variable with base in 2005. Firm growth variable is frequently used in the innovation-performance analysis mainly due to the anonymization that innovation surveys have do not led access to other accounting variables (e.g. Audretsch, Segarra, et al., 2014; Raymond et al., 2010).

As mentioned above, the equation (4) includes the predicted values of innovation output from the previous stage, one year lag of the dependent variables which was instrumented with a two year lag of the same variable. The independent variables included are firm size; the firm age (in logarithm); a proxy of the firms capacity of investment measured by the logarithm of the firm average gross investment in tangible assets in the period t to t-2; market internationalization thought the percentage of overseas sales outside the UE; a dummy variable for being part of group of enterprises; a dummy variable if firm is private and with foreign participation; a dummy if the firm was able to introduced a non-technological innovation (organizational and marketing) in the same period (t to t-2) since 2009; and four main sectors: trade, hospitality, services, construction, and finance; Finally, I included a dummy for the period of economic crisis started in 2009.

[30] We run an additional regression where the dependent variable is a dummy that takes the value 1 if a firm successfully introduced process or non-technological innovations in the period t to t-2 but not product innovation. The exploratory variables are the same ones introduced for equations 3 (innovation output).

Results

Following the model, I have divided the results into four stages based on: the decision to innovate, how much to innovate (innovation input), innovation output, and the effect on productivity. I have found differences in the descriptive analysis between small (including micro) firms and large (including medium) firms, for that reason I present also in the tables the results of these subsamples. For these three groups, I inspected the pre-crisis and crisis economic period.

1. Decision to innovate

Table 4 presents the results of the estimation for the whole sample, the period of economic pre-crisis (2005-2008) and the period of economic downturn (2009-2013). Starting by the firms' determinant of the decision to innovate, firm size is the main difference between a period of economic expansion and a period of economic crisis in the probability to innovate. Contrary to Cohen and Klepper (1996) and Hashi and Stojčić (2013) the probability of a firm to undertake innovation decreases with firm size, but there is a clear difference along the periods studied. Whereas in period of pre-crisis (2005 to 2008) size strongly decrease the decision to innovate, in the period of economic crisis (2009 to 2013) the negative effect disappear. One likely explanation is that bigger companies have better internal and external capital market to finance innovation activities during periods of economic crisis. In other words, small firms are less able to engage in innovation strategies in times of crisis. Changes in the demand and the uncertainty environment reduce the incentives of smaller firms to innovate.

The rest of variables explored keep the same relationship in both types of economic periods. Factors that hampering innovation such as cost, lack of knowledge and market structure, do not decrease the probability to innovate, even the high cost of innovation and the market structure led to an increase on the probability of innovate. This result has also been found for Hashi and Stojčić (2013) or Lööf and Heshmati (2006) using a sample of European and Sweden firms respectively. Companies find the factors hampering innovation as an opportunity to differentiate themselves to generate extra value added difficult to replicate from their competitors.

Similarly, past experiences on innovation activities increases the probability of a firm to innovate. Previous experience is the most important variable in the decision to innovate along the period. Experience reduces the risk and enhances the potential profit of innovation. In this vein, the company's funds, measured by the proxy of firm's tangible investment, increases the probability of engagement in innovation. Likewise, be the parent company in a group increases this probability. This variable is highly important in the probability to innovate. The knowledge transfer is less costly when go from up to down of the company, and when parents company's assume the innovation risks. Further, companies which were oriented towards oversea markets (outside EU) in t-2 are more likely to innovate than firms oriented towards local or regional markets. This implies that the intensity of competition motivates firms to innovate.

Table 4. Results of the selection equation.

	Total firms sample			Micro and small firms sample			Medium and high firms sample		
	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis
Factors hampering innovation									
Cost f.[a]	0.297***	0.362***	0.267***	0.227***	0.326***	0.179***	0.403***	0.450***	0.387***
	(0.0208)	(0.0313)	(0.0265)	(0.028)	(0.043)	(0.033)	(0.032)	(0.047)	(0.038)
Know. F[a]	-0.0183	-0.0108	-0.0419	-0.048	-0.063	-0.044	0.010	0.055	-0.031
	(0.0276)	(0.0395)	(0.0359)	(0.035)	(0.051)	(0.041)	(0.043)	(0.061)	(0.054)
Market f.[a]	0.0475**	0.0218	0.0651**	0.007	0.013	0.003	0.119***	0.075	0.145***
	(0.0230)	(0.0338)	(0.0295)	(0.030)	(0.045)	(0.035)	(0.036)	(0.051)	(0.044)
Previous experiences in innovation									
Inno. in t-3[a]	1.162***	1.253***	1.105***	0.988***	1.013***	0.976***	1.318***	1.520***	1.155***
	(0.0229)	(0.0312)	(0.0308)	(0.033)	(0.046)	(0.038)	(0.032)	(0.043)	(0.042)
Firms characteristics									
Firm size[b]	-0.0690***	-0.184***	0.0150						
	(0.00935)	(0.0127)	(0.0119)						
Company age[b]	-0.0855***	-0.0636**	-0.0763**	-0.212***	-0.232***	-0.195***	-0.001	-0.013	0.012
	(0.0222)	(0.0267)	(0.0302)	(0.031)	(0.038)	(0.039)	(0.030)	(0.035)	(0.038)
GITA[b]	0.0569***	0.0533***	0.0592***	0.065***	0.059***	0.068***	0.044***	0.038***	0.049***
	(0.00171)	(0.00239)	(0.00226)	(0.002)	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)
Type of company									
PRIV [a]	0.00672	0.0144	-0.0291	-0.077	-0.316***	-0.004	-0.001	0.049	-0.027
	(0.0385)	(0.0549)	(0.0464)	(0.075)	(0.119)	(0.081)	(0.045)	(0.062)	(0.054)
Parent[a]	0.251***	0.314***	0.217***	0.148*	0.112	0.158*	0.247***	0.251***	0.261***
	(0.0466)	(0.0679)	(0.0570)	(0.082)	(0.128)	(0.087)	(0.055)	(0.077)	(0.067)
Subsidiary[a]	0.0463	0.0574	0.0308	0.011	0.192**	-0.053	0.038	-0.057	0.108**
	(0.0314)	(0.0430)	(0.0380)	(0.053)	(0.085)	(0.059)	(0.038)	(0.051)	(0.046)
Firm environment									
Tech. park[a]	0.605***	0.617***	0.635***	0.525***	0.593***	0.508***	0.714***	0.619***	0.753***
	(0.0742)	(0.117)	(0.0893)	(0.093)	(0.145)	(0.105)	(0.123)	(0.187)	(0.149)
Exp. t-2[a]	0.280***	0.314***	0.263***	0.233***	0.276***	0.218***	0.335***	0.341***	0.336***
	(0.0176)	(0.0272)	(0.0208)	(0.023)	(0.041)	(0.025)	(0.026)	(0.036)	(0.031)

(continued)	Total firms sample			Micro and small firms sample			Medium and high firms sample		
	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis
Crisis[a]	-0.520***			-0.676***			-0.337***		
	(0.0182)			(0.025)			(0.027)		
Firm main sector									
Construction[a]	-0.232***	-0.171**	-0.247***	-0.470***	-0.425***	-0.481***	-0.117*	-0.108	-0.126
	(0.0585)	(0.0791)	(0.0740)	(0.095)	(0.128)	(0.105)	(0.070)	(0.098)	(0.089)
Health[a]	-0.0565	0.00958	-0.167*	0.134	0.224*	0.035	-0.156**	-0.135	-0.169*
	(0.0602)	(0.0692)	(0.0907)	(0.108)	(0.121)	(0.165)	(0.072)	(0.089)	(0.096)
W&E[a]	0.153*	0.198	0.112	0.025	0.025	0.027	0.219*	0.319*	0.182
	(0.0895)	(0.148)	(0.114)	(0.145)	(0.229)	(0.153)	(0.117)	(0.192)	(0.138)
Hospitality[a]	-1.072***	-1.203***	-0.928***	-1.104***	-0.900***	-1.303***	-1.014***	-1.274***	-0.831***
	(0.0997)	(0.140)	(0.133)	(0.215)	(0.244)	(0.370)	(0.113)	(0.177)	(0.133)
Food[a]	-0.0166	0.125*	-0.120**	-0.229***	-0.065	-0.316***	0.196***	0.328***	0.124
	(0.0444)	(0.0644)	(0.0573)	(0.062)	(0.091)	(0.074)	(0.065)	(0.090)	(0.084)
Textile[a]	0.119	0.249*	0.0405	-0.070	0.007	-0.112	0.466***	0.672***	0.343**
	(0.0874)	(0.138)	(0.103)	(0.109)	(0.165)	(0.122)	(0.162)	(0.261)	(0.168)
HT manu.[a]	0.612***	0.511***	0.703***	0.510***	0.441***	0.557***	0.903***	0.727***	1.156***
	(0.0757)	(0.110)	(0.0953)	(0.088)	(0.127)	(0.100)	(0.152)	(0.205)	(0.269)
HT serv.[a]	0.448***	0.675***	0.393***	0.567***	1.071***	0.489***	0.311***	0.508**	0.244**
	(0.0723)	(0.146)	(0.0805)	(0.094)	(0.207)	(0.098)	(0.109)	(0.204)	(0.119)
Constant[b]	-0.0161	0.350***	-0.883***	0.440***	0.429***	-0.247*	-0.830***	-0.803***	-1.162***
	(0.0687)	(0.0861)	(0.0968)	(0.098)	(0.119)	(0.128)	(0.100)	(0.121)	(0.134)
Sample size	59,949	26,644	26,644	30,436	13,289	17,147	29,513	13,355	16,158
Number of firms	6661	6661	6661	3758	3489	3648	3658	3518	3464

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. Cluster-Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for variable details.

Following with the environment determinants, additionally the export intensity described above, the market environment measured by firm's main sector is a strong indicator of the probability to innovate in both periods. In other words, companies whose main sector is hospitality, construction, decrease the probability to innovate, whereas companies main sector belonging to High Tech are more likely to innovate. These differences keep the same during the whole period except for food sector, whose coefficient turns to positive into negative in the period of crisis. Further, companies belonging to a scientific park are likely to innovate more than other companies showing the positive dynamic of these areas in innovation. Finally, the macroeconomic environment is also determinant in the probability to innovate. Periods of economic crisis decreases the probability to innovate.

Analysing differences between micro and small firms (MS) versus median and large (ML), the period of downturn decrease the probability to innovate nearly double in MS firms than in ML. This result is in line with the descriptive analysis above, indicating that MS firm strongly suffer in period of economic crisis. Company age decrease the probability to innovate in MS firms but not in ML. Similarly, in MS firms the negative effect of private firms with foreign participation disappears in period of crisis. Company age decrease the probability to innovate in MS firms but not in ML. Further, subsidiary firms in ML subgroup increase the probability to innovate in crisis, but not for MS firm subgroup. Finally, there are small differences in the relative importance of other variables such as experience, sector, or factor that humper innovation.

2. Innovation investment (innovation intensity).

The results from the estimation of the innovation investment equation are presented in table 5. There are four columns of output, and three subgroups: the overall sample, MS firms and ML firms. The first left column in each subgroup is for the whole period (2005-2013), then for pre-crisis (2005-2008) and crisis period (2009-2013), and finally, an additional column which included extra variables available since 2009.

Although the period of crisis decreases the probability to innovate, it increases the innovation expenditure intensity. One possible explanation is that companies which expend in innovation in crisis are those that have greater financial resources, or those with clear objectives and planning to innovate.

I found differences in the innovation intensity determinants between pre and crisis period. First, the coefficient of the expenses on acquisition of machines, equipment and software is statistically significant in pre-crisis period, but not in crisis. It is likely that companies prefer to postpone this type of investment under uncertainty, which generally represents a high proportion of the total innovation cost.

Cooperation is another key factor to increase the investment in innovation. Cooperation's coefficients are positive and significant for the whole sample. I also find differences between both periods: cooperation with public institutions and competitors in periods of crisis are more relevant to the investment on innovation than in periods of expansion. One likely explanation is that companies try to keep cooperation agreement to split the risks in period of crisis, which led the company invest more in cooperative innovations. This relationship

is particularly relevant in MS firms. Thus the role of institutions in maintaining and increasing investment in innovation is important which is also highlighted with the positive effect of public funds on

Table 5. Results of the innovation investment equation.

	Total firms sample				Micro and small firms sample				Medium and high firms sample			
	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Highly important sources of information about innovation												
Internal s.[a]	0.208***	0.215***	0.193***	0.169***	0.166***	0.180***	0.147***	0.137***	0.225***	0.234***	0.206***	0.182***
	(0.020)	(0.024)	(0.025)	(0.025)	(0.025)	(0.031)	(0.032)	(0.032)	(0.034)	(0.042)	(0.042)	(0.043)
Market s.[a]	0.143***	0.145***	0.140***	0.114***	0.116***	0.089***	0.137***	0.124***	0.165***	0.182***	0.149***	0.127***
	(0.019)	(0.024)	(0.024)	(0.024)	(0.024)	(0.030)	(0.030)	(0.030)	(0.033)	(0.041)	(0.040)	(0.040)
Inst. S.[a]	0.078***	0.063**	0.091***	0.087***	0.088**	0.079*	0.099**	0.097**	0.121***	0.112**	0.120**	0.117**
	(0.027)	(0.032)	(0.032)	(0.033)	(0.035)	(0.043)	(0.043)	(0.043)	(0.044)	(0.055)	(0.051)	(0.051)
Factors hampering innovation												
Cost factors[a]	-0.033*	-0.004	-0.056**	-0.062**	0.017	0.052	-0.014	-0.017	-0.073**	-0.033	-0.099**	-0.101**
	(0.020)	(0.025)	(0.026)	(0.026)	(0.026)	(0.032)	(0.034)	(0.034)	(0.033)	(0.042)	(0.041)	(0.041)
Know. F. [a]	-0.074***	-0.084***	-0.066**	-0.072**	-0.076**	-0.095**	-0.060	-0.065*	-0.039	-0.033	-0.051	-0.054
	(0.024)	(0.028)	(0.031)	(0.031)	(0.030)	(0.037)	(0.039)	(0.039)	(0.044)	(0.052)	(0.058)	(0.058)
Market factors[a]	-0.079***	-0.091***	-0.071***	-0.077***	-0.078***	-0.063*	-0.091***	-0.092***	0.007	-0.031	0.034	0.027
	(0.020)	(0.025)	(0.025)	(0.025)	(0.026)	(0.033)	(0.032)	(0.032)	(0.035)	(0.045)	(0.044)	(0.044)
Type of innovation												
Intramural R&D[a]	0.923***	0.842***	0.998***	0.983***	0.837***	0.770***	0.908***	0.903***	0.989***	0.893***	1.068***	1.053***
	(0.024)	(0.027)	(0.030)	(0.030)	(0.029)	(0.035)	(0.037)	(0.037)	(0.041)	(0.048)	(0.053)	(0.053)
Extramural R&D[a]	0.472***	0.471***	0.471***	0.469***	0.356***	0.344***	0.368***	0.368***	0.511***	0.515***	0.502***	0.500***
	(0.022)	(0.027)	(0.028)	(0.028)	(0.028)	(0.033)	(0.036)	(0.036)	(0.036)	(0.044)	(0.043)	(0.043)
Soft.[c]	0.195***	0.487***	-0.049	-0.057	0.132**	0.457***	-0.131*	-0.139*	0.177**	0.470***	-0.085	-0.083
	(0.047)	(0.060)	(0.058)	(0.058)	(0.060)	(0.082)	(0.074)	(0.074)	(0.075)	(0.091)	(0.093)	(0.093)
Expl. Inn.[a]				0.097***				0.012				0.176***
				(0.028)				(0.036)				(0.045)
Accum. Inn.[a]				0.121***				0.091**				0.028
				(0.029)				(0.038)				(0.043)
Cooperation with:												
Coop. Abr.[a]	0.299***	0.334***	0.311***	0.308***	0.172***	0.208***	0.163***	0.162***	0.195***	0.169***	0.257***	0.255***
	(0.032)	(0.043)	(0.036)	(0.036)	(0.044)	(0.055)	(0.053)	(0.053)	(0.044)	(0.061)	(0.048)	(0.048)
Coop. Public [a]	0.111***	0.053*	0.149***	0.152***	0.136***	0.094**	0.163***	0.164***	0.048	0.028	0.057	0.059
	(0.025)	(0.031)	(0.030)	(0.030)	(0.033)	(0.040)	(0.042)	(0.042)	(0.038)	(0.050)	(0.045)	(0.045)
Competitors[a]	0.277***	0.176***	0.332***	0.330***	0.162***	0.138**	0.172***	0.172***	0.235***	0.124*	0.297***	0.292***
	(0.035)	(0.045)	(0.040)	(0.040)	(0.042)	(0.058)	(0.049)	(0.049)	(0.053)	(0.070)	(0.060)	(0.060)
Access to subsidies												
Public funds[a]	0.633***	0.626***	0.616***	0.617***	0.642***	0.623***	0.630***	0.633***	0.583***	0.572***	0.578***	0.577***
	(0.021)	(0.025)	(0.027)	(0.027)	(0.028)	(0.033)	(0.037)	(0.037)	(0.033)	(0.043)	(0.041)	(0.041)
Type of company												
PRIV[a]	0.200***	0.188***	0.201***	0.202***	0.083	-0.022	0.131**	0.137**	0.055	0.069	0.046	0.043
	(0.042)	(0.053)	(0.046)	(0.046)	(0.061)	(0.085)	(0.065)	(0.066)	(0.052)	(0.063)	(0.059)	(0.059)
Parent[a]	0.257***	0.300***	0.215***	0.216***	0.083	0.109	0.062	0.064	-0.104*	-0.089	-0.120*	-0.122*
	(0.044)	(0.055)	(0.050)	(0.050)	(0.072)	(0.092)	(0.079)	(0.079)	(0.061)	(0.074)	(0.069)	(0.069)
Subsidiary[a]	0.288***	0.353***	0.231***	0.229***	-0.020	0.073	-0.085	-0.088	0.122***	0.133**	0.109**	0.106**

	(0.032)	(0.041)	(0.037)	(0.037)	(0.050)	(0.064)	(0.057)	(0.057)	(0.045)	(0.055)	(0.052)	(0.052)
(continued)		Total firms sample				Micro and small firms sample				Medium and high firms sample		
	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Firms characteristics and environment												
Firm size[b]	-0.581***	-0.607***	-0.558***	-0.560***								
	(0.013)	(0.014)	(0.015)	(0.015)								
Export [c]	0.053***	0.060***	0.045***	0.042***	-0.014	-0.016	-0.019	-0.019	0.124***	0.101***	0.143***	0.137***
	(0.013)	(0.015)	(0.016)	(0.016)	(0.018)	(0.022)	(0.021)	(0.021)	(0.021)	(0.024)	(0.026)	(0.026)
Company age[b]	-0.027	-0.026	-0.024	-0.024	-0.398***	-0.372***	-0.453***	-0.452***	-0.009	-0.010	-0.002	-0.000
	(0.024)	(0.025)	(0.031)	(0.031)	(0.030)	(0.031)	(0.039)	(0.039)	(0.035)	(0.037)	(0.043)	(0.043)
GITA[b]	0.018***	0.020***	0.015***	0.015***	0.005*	0.009**	0.001	0.001	-0.015***	-0.014***	-0.017***	-0.017***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)
Tech. park[a]	0.373***	0.420***	0.334***	0.336***	0.330***	0.374***	0.295***	0.297***	0.421***	0.585***	0.311***	0.306***
	(0.052)	(0.069)	(0.056)	(0.056)	(0.064)	(0.086)	(0.069)	(0.069)	(0.095)	(0.128)	(0.098)	(0.098)
Crisis[a]	0.095***				0.150***				0.154***			
	(0.017)				(0.023)				(0.027)			
Firm main sector												
Const.[a]	-0.425***	-0.389***	-0.489***	-0.479***	-0.394***	-0.333***	-0.481***	-0.478***	-0.612***	-0.630***	-0.634***	-0.621***
	(0.078)	(0.094)	(0.095)	(0.094)	(0.104)	(0.128)	(0.141)	(0.141)	(0.126)	(0.150)	(0.142)	(0.141)
Health[a]	-0.263***	-0.206**	-0.371***	-0.357***	0.316***	0.427***	-0.046	-0.042	-0.848***	-0.952***	-0.732***	-0.720***
	(0.083)	(0.091)	(0.116)	(0.116)	(0.109)	(0.119)	(0.180)	(0.180)	(0.132)	(0.148)	(0.162)	(0.162)
W&E[a]	0.052	0.259**	-0.078	-0.069	0.179	0.360*	0.096	0.092	-0.201	-0.018	-0.307*	-0.283*
	(0.108)	(0.128)	(0.127)	(0.127)	(0.194)	(0.204)	(0.253)	(0.252)	(0.146)	(0.176)	(0.170)	(0.170)
Hospitality[a]	-1.094***	-1.154***	-1.041***	-1.046***	-1.645***	-1.822***	-1.337***	-1.336***	-0.911***	-0.900**	-0.893***	-0.898***
	(0.214)	(0.327)	(0.237)	(0.234)	(0.227)	(0.292)	(0.167)	(0.164)	(0.261)	(0.360)	(0.299)	(0.296)
Food[a]	-0.178***	-0.185***	-0.190***	-0.190***	-0.233***	-0.180**	-0.310***	-0.310***	-0.102	-0.145*	-0.076	-0.076
	(0.048)	(0.054)	(0.058)	(0.058)	(0.069)	(0.085)	(0.082)	(0.081)	(0.071)	(0.079)	(0.084)	(0.084)
Textile[a]	-0.189**	-0.159**	-0.233**	-0.233**	-0.110	-0.070	-0.153	-0.151	-0.051	-0.001	-0.118	-0.117
	(0.074)	(0.076)	(0.093)	(0.092)	(0.108)	(0.115)	(0.139)	(0.139)	(0.109)	(0.114)	(0.138)	(0.137)
HT. Manu.[a]	0.441***	0.388***	0.514***	0.517***	0.304***	0.262***	0.378***	0.379***	0.660***	0.667***	0.666***	0.671***
	(0.051)	(0.055)	(0.060)	(0.060)	(0.054)	(0.063)	(0.065)	(0.065)	(0.077)	(0.083)	(0.093)	(0.093)
H.T. Serv. [a]	0.910***	1.034***	0.844***	0.862***	0.853***	0.962***	0.775***	0.780***	1.219***	1.377***	1.158***	1.181***
	(0.059)	(0.080)	(0.061)	(0.061)	(0.065)	(0.084)	(0.069)	(0.069)	(0.129)	(0.201)	(0.125)	(0.126)
IM.1	-0.523***	-0.488***	-0.521***	-0.510***	-0.276***	-0.194**	-0.305***	-0.302***	-1.127***	-1.202***	-1.055***	-1.049***
	(0.048)	(0.071)	(0.057)	(0.056)	(0.064)	(0.098)	(0.074)	(0.074)	(0.083)	(0.123)	(0.098)	(0.098)
Constant	9.005***	9.031***	9.068***	9.070***	8.562***	8.387***	8.965***	8.962***	6.447***	6.433***	6.598***	6.588***
	(0.073)	(0.079)	(0.101)	(0.101)	(0.097)	(0.107)	(0.139)	(0.139)	(0.134)	(0.147)	(0.180)	(0.180)
Sample size	59,949	26,644	26,644	26,644	30,436	13,289	17,147	17,147	29,513	13,355	16,158	16,158
Number of firms	6661	6661	6661	6661	3758	3489	3648	3648	3658	3518	3464	3464

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. IMR: Inverse Mills Ration. Cluster-Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for variable details.

innovation intensity. The cooperation with competitors also led to an increase in the firm's innovation intensity, which is more intensive in ML firms. Finally, MS firms with foreign participation increase innovation intensity expense in period of crisis. This result may means that MS companies with foreign participation can gather more financial resources that MS companies with national participation.

There are also differences between company sizes. Whereas the market structure hampers innovation in MS firms, it is not for ML ones. In period of crisis, those MS companies with a clear objective of accumulative innovation increase innovation intensity, but not those with a clear explorative innovation objective. This relationship is just the opposite in ML firms. Last result means that ML companies have a tendency over explorative innovation that leads to radical innovation, whereas MS firms are more concerns in accumulative innovations. Finally, in ML firms, exports increase innovation expenses intensity. International competition pushes firms to increase innovation expenses.

For the overall sample and independently of the economic period, belong to groups (parent or subsidiary) increase innovation expenses intensity. Also be involved in intra and extramural R&D, be established in a technological park, and the capacity to invest, increase innovation intensity. Extramural R&D has a slightly higher coefficient in ML than in MS firms. Although I found that factors hampering innovation increase the probability to innovate, they decrease the amount of expenses in innovation. Markets factors reduce the innovation expenses in MS but not in ML firms. Finally, the competitive environment and framework of the company represented by the sector is contingent on determining investment in innovation. Companies in sectors such as construction, hospitality, food and textiles decrease investment in innovation, while sectors belonging to high technology increases them. Similarly companies exposed to foreign market and foreign participation spent more in innovation.

3. Innovation output

The third stage consists only on firms that have reported a positive amount of innovation output measured by the share of sales coming from the introduction of new product or services to the firm or market. Two inverse Mill's ratio was included to control for potential selectivity bias. One comes from the first equation and another one for an auxiliary regression of the equation 3. The results of the estimation are presented in table 6. The inverse Mill's ratio from the first equation is insignificant but not the inverse Mill's ratio from the auxiliary regression suggesting the appropriateness of correcting for selection bias.

Starting by the determinants of the innovation output, I found differences between pre crisis and periods of economic crisis. The coefficients of innovation input yields a positive relationship with innovation output in the whole sample (0,244). Nevertheless, the elasticity is higher in micro and small (SM) firms than in medium and large (ML). There is also a decrease in the elasticity during period of economic crisis compared with period of expansion. One likely explanation is that in period of economic crisis the objectives of innovation activities changes from product into process or non-technological. Another explanation is that the demand change in period of crisis, diluting the potential positive effect of new product or services. However, as I could analyse in table 1, the average share of innovative products and services launched remained similar in

period of crisis. Thus, there are not clear demand factors as changes in consumer's preferences. Finally, it is also likely that companies prefer to defend their position in the market exploiting the existing technology and knowledge which may lead to an inefficient investment in innovation in period of crisis (Auh & Menguc, 2005; March, 1991).

In period of economic crisis, other factors become important to generate innovation output. Firms involved in continuous R&D lead to an increase in the innovation output. The coefficient is higher in period of economic crisis. Further, continuous R&D generates higher innovation output in MH firms than in MS. This means that those companies that have an established research department, for which they carry out innovation activities on an ongoing basis, obtain greater innovation output than those companies that innovate on an occasional basis.

Furthermore, previous experience in innovation positively affects innovation output. Again, the positive effect is higher in periods of economic crisis. Those companies that had already introduced innovations in previous periods (t-3) have a greater capacity to readapt to the new adverse macroeconomic conditions and obtain greater innovation performance in terms of introducing and sell new products or services. This variable isn't relevant for ML firms in period of expansion but becomes significant in period of crisis. For MS firms, previous experience is essential for successful innovation in, especially in downturns. Again the learning process and experiences are relevant in period of downturn. However, extramural R&D does not influence positively the innovation performance in any kind of period. Therefore, the same conclusion arises: investment in innovation is a necessary condition, but other key factor can enhances innovation output in periods of crisis. This investment must be accompanied by previous experience and knowledge.

Combine product and process innovation increase the innovation output. Both strategies are related since the introduction of a new product and services usually requires new processes. The coefficient of non-technological innovation yields the same results for period of crisis. When the company is able to innovate in several types of innovation increases the innovation output.

Further, those companies that have a clear objective of exploratory and cumulative innovation increase the innovation output in period of economic crisis. The positive effect of cumulative innovation is twice as much as exploratory innovation. This can mean two things: the first is that because Spain is a "follower" country in terms of technology, cumulative innovation causes a greater increase in the share of sales of new goods and services; and second is that in periods of crisis, changes in demand preferences (e.g. more focus on price and basic needs) causes cumulative innovations to perform better than the exploratory ones in terms of percentage of new products or services in relation to their total sales.

The cooperation with other foreign institutions or firms influences the innovation output positively in the whole period. The cooperation with abroad institution is significant for MS firms but not for ML. This means that MS firms take advantages of this type of cooperation to generate new product or services. But, cooperation with public institutions and competitors impact negatively in the innovation output. The last

Table 6. Results of the innovation output equation.

	Total firms sample				Micro and small firms sample				Medium and high firms sample			
	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Innovation Characteristics												
Inno. input[b]	0.244***	0.256***	0.234***	0.230***	0.220***	0.260***	0.196***	0.202***	0.133***	0.193***	0.114***	0.122***
	(0.034)	(0.054)	(0.043)	(0.043)	(0.031)	(0.051)	(0.040)	(0.040)	(0.029)	(0.052)	(0.035)	(0.035)
Cont. R&D[a]	0.228***	0.189**	0.253***	0.255***	0.152**	0.140	0.168*	0.183**	0.228***	0.305**	0.218**	0.218**
	(0.059)	(0.091)	(0.075)	(0.075)	(0.067)	(0.106)	(0.086)	(0.086)	(0.075)	(0.130)	(0.093)	(0.092)
Extra. R&D[a]	-0.043**	-0.038	-0.045*	-0.043*	-0.034	-0.025	-0.041	-0.042	-0.022	-0.011	-0.017	-0.020
	(0.018)	(0.028)	(0.023)	(0.023)	(0.026)	(0.042)	(0.034)	(0.034)	(0.028)	(0.050)	(0.034)	(0.034)
Proc. inno.[a]	0.066***	0.079***	0.060***	0.037	0.097***	0.084**	0.105***	0.076**	0.037	0.103*	0.010	-0.022
	(0.017)	(0.028)	(0.022)	(0.024)	(0.023)	(0.038)	(0.029)	(0.032)	(0.030)	(0.053)	(0.036)	(0.038)
N-T. inn.[a]				0.041*				0.071**				-0.006
				(0.024)				(0.032)				(0.036)
Expl. inn.[a]				0.044*				0.021				0.065*
				(0.023)				(0.033)				(0.035)
Accum. inn.[a]				0.109***				0.100***				0.135***
				(0.0258)				(0.037)				(0.034)
Inno. in t-3 [a]	0.264***	0.189**	0.355***	0.368***	0.290***	0.248**	0.357***	0.385***	0.126	0.124	0.184*	0.198*
	(0.060)	(0.088)	(0.082)	(0.081)	(0.070)	(0.109)	(0.095)	(0.096)	(0.078)	(0.129)	(0.103)	(0.102)
Cooperation												
Abroad inst.[a]	0.098***	0.087	0.111**	0.117**	0.180***	0.174**	0.175**	0.190***	0.053	0.090	0.054	0.055
	(0.037)	(0.057)	(0.047)	(0.047)	(0.056)	(0.088)	(0.073)	(0.073)	(0.050)	(0.090)	(0.061)	(0.060)
Public inst.[a]	-0.060***	-0.025	-0.081***	-0.079***	-0.050	0.028	-0.091**	-0.090**	-0.092***	-0.088	-0.095**	-0.090**
	(0.022)	(0.034)	(0.027)	(0.027)	(0.031)	(0.050)	(0.040)	(0.040)	(0.034)	(0.061)	(0.041)	(0.040)
Competitors[a]	-0.076***	-0.065	-0.077**	-0.079**	-0.128***	-0.113	-0.136**	-0.142**	-0.010	-0.021	-0.003	-0.008
	(0.029)	(0.047)	(0.036)	(0.035)	(0.044)	(0.074)	(0.055)	(0.055)	(0.042)	(0.078)	(0.050)	(0.049)
Access to subsidies												
Spa. funds[a]	0.052**	0.021	0.069***	0.075***	0.086***	0.040	0.109***	0.122***	0.021	-0.005	0.033	0.036
	(0.021)	(0.032)	(0.026)	(0.026)	(0.031)	(0.049)	(0.039)	(0.039)	(0.032)	(0.056)	(0.039)	(0.038)
UE funds[a]	-0.035	0.028	-0.058	-0.056	0.013	0.029	0.019	0.007	-0.064	-0.008	-0.095	-0.081
Feedback effect												
	(0.038)	(0.062)	(0.047)	(0.047)	(0.055)	(0.096)	(0.068)	(0.068)	(0.054)	(0.100)	(0.064)	(0.063)
Sales growth[b]	0.110***	0.135*	0.116***	0.117***	0.072***	0.117	0.078***	0.077***	0.138***	-0.014	0.161***	0.167***
	(0.020)	(0.072)	(0.022)	(0.022)	(0.026)	(0.088)	(0.027)	(0.027)	(0.033)	(0.123)	(0.035)	(0.035)

(Continuation)	Total firms sample				Micro and small firms sample				Medium and high firms sample			
Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total
Firm and environment characteristics												
Firm size [b]	-0.007	-0.026	-0.002	-0.009								
	(0.015)	(0.024)	(0.018)	(0.018)								
High degree [b]	0.000	0.013	-0.007	-0.007	-0.008	-0.003	-0.012	-0.012	-0.007	0.013	-0.016	-0.014
	(0.007)	(0.011)	(0.008)	(0.008)	(0.009)	(0.015)	(0.012)	(0.012)	(0.010)	(0.019)	(0.012)	(0.012)
Tech. park [a]	0.026	0.175**	-0.027	-0.025	0.026	0.169*	-0.033	-0.037	0.152**	0.301**	0.112	0.093
	(0.042)	(0.070)	(0.052)	(0.052)	(0.053)	(0.093)	(0.066)	(0.066)	(0.064)	(0.122)	(0.076)	(0.074)
Crisis [a]	-0.071***				-0.123***				-0.009			
	(0.021)				(0.030)				(0.032)			
HT manu. [a]	-0.006	-0.073	0.049	0.052	0.055	-0.042	0.128**	0.130**	0.015	-0.035	0.040	0.040
	(0.034)	(0.050)	(0.043)	(0.043)	(0.044)	(0.068)	(0.058)	(0.058)	(0.055)	(0.093)	(0.068)	(0.067)
HT serv.[a]	-0.175**	-0.250**	-0.122	-0.114	-0.094	-0.251**	-0.008	-0.015	0.050	0.101	0.069	0.043
	(0.070)	(0.114)	(0.087)	(0.087)	(0.073)	(0.122)	(0.092)	(0.091)	(0.094)	(0.191)	(0.111)	(0.109)
MR.1[c]	0.102	0.053	0.156	0.167*	0.369	0.490	0.321	0.432	0.112	-0.064	0.167	0.183
	(0.080)	(0.156)	(0.097)	(0.096)	(0.263)	(0.424)	(0.335)	(0.336)	(0.113)	(0.244)	(0.132)	(0.130)
MR.3[c]	0.786***	0.841**	0.767**	0.808**	0.191*	0.183	0.230*	0.234*	0.405	1.002*	0.262	0.341
	(0.259)	(0.410)	(0.330)	(0.329)	(0.110)	(0.218)	(0.133)	(0.132)	(0.289)	(0.516)	(0.352)	(0.349)
Constant	-0.198	-0.319	-0.323	-0.351	0.420	-0.165	0.425	0.228	0.771*	0.620	0.853	0.669
	(0.510)	(0.826)	(0.657)	(0.653)	(0.457)	(0.779)	(0.584)	(0.586)	(0.456)	(0.957)	(0.551)	(0.546)
Sample size	22,573	7,046	15,527	15,527	11,264	3,660	7,604	7,604	11,309	3,386	7,923	7,923

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for description of the variables.

result not imply that the cooperation with public institution is not effective, if not that the cooperation with public institution may not have the objective to introduce new product or services. Finally, the subsidies of Spanish public institutions allow, in times of crisis, to achieve greater innovation output, especially for SM firms.

Analysing the firm's internal characteristics, the effects of firm's growth on innovation output is positive in the whole period, without difference between MS and ML firms. There is a feedback effect in which firms with higher growth also gather higher innovation output. Finally, the environment is also contingent to the innovation performance. In period of economic expansion, technology parks are positively related with innovation output. The proximity of firms that generate knowledge spillover produces a positive impact on firms that are located in cluster in terms of performance and efficiency (Audretsch & Feldman, 2004). Thus, firms are able to assimilate knowledge spillover for their neighbours. However, this relationship disappear in period of economic crisis. One likely explanation is that in period of crisis, the free share of information and knowledge is smaller which reduce the advantages of technology parks.

4. The growth equation.

In this fourth stage, I analysed firm growth, which is determined by the innovation output, as well as other control variables available in the database. Table 7 contains the results estimated by 3SLS.

The results indicate that innovation output significantly increases firm growth. But again, I find differences between the pre-crisis and crisis period and between micro and small firms (MS) vs medium and large (ML). Whereas the elasticity of firm growth-innovation output is 0.256 in period of expansion, it decreases to 0.112 in in period of economic crisis. Thus, the effect of innovation output on firm growth is half in period of economic downturns. There are also differences taking into account company size. Whereas in MS firms, innovation output leads to increase firm growth, it is not the same for ML firms where the positive effect disappears in period of crisis. Further the elasticity is higher in MS firms than in ML. For MS innovation is a clear strategy to become a competitive firm.

Similarly, the introduction of process and not technological innovation does not enhance firm's growth in period of economic crisis. The non-significance of process and non-technological innovation dummies is frequent once the intensity of product innovation is introduced as a continuous variable (Lee et al., 2003; Criscuolo, 2009)

The coefficient of the lag of the firm growth is statistically significant and positive, indicating the persistence of the changes implemented by the company to improve its productivity and growth. Firm size is positively related with firm growth. One likely explanation is that the stronger benefits derived from dominance position, access to internal and external financing of bigger firms leads then to increase their size.

Export and investment capacity increase firm size, but its elasticity is relatively small compared to the other variables. Export becomes relevant in period of economic crisis. Those companies present in international

Table 7. Results of the productivity equation.

	Total firms sample				Micro and small firms sample				Medium and high firms sample			
VARIABLES	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Inn. Output.[b]	0.152***	0.241***	0.112***	0.108***	0.133***	0.201***	0.092***	0.090***	0.049**	0.075**	0.034	0.047**
	(0.017)	(0.034)	(0.018)	(0.019)	(0.021)	(0.039)	(0.024)	(0.025)	(0.021)	(0.032)	(0.025)	(0.022)
Proc. Inn.[a]				-0.003				-0.004				0.008
				(0.006)				(0.009)				(0.008)
Non-tech. inn.[a]				-0.002				0.004				0.001
				(0.006)				(0.009)				(0.008)
Crisis[a]	-0.114***				-0.128***				-0.100***			
	(0.005)				(0.008)				(0.006)			
S. Growth (t-1)[b]	0.965***	0.913***	0.974***	0.975***	0.972***	0.939***	0.979***	0.979***	0.973***	0.919***	0.981***	0.978***
	(0.006)	(0.025)	(0.006)	(0.006)	(0.008)	(0.032)	(0.008)	(0.008)	(0.008)	(0.028)	(0.008)	(0.008)
Firms size.[b]	0.025***	0.035***	0.022***	0.023***								
	(0.002)	(0.005)	(0.003)	(0.003)								
Export. [c]	0.014***	-0.010	0.025***	0.025***	0.029***	0.004	0.040***	0.040***	0.006	-0.012	0.013***	0.013***
	(0.003)	(0.006)	(0.003)	(0.003)	(0.004)	(0.009)	(0.005)	(0.005)	(0.004)	(0.008)	(0.005)	(0.005)
GITA[b]	0.004***	0.003***	0.005***	0.005***	0.007***	0.004***	0.008***	0.008***	0.003***	0.002**	0.004***	0.004***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Company age[b]	-0.035***	-0.040***	-0.029***	-0.030***	-0.045***	-0.071***	-0.024**	-0.025**	-0.018***	-0.012	-0.020**	-0.021***
	(0.006)	(0.010)	(0.006)	(0.006)	(0.009)	(0.016)	(0.010)	(0.010)	(0.006)	(0.010)	(0.008)	(0.008)
Part. group[a]	-0.026***	-0.030***	-0.024***	-0.025***	-0.017*	-0.025	-0.015	-0.015	-0.014**	-0.014	-0.012*	-0.014*
	(0.005)	(0.010)	(0.006)	(0.006)	(0.009)	(0.017)	(0.010)	(0.010)	(0.006)	(0.012)	(0.007)	(0.007)
PRIV[a]	-0.002	-0.009	-0.001	-0.000	0.029*	0.054	0.023	0.024	-0.006	-0.020	-0.001	-0.001
	(0.007)	(0.014)	(0.007)	(0.007)	(0.015)	(0.033)	(0.017)	(0.017)	(0.007)	(0.015)	(0.008)	(0.008)
Trade[a]	0.008	0.005	0.006	0.006	0.006	0.012	0.002	0.001	-0.001	-0.017	0.002	0.003
	(0.010)	(0.020)	(0.012)	(0.012)	(0.015)	(0.029)	(0.018)	(0.018)	(0.014)	(0.028)	(0.016)	(0.016)
Hospitality[a]	0.021***	0.035***	0.011*	0.011*	0.016*	0.015	0.015	0.015	0.027***	0.062***	0.012	0.013
	(0.006)	(0.011)	(0.006)	(0.006)	(0.009)	(0.017)	(0.010)	(0.010)	(0.007)	(0.015)	(0.009)	(0.009)
Construction[a]	-0.034**	0.042	-0.071***	-0.073***	-0.039	0.010	-0.065*	-0.068*	-0.047**	0.047	-0.084***	-0.083***
	(0.018)	(0.033)	(0.021)	(0.020)	(0.033)	(0.059)	(0.040)	(0.040)	(0.019)	(0.037)	(0.023)	(0.022)
Finance[a]	0.051**	0.041	0.056**	0.053**	0.104*	0.080	0.112	0.112	0.014	-0.023	0.032	0.030

	(0.020)	(0.040)	(0.023)	(0.023)	(0.060)	(0.104)	(0.073)	(0.073)	(0.020)	(0.040)	(0.023)	(0.023)
Constant	-0.277***	-0.312**	-0.319***	-0.306***	-0.167*	-0.140	-0.264***	-0.255***	0.067	0.239	-0.022	-0.043
	(0.065)	(0.158)	(0.069)	(0.069)	(0.087)	(0.198)	(0.093)	(0.096)	(0.075)	(0.168)	(0.087)	(0.081)
Observations	22,573	7,046	15,527	15,527	11,264	3,660	7,604	7,604	11,309	3,386	7,923	7,923
R-squared	0.608	0.334	0.718	0.721	0.638	0.307	0.730	0.731	0.705	0.397	0.772	0.767

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. GITA: Gross investment in tangible assets; PRIV: Private with foreign participation. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for further information about the variables

markets can offset the decline in domestic markets demand. Contrary, company age and be part of a group reduces firm growth. Finally, the period of economic crisis reduces the firm growth.

Discussion and conclusion

The economic crisis of 2008 changed the environment conditions, which affects the decision to innovate and the total investment in innovation (e.g. Archibugi et al., 2013b; Paunov, 2012). Similarly, the performance of these innovations and their final effect on firm performance may also be determined by the macroeconomic cycle. In contractive environments, uncertainty, liquidity and demand constraints may limit the benefits that derive from its innovation strategies. The objective of the article has been (i) to analyze the determinants of innovation performance and (ii) to examine how these outputs determine the company's growth, during the expansionary and contractionary periods of the economy. With this aim, I have obtained information from Spanish companies (one of the countries most affected during the crisis of 2008) and I estimated a sequential model based on four stages: decision to innovate, how much to innovate, the performance of innovation and finally the effect of these innovation output in firm growth.

Effect of the economic crisis: The size of the company in the input and output of the innovation.

This study corroborates that the crisis has reduced the number of companies that decide to innovate in Spain, which decreases the total investment in innovation. This result is in line previous studies for European and OECD countries (OECD, 2012). Thus, the percentage of firms that have introduced innovations in the crisis period has been reduced drastically, especially in the micro and small enterprises. In times of crisis, under the mix of uncertainty and risk, it makes difficult for small firms to access external capital markets to finance innovation projects (B. H. Hall et al., 2016; N. Lee et al., 2015). Yet, for firms that decide to innovate, the crisis does not diminish the intensity in innovation spending (especially medium and large companies). Therefore, size becomes a key variable for understanding the decision and how much to spend on innovation.

Previous studies show a mix of results on the effects of size in the decision to innovate and how much to invest (e.g. Lööf & Heshmati, 2006). In this research, I found that the size of the firm reduces the probability of investing in innovation in pre-crisis periods, but not in contractionary periods. This implies that small firms have greater difficulty in embarking on innovation activities in the face of uncertain scenarios such as periods of crisis. On the other hand, the larger the size of the company, the lower the intensity of innovation costs, regardless of the macroeconomic conditions. But, in our results the size has no relation to the outputs of the innovation. One possible explanation is that the measure of innovation output used (the share of sales of new products or services for the company or market) underestimates the share when total sales are high, as in large companies. Another is that transaction costs and bureaucratic costs within large companies can reduce the efficiency of innovations.

Experience and persistence in innovation to generate "innovation output" in periods of crisis.

One of the main results of the study is that the economic crisis has not only negatively affected the probability of innovation, but also (1) innovation performance and (2) the effect of these outputs have on company growth.

Although the relationship between innovation input (innovation investment) and innovation output remains positive in both pre-crisis and contractionary periods, the relationship returns are slightly lower in periods of crisis. In this period, investing more in innovation has associated a smaller increase of the performance of this innovation than in pre-crisis periods. One possible explanation is the reduction of expenditures on the purchase of equipment and machinery for innovation, a variable that some studies have found to be "crucial" to generate innovation output (Love & Roper, 2015; Pellegrino, Piva, & Vivarelli, 2012). Another explanation is that liquidity and financing constraints in times of crisis oblige the firm to keep only the innovation projects that allow them to preserve their relative position in the market compared to the competitors in terms of technology and knowledge (Auh and Menguc, 2005; March, 1991).

However, in our study, two factors are important to generate performance in innovation in contractive periods: previous experience in innovation and persistence in R&D. The positive effect of experience is more evident in times of crisis than in expansion. Experience in related projects can create internal capabilities within the organization, learning economies, and "internal spillovers" that reduce the negative side effects of the economic crisis on innovation performance (Phene & Almeida, 2008; David J Teece, 2014). This result is in line with Amore (2015) who obtained that companies with experience in innovation during previous economic crises obtain greater yield of the innovation in new crises.

With respect to persistence in the knowledge created, continuous R&D is creative work carried out within the enterprise, which is undertaken systematically in order to increase the volume of knowledge to conceive new applications, such as goods or services and new or significantly improved processes. In our study, I find that companies that carry out R&D on a continuous basis obtain greater performance from their innovations than those companies that buy R&D or simply do it on an occasional basis. This positive effect is most evident in times of crisis. These results imply that those companies with a continuous innovation strategy (which is also related to the size of the company), are capable of generating higher levels of introduction of new products in periods of economic crisis. Under the evolutionary perspective, firms that carry out R&D activities on a continuous basis accumulate knowledge and extract technology and technological trajectories that help them to improve innovation performance (Raymond et al., 2010). This continued learning is especially relevant in times of crisis, where the company does not have the same capacity to adapt to technological changes. The companies that innovate continually have the capacity to adapt to the new circumstances of the environment and can obtain greater yields of their innovation. Yet, the purchase of R&D is not enough to generate innovation output in times of crisis. Internal and external R&D is one of the most studied variables in the field of innovation with a positive relationship in innovation output (e.g. Crepon et al, 1998; Love et al. 2009; Roper et al. 2008).

Therefore, companies that do not have previous experience on innovations or are involved in innovation in an occasional basis, must re-evaluate the performance of their innovations in times of crisis so as not to fall into inefficiencies and sunk costs.

Firm growth: The role of the innovation outputs.

Apart from the negative effect of the period of crisis on firm growth, the results show that the economic crisis limits the efficiency of innovation. Innovation output positively influences the growth of the company, but in periods of crisis the positive effect of innovation output is reduced by half. This implies that a greater share of sales due to the introduction of new products or services for the company or market does not entail a clear increase in the firm growth. One possible explanation is that in crisis there are adjustments in demand. Consumers have greater budget constraints which may limit the demand for innovative products. Another is that the innovations introduced are not radical enough to generate a competitive advantage in times of crisis. These recessive periods force firms to keep only the innovation projects that allow them to maintain their relative position in the market compared to the competitors, in terms of technology and knowledge (Auh & Menguc, 2005; March, 1991).

Is innovation recommendable in times of crisis? The answer is yes, innovation helps the growth of the company through sales, but the firm must be aware that the performance of innovation is lower than in expansive periods. Therefore companies should: first recalculate the opportunity cost of innovation, second to invest in projects with previous experience, or to cooperate with companies experienced in innovation, and third to focus efforts on continued R&D activities. All this helps companies in contractive periods to reduce risk and to take positive externalities of the characteristics of the company on innovation.

The role of public funding in innovation.

Another main question is whether public funds earmarked for firm innovation are effective in times of crisis. According to the results, public aid increases the investment in innovation of firms significantly, regardless of the period considered. In addition, public funds increase innovation output in times of crisis, but not in pre-crisis periods. Specifically, public funds from Spanish administrations have a positive effect on the introduction of new products and services in times of economic crisis. This relationship is not seen in expansive periods or funds coming from the EU. One explanation is that many of the EU funds are based on very long-term innovation projects, with a fundamental objective of expanding the boundaries of knowledge and generating positive externalities for society, thus its positive effect cannot be captured with this model. In any case, public subsidies allow firms to increase their spending on innovation and generate greater outputs of this investment in times of crisis, especially in small and micro enterprises, which ends up impacting on the growth of the company. However, cooperation with public entities (e.g. Universities, or state research centers), while increasing investment in innovation, decreases the share of new products and services in the enterprise market (output), especially in times of crisis. Again, one possible explanation is that innovations

developed in cooperation with public entities may be directed towards other types of innovation, such as process innovations rather than products.

Despite the interest of these results, it is important to mention that this study was subject to several limitations. First, the indicators used to measure firm growth at the firm level are not neutral with respect to empirical results (Audretsch, Segarra, et al., 2014). For comparability I selected the variable most frequently used in this field, but results may be different with other performance variables. Second, although I corrected in the model for selection bias and omitted variables, firm growth, as well as innovation output, it is also associated with specific unobservable firm's capabilities, such as managerial capacity, entrepreneurship, ownership or firm diversification. Finally, the study is conducted in Spain which may not represent other countries or specific sectors.

Appendix A.

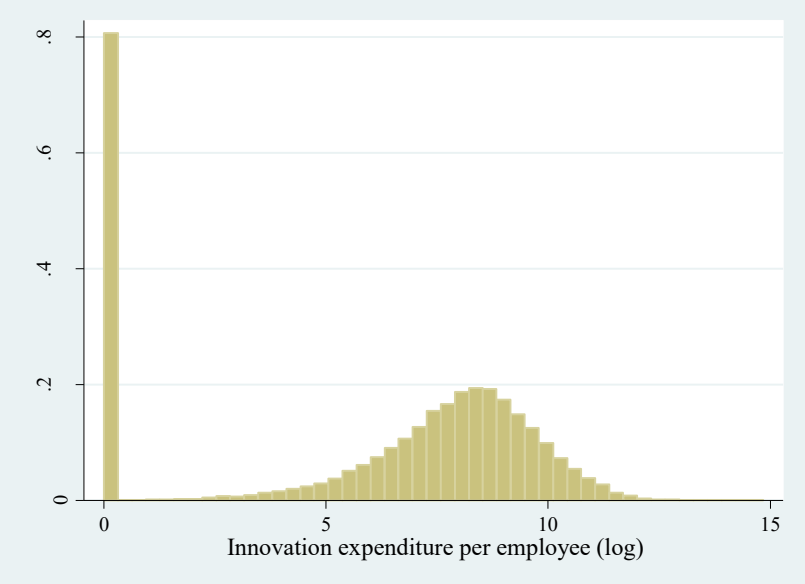
Table A.1. Explanation of variables.

Dependent variables	Abbreviation	Definition
Eq. (1): Decision to innovate		Dummy variable; 1 if firm, in years t to t-2, engaged in any type of innovation expenditures follow Oslo Manual 2005 definition. Thus is in intramural or extramural R&D, purchased new machinery, equipment, software or other external knowledge, engaged in training of personnel, market research or did any other preparations to implement new or significantly improved products and processes, or new or significantly improved organization or distribution methods.
Eq. (2): Innovation input (natural logarithm)	Inno. input	Innovation intensity: Amount (in euro) of average expenditure on innovation in year t to t-2 divided by the average employees in the period t to t-2 (Innovation expenditure: Oslo Manual 2005 definition).
Eq. (3): Innovation output (natural logarithm)	Inno. output	Percent of firm's turnover in year t coming from goods or services that were new to market or to the firm in years t to t-2.
Eq. (4): Firm growth (natural logarithm)	Sales growth	Sales growth: Index number with base in firm's turnover in 2005
Independent variables		
Firm size (natural logarithm)	Firm size	Number of employees in year t
Private company with foreign participation	PRIV	Dummy variable; 1 if firm is private and with foreign participation in year t.
Company age (natural logarithm)	Age	Number of years since the set-up of the firm
Gross investment (natural logarithm)	GITA	Gross investment (in euros) in tangible assets in year t
Part of a group	Part. group	Dummy variable; 1 if firm is part of an enterprise in year t.
Part of a group being the parent	Parent	Dummy variable; 1 if firm is part of an enterprise group being the parent company in year t.
Part of a group being the subsidiary	Subsidiary	Dummy variable; 1 if firm is part of an enterprise group being a subsidiary company in year t.
High degree employees	High degree	Percent of employees in the firm with University studies.
Location in a Scientific or Technological Park	Tech. park	Dummy variable; 1 if firm is located in a Scientific or Technological Park in year t
Exporter abroad UE	Export.	Categorical variable: 1 if firm export outside the UE less than 20% of the turnover; 2 if firm export in range 20% to 50%; 3 if firm export more than 50%; 0 in other cases (in year t).
Exporter in t-3	Exp. t-2	Dummy variable; 1 if firm sold goods or services outside the UE in year t-2
Innovation characteristics		
Intramural R&D	Intra. R&D	Dummy variable; 1 if firm is involved in-house R&D in year's t to t-2.
Continuous R&D	Cont. R&D	Dummy variable; 1 if firm is involved in continuous in-house R&D in year t. (lagged in equation 3) Survey question: "Has your company carried out internal R & D activities in *year t*? Continuously or occasionally?"
Extramural R&D	Entra. R&D	Dummy variable; 1 if firm bought R&D from other enterprise or research organization in years t. (lagged in equation 3)
Process innovation	Proc. inno	Dummy variable; 1 if firm introduced process innovation in year's t to t-2
Non-technological innovation	N-T. inn	Dummy variable; 1 if firm in years t to t-2, introduced organizational or marketing innovations follow Oslo Manual 2005 definition.
Explorative innovation	Expl. Inn.	Dummy variable; 1 if firm considered as highly important factor in their decision to innovate (t; t-2) at least two of the following: (i) increase range of goods or services; (ii) entering new markets; (iii) increased market share
Accumulative innovation	Accum. Inn.	Dummy variable; 1 if firm considered as highly important factor in their decision to innovate (t; t-2) at least half of the following: (i) Replace old products and process; (ii) Improving quality of goods or services; (iii) Improving flexibility for producing goods or services; (iv) Increasing capacity for producing goods or services; (v) Reducing costs per unit produced; (vi) Less energy per unit produced; (vii) Less materials per unit produced
Expenses in equipment and software (natural logarithm)	Soft.	Percentage of total innovation expenditure in t, on acquisition of machines, equipment and software (not included in R&D).
Experience in innovation	Inno. in t-3	Dummy variable; 1 if firm was able to introduce an innovation in t-3.
Hampering innovation		
Cost factors	Cost f.	Dummy variable; 1 if firm perceives the lack of funds, finance from sources outside the enterprise and high costs of innovation as highly important factors hampering its innovation activities, projects or decision to innovate (years t to t-2).
Knowledge factors	Know. F.	Dummy variable; 1 if firm perceives the lack of qualified personnel, information on technology or markets or difficulties in finding cooperation partners for

		innovation as highly important factors hampering its innovation activities, projects or decision to innovate (years t to t-2).
Market factors	Market f.	Dummy variable; 1 if firm perceives the domination over market by established enterprises or the uncertainty of demand for innovation goods and services as highly important factors hampering its innovation activities, projects or decision to innovate (years t to t-2).
Public support		
Public financial support	Public fund	Dummy variable; 1 if firm received financial support for innovation activities from local/regional, central government or EU authorities (loans, grants, subsidies ...) in year t to t-2
National subsidies	Spa. funds	Dummy variable; 1 if firm in years t to t-2 received financial support for innovation activities from central government. (with 1 lag in Equation 3)
EU subsidies	UE funds	Dummy variable; 1 if firm in years t to t-2 received financial support for innovation activities from EU authorities (with 1 lag in Equation 3)
Sources of innovation about technological innovations		
Internal sources	Internal S.	Dummy variable; 1 if firm perceives sources of information within enterprise or group as highly important sources of information on innovation (t; t-2).
Market sources	Market S.	Dummy variable; 1 if firm perceives suppliers, customers, competitors, consultants or R&D labs as highly important sources of information on innovation (t; t-2).
Institutional sources	Inst. S.	Dummy variable; 1 if firm perceives universities or government as highly important sources of information on innovation (t; t-2).
Cooperation		
Cooperation with abroad countries	Coop. abr.	Dummy variable; 1 if firm cooperated on innovations with other overseas enterprises or institutions in years t to t-2
Cooperation with competitors	Competitors	Dummy variable; 1 if firm cooperated on innovations with other competitors enterprises or enterprises in the same main sector in years t to t-2 prior to survey
Cooperation with public institutions	Coop. Public	Dummy variable; 1 if firm cooperated on innovations with public institutions in years t to t-2 prior to survey
Firm main sector		
Food, beverages and tobacco	Food	Dummy variable; 1 if firm operates in manufacture of food, beverages and tobacco products.
Textile	Textile	Dummy variable; 1 if firm operates in manufacture of textiles
Chemical	Chemical	Dummy variable; 1 if firm operates in manufacture of chemicals and chemical products.
Textile		Dummy variable; 1 if firm operates in manufacture of textiles
Water and energy	W&E	Dummy variable; 1 if firm operates in electricity, gas, steam, air conditioning supply, water supply; sewerage; waste management and remediation activities (Group D and E NACE2009)
High Tech Manufactures	HT manu.	Dummy variable; 1 if firm operates in High Technology manufacture sector (OCDE Definition)
High Tech Services	HT serv.	Dummy variable; 1 if firm operates in High Technology service sector (OCDE Definition)
Construction	Const.	Dummy variable; 1 if firm operates in construction. (Group F)
Hospitality	Hospitality	Dummy variable; 1 if firm operates in accommodation and food service activities (Group I)
Finance	Finance	Dummy variable; 1 if firm operates in financial and insurance sector (Group K)
Health	Health	Dummy variable; 1 if firm operates in human health and social work activities (Group Q)
Controls		
IMR equation 1	IM.1	Inverse Mill's ratio from selection equation
IMR auxiliary equation 3	IM.3	Inverse Mill's ratio from auxiliary equation of innovation output with dependent variable Dummy variable be 1 if firm in year t to t-2, introduced process, organizational or marketing innovations but not product innovation.
Period of crisis		Dummy variable; 1 in the period 2009 to 2013

Appendix B.

Figure B.1. Histogram of the ratio of innovation expenditure per employee (in logarithms).



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