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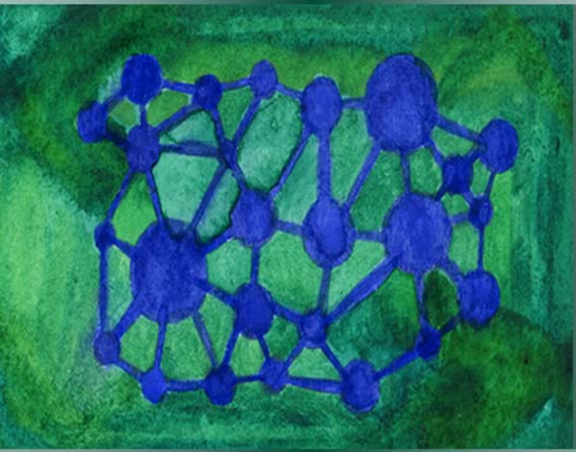

TESIS DOCTORAL

CONOCIMIENTO INCORPORADO Y VÍNCULOS INTERSECTORIALES

APROXIMACIONES MEDIANTE EL ANÁLISIS INPUT-OUTPUT

MARTIN FEDERICO ALBA

DIRECTORES

FRANCISCO MAS VERDÚ

JOSÉ MARÍA GARCÍA ÁLVAREZ-COQUE

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Presentada por:

MARTIN FEDERICO ALBA

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UNIVERSITAT POLITÈCNICA DE VALÈNCIA

DEPARTAMENTO DE ECONOMÍA Y CIENCIAS SOCIALES

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A Chabe, Cholo, Andrus y Adri (mi familia)

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Resumen

Esta tesis doctoral tiene por objetivo el estudio de la actividad innovadora de los sectores económicos desde la perspectiva de los vínculos tecno-productivos que se establecen entre ellos. Dentro de este objetivo general, cobra una destacada importancia el territorio en el cual se encuentran estos sectores, siendo España y la Comunidad Valenciana los casos analizados.

Ante estos objetivos, se plantean las siguientes preguntas que guían la investigación:

i. ¿Qué rol desempeñan los servicios empresariales intensivos en conocimiento en la generación y difusión de innovación en el sistema económico? ¿Qué contribución cuantitativa realizan tales sectores al sistema de creación y generación de conocimiento?

i) ¿Cuáles son los patrones de innovación de sectores menos intensivos en conocimiento, clasificados típicamente como tradicionales, pero con gran arraigo e influencia territorial (en particular el sector agroalimentario)? ¿A qué fuentes recurren con mayor intensidad cuando el territorio presenta también bajas intensidades tecnológicas o baja capacidad de absorción (la Comunidad Valenciana)?

ii) ¿Qué patrones de innovación se corresponden con distintas capacidades sectoriales para crear nuevas empresas? O en otras palabras, ¿el patrón de generación/absorción de conocimiento de cada sector afecta a su capacidad para crear nuevas empresas?

Para dar respuesta a estas preguntas se ha utilizado el enfoque del "*embodied knowledge*". Esta aproximación permite mensurar el conocimiento "incorporado" en los productos y servicios que cada sector utiliza como inputs en sus procesos productivos y que

indirectamente contribuyen a su propia intensidad o esfuerzo tecnológico y de innovación. La metodología implementada puede sintetizarse en la idea de que el mayor o menor grado de esfuerzo innovador en un sector no solo estará determinado por su propio gasto en actividades innovadoras, sino también por el gasto que sus proveedores realizan en estas actividades. Estos proveedores trasladarán a este sector usuario una intensidad de innovación que aparecerá incorporada en los productos y servicios que intercambien. Así un sector podría realizar un gasto relativamente reducido en actividades innovadoras, pero podría adquirir en mayor grado productos y servicios con un alto contenido tecnológico, aspecto que no es generalmente mensurado en este tipo de estadísticas.

Esta tesis se estructura en 3 capítulos auto-contenidos que se complementa con una introducción y con un apartado de discusión de resultados y conclusiones. Cada capítulo auto-contenido constituye un artículo publicado en revistas científicas reconocidas (dos de ellas forman parte del *Journal Citation Reports -JCR-*).

Abstract

This Ph.D. Thesis aims to study the innovative activity of economic sectors from the perspective of techno-productive links established between them. Within this general objective, the territory where these sectors operate also takes a remarkable importance. In this sense we have analyzed the cases of Spain and Valencian Community.

Given these objectives, this thesis proposes the following questions to guide research:

i. What is the role played by knowledge-intensive business services in the generation and diffusion of innovation in the economic system? What quantitative contribution is given by these sectors to the system of creation and generation of knowledge?
ii. What are the patterns of innovation in low tech industries, typically classified as traditional, but with deep roots and territorial influence (in particular the agrifood industry)? What are the main sources of innovation in this sector given that the territory has also a low absorptive capacity (Valencian Community)?
iii. What innovation patterns correspond to different industrial capabilities to create new firms? Or in other words, the pattern of generation / absorption of knowledge of each industry affect their ability to create new companies?

To answer these questions we have used the approach of the "Embodied knowledge". This approach allows measuring knowledge "embedded" in products and services that each sector uses as inputs in their production processes and indirectly contributes to their own strength or technological effort and innovation. The methodology can be summarized by the idea that the greater or lesser degree of

innovative effort in a sector not only be determined by its own spending on innovative activities, but also by spending their suppliers to perform these activities. These providers will be taken to the user sector innovation intensity that appears embedded in the products and services exchanged. This sector could make a relatively small expenditure on innovative activities, but may acquire a greater degree products and services with high technological content, something that is not usually measurable in this kind of statistics.

This thesis is divided into 3 self-contained chapters complemented by an introduction and a section for discussion of results and conclusions. Finally, each chapter is an article published in recognized scientific journals (two of them are part of the Journal Citation Reports-JCR-).

Resum

Aquesta tesi doctoral té per objectiu l'estudi de l'activitat innovadora dels sectors econòmics des de la perspectiva dels vincles tecno-productius que s'estableixen entre ells. Dintre d'aquest objectiu general, cobra una destacada importància el territori on es troben aquests sectors, Espanya i la Comunitat Valenciana són els casos analitzats.

Davant d'aquests objectius, es plantegen les següents preguntes que guien la investigació:

i. Quin rol exerceixen els serveis empresarials intensius en coneixement en la generació i difusió de la innovació en el sistema econòmic? Quina contribució quantitativa realitzen els anomenats sectors al sistema de creació i generació de coneixement?
ii. Quins són els patrons d'innovació de sectors menys intensius en coneixement, classificats típicament com a tradicionals, però amb gran arrelament i influència territorial (en particular el sector agroalimentari)? A quines fonts recorren amb major intensitat quan el territori presenta també baixes intensitats tecnològiques o baixa capacitat d'absorció (la Comunitat Valenciana)?
iii. Quins patrons d'innovació es corresponen amb diferents capacitats sectorials per crear noves empreses? En altres paraules, el patró de generació/absorció de coneixement de cada sector afecta a la seua capacitat per crear noves empreses?

Per donar resposta a aquestes preguntes s'ha utilitzat l'enfocament de l'*"embodied knowledge".* Aquesta aproximació permet mesurar el coneixement "incorporat" als productes i serveis que cada sector utilitza com inputs en els seus processos productius i que

indirectament contribueixen a la seua pròpia intensitat o esforç tecnològic i d'innovació. La metodologia implementada pot sintetitzar-se en la idea de que el major o menor grau d'esforç innovador en un sector no només estarà determinat per la seua pròpia despesa en activitats innovadores, sinó també per la despesa que els seus proveïdors realitzen en aquestes activitats. Aquests proveïdors traslladaran a aquest sector usuari una intensitat d'innovació que apareixerà incorporada als productes i serveis que intercanvien. Així, un sector podria realitzar una despesa relativament reduïda en activitats innovadores però podria adquirir en major grau productes i serveis amb un alt contingut tecnològic, aspecte que no es generalment mesurat en aquest tipus d'estadístiques.

Aquesta tesi s'estructura en 3 capítols auto-continguts que es complementen amb una introducció i un apartat de discussió de resultats i conclusions. Cada capítol auto-contingut constitueix un article publicat en revistes científiques reconegudes (dos d'elles formen part del *Journal Citation Reports -JCR-*).

Índice

Capítulo 1

Introducción

Capítulo 1

Introducción

La presente tesis doctoral, se estructura en un esquema de 3 capítulos auto-contenidos. Cada uno de ellos es un artículo publicado o próximo a publicarse en revistas científicas reconocidas (dos de ellas forman parte del *Journal Citation Reports -JCR-*).

El objetivo de nuestra investigación es el estudio de la actividad innovadora de los sectores económicos y su relación con los vínculos tecno-productivos que se establecen entre ellos. En este objetivo general, también cobra una destacada importancia el territorio en el cual se encuentran estos sectores, siendo España y la Comunidad Valenciana, los casos analizados.

Ante estos objetivos, surgen las siguientes 3 preguntas de investigación, que guían la presente tesis:

i) ¿Qué rol tienen los sectores más intensivos en conocimiento en la generación y difusión de innovación en el sistema económico? ¿En cuánto contribuyen estos sectores al sistema de creación y generación de conocimiento?
ii) ¿Cuáles son los patrones de innovación de sectores menos intensivos en conocimiento, clasificados típicamente como tradicionales, pero con gran arraigo e influencia territorial (en particular el sector agroalimentario)? ¿A qué fuentes recurren con mayor intensidad cuando el territorio presenta también bajas intensidades tecnológicas o baja capacidad de absorción (la Comunidad Valenciana)?

iii) ¿Qué patrones sectoriales de innovación se corresponden con distintas capacidades para crear nuevas empresas? O en otras palabras, ¿el patrón de generación/absorción de conocimiento de cada sector afecta su capacidad para crear nuevas empresas?

Para dar respuesta a estas preguntas, hemos utilizado el enfoque del "*embodied knowledge*". Esta aproximación permite mensurar el conocimiento "incorporado" en los productos y servicios que cada sector utiliza como inputs en sus procesos productivos y que indirectamente contribuyen a su propia intensidad o esfuerzo tecnológico y de innovación.

La metodología implementada (que aparece ampliamente desarrollada en cada artículo presentado) puede sintetizarse en la idea de que el mayor o menor grado de esfuerzo innovador en un sector no solo estará determinado por su propio gasto en actividades innovadoras, sino también, por el gasto que sus proveedores realizan en estas actividades. Estos proveedores "trasladarán" a este sector usuario, una intensidad de innovación que aparecerá incorporada en los productos y servicios que intercambien. Así un sector podría no realizar un gasto demasiado amplio en actividades innovadoras, pero sí podría adquirir productos y servicios con un alto contenido tecnológico, aspecto que no es generalmente mensurado en este tipo de estadísticas.

La implementación de esta metodología se realiza a través del modelo abierto de Leontief y combina principalmente dos fuentes de información:

i) Las tablas input-output del territorio que analicemos, y
ii) la información de intensidades de innovación de cada sector que se quiera analizar.

1.1. El marco conceptual y metodológico en el estudio de los vínculos de conocimiento y de innovación.

Los flujos de conocimiento, o en un sentido más amplio, las interacciones entre ciencia/tecnología/producción, toman varias formas asociadas con los canales y los tipos específicos de conocimiento que se intercambian (Cohen, 2002). Las interacciones sectoriales son las bases del estudio de interdependencias tecnológicas y permiten obtener lo que en la literatura identifica como matrices de flujos tecnológicos o matrices de innovación (Johnson, 1997; Verspagen, 1997; DeBresson, 1994; Scherer, 1982).

Los mecanismos por los cuales una tecnología desarrollada en una industria se distribuye o expande a otras, envuelve distintos tipos de *spillovers* (Griliches, 1984). Éstos están asociados, entre otros factores, al precio que las industrias usuarias pagan por estos inputs. Si la estructura de mercado es competitiva en las industrias proveedoras, la presión competitiva puede provocar que los precios no reflejen adecuadamente los cambios en la productividad marginal, calidad o valor que el usuario asigna a los nuevos bienes. Como resultado, las industrias cliente pueden capturar parte de los frutos del esfuerzo innovador de otras industrias, y su productividad puede incrementarse gracias al esfuerzo que realizan sus industrias proveedoras. Por otro lado, si las industrias proveedoras se mueven en un mercado monopolista, serán capaces de cargar altos precios a sus productos, por lo que podrán capturar la mayoría del beneficio social (Mohnen, 1986). La influencia que la estructura de mercado pueda tener sobre el comportamiento innovador sectorial será analizada en el capítulo 4 de esta tesis.

Las vinculaciones intersectoriales a su vez pueden clasificarse según el medio a través del cual se transfiere conocimiento. En este sentido, la literatura existente nos permite clasificar estos flujos de conocimiento, según si éste está incorporado o desincorporado de los productos y servicios que se intercambian entre sectores (Park, 1999; Papaconstantinou et al., 1996).

Por una parte, los flujos de conocimiento desincorporado *(Disembodied knowledge flows)* hacen referencia a la transmisión de conocimientos, experiencias, y no necesariamente implican la compra de productos o servicios. Generalmente es una consecuencia del propio proceso innovador, donde el conocimiento que desarrolla una empresa se convierte en disponible para otras. Estos flujos pueden materializarse, a través de contactos personales (en congresos científicos, conferencias, colaboración en proyectos conjuntos –Cohen, 2002-) o a través del canal de "publicaciones-patentes". Este último analiza el impacto que tienen las publicaciones científicas sobre el desarrollo tecnológico en empresas existiendo una amplia literatura al respecto (Nomaler y Verspagen, 2008; Verspagen, 2004; Scherer, 2003; Jaffe y Trajtenberg, 1999; Johnson y Evenson, 1997; Narin, 1997; Verspagen, 1997; Jaffe, 1986; Scherer, 1982).

Por otra parte, al referirnos a los flujos de conocimiento incorporado *(embodied knowledge flows)* se hace referencia al conocimiento que aparece incorporado en los productos y servicios que los sectores intercambian (Hauknes y Knell, 2009; Papaconstantinou et al., 1996, 1998; Sakurai et al., 1996, 1997; Terleckyj, 1974) o bien, en los trabajadores, cuya movilidad entre firmas y sectores, se convierte en vehículo de conocimiento (Zellner, 2003; Tomlinson, 1999).

El análisis de las relaciones intersectoriales de un sistema productivo tiene como base metodológica los trabajos de Wassilly Leontief desarrollados a mediados de 1930 (Leontief, 1936, 1937; Camacho y Rodríguez, 2005). Sin embargo, no fue hasta después de 1960 donde las vinculaciones tecnológicas cobraron entidad en los estudios input output. Los trabajos seminales de Jacob Schmookler en 1966, Nestor Terleckyj en 1974 y Frederic Scherer en 1982 marcan hitos importantes en el estudio de las relaciones tecnológicas entre sectores y su vinculación con el crecimiento económico, en ellos se combinan datos input-output con información empresarial de I+D.

En el ámbito del "*embodied knowledge*", se destacan más recientemente los artículos de Johan Hauknes (1998 y 1999) focalizados en los flujos de tecnología incorporada en la economía noruega y los artículos de Papaconstantinou et al. (1996, 1998), aplicados a 10 países de la OCDE[1]. La metodología que utilizaron estos autores se extendería y perfeccionaría en su aplicación. En la extensión podemos señalar los estudios para España (Camacho y Rodríguez, 2005) y los estudios para 25 paises de la Unión Europea, Estados Unidos y Japón (Knell, 2008). En el perfeccionamiento mencionado se destaca principalmente la estimación y análisis de las interacciones tecnológicas entre sectores usuarios y productores de conocimiento (Hauknes y Knell, 2009). **Estos últimos avances metodológicos, son los que se aplican en la presente tesis doctoral.**

1.2. Los capítulos incluidos en esta tesis

Como se ha comentado previamente, la estructura de esta tesis doctoral se basa en 3 capítulos auto contenidos, cada uno, constituye un artículo publicado o próximo a publicarse en revistas científicas reconocidas. Estos artículos describen distintas aplicaciones y variaciones de la metodología previamente mencionada, marcando avances en el estudio económico de la innovación a nivel sectorial y territorial.

El primer capítulo, titulado "***How much does KIBS contribute to the generation and diffusion of innovation?",*** publicado en la revista *"Service Business",* busca establecer ¿Cuál es la contribución de los servicios empresariales intensivos en conocimiento (KIBS por sus

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[1] Una primera versión de estos trabajos data de 1993 (Sakurai, Wyckoff y Papaconstantinou, 1993)

siglas en inglés) al sistema español de innovación? Específicamente se busca mensurar esta contribución, tanto desde la generación como en la difusión de innovación.

Los KIBS incluyen varios tipos de servicios, desde asistencia legal, marketing, consultoría, ingeniería y asistencia tecnológica. Desde el punto de vista de la innovación, la literatura al respecto identifica tres tipos de funciones de los KIBS (Naranjo-Valencia et al. 2011; Zortea-Johnston et al. 2011; Camacho y Rodríguez, 2008; Tether, 2005; den Hertog 2000):

i) sus actividades son inherentemente innovadoras
ii) son fuente de innovación para otros sectores y
iii) son un medio de transferencia de conocimiento.

Finalmente, los KIBS pueden ser identificados como potenciadores del conocimiento (Strambach, 2008), o desempeñando además un papel clave en el desarrollo y en la comercialización de nuevos productos, procesos y servicios (Muller y Doloreux, 2009).

Aunque la literatura destaca la importancia de los KIBS, las investigaciones se han focalizado principalmente a nivel de firma, sin avanzar demasiado en mensurar el impacto de este sector tanto para la generación como para la difusión de conocimiento e innovación en todo el sistema productivo. Es en este ámbito, donde se ha focalizado este artículo, aportando nuevos elementos a la literatura en la estimación de flujos intersectoriales de conocimiento. Los resultados, han demostrado que los KIBS son fundamentales, tanto para la creación como la para la difusión de innovaciones.

En el segundo artículo, titulado ***"Innovation and sectoral linkages in the agri-food system in the Valencian Community ",*** aceptado para su publicación en la revista "*Spanish Journal of Agricultural Research*", se ha enfocado el análisis en el sector agroalimentario (un sector caracterizado como tradicional y de baja intensidad tecnológica), estudiando su comportamiento, en un territorio (la Comunidad Valenciana), caracterizado también por su baja capacidad de absorción (Azagra et al, 2006). Los principales objetivos de investigación en este artículo han sido:

i) analizar el comportamiento innovador de un sector tipificado como tradicional, pero con fuertes impactos a nivel regional (el complejo agroalimentario) y
ii) estudiar las interrelaciones que se establecen en este sector, cuando se encuentra en un territorio con baja capacidad de absorción, mensurando su capacidad de arrastre en términos de innovación.

El modelo input-output ha sido empleado para la medición del conocimiento incorporado en los flujos intersectoriales principalmente a nivel de países, y de distintos sectores y complejos productivos. Sin embargo, estos trabajos aportaban poco detalle sobre: a) el papel del complejo agroalimentario en la generación y utilización de conocimiento entre sectores, y b) sobre la generación de efectos inducidos de innovación en ámbitos sub-nacionales.

El artículo ha estimado tanto la intensidad de innovación directa que se produce en los subsectores del complejo agroalimentario de la Comunidad Valenciana como los flujos de innovación incorporada debidos a las adquisiciones de insumos procedentes de la propia región y del resto de España.

La literatura clasifica habitualmente al sector agroalimentario como de baja intensidad en I+D (Connor y Schiek, 1997), lo que se ha manifestado también en el caso de España (García y Briz, 2000). Ello no ha impedido, según López *et al*. (2003), que el sector aparezca como "usuario gratuito" en la adopción de avances generados en otros. Trabajos realizados sobre el sector primario español apuntan a resultados similares, con una creciente dependencia de tecnología importada (Rivas y Herruzo, 2003). Los datos de la Encuesta sobre

Innovación Tecnológica en Empresas (INE, 2010), a pesar de sus limitaciones, vienen indicando también la reducida intensidad de innovación directa tanto en el sector primario como en las actividades de la industria alimentaria en relación a las intensidades estimadas en otros sectores.

A este respecto surgen dos preguntas que tienen que ver con la generación de tecnología por parte del sector agroalimentario que se presenta como estratégico por su función de suministro de alimentos y ocupación del territorio:

i) La escasa intensidad de innovación que sugieren la estadísticas, ¿se manifiesta también en los flujos indirectos de innovación que el complejo agroalimentario genera a través de sus relaciones con otros sectores?
ii) Este conocimiento incorporado, adquirido por el complejo agroalimentario, ¿se genera dentro del territorio o es importado de otros territorios? Esta cuestión adquiere una destacada relevancia en cuanto a que la agricultura y la industria agroalimentarias se presentan como sectores muy vinculados al territorio.

Para responder a ambas preguntas, se ha abordado la medición de los flujos de innovación incorporada de este sector, aplicando el análisis a nivel regional. Ambos elementos, constituyen el valor añadido de este trabajo con respecto a la literatura sobre la materia.

Finalmente, en el último artículo, titulado ***"New firm creation and innovation: industrial patterns and intersectoral linkages"***, aceptado para su publicación en la revista *"International Entrepreneurship and Management Journal"* se analizan los vínculos entre creación de nuevas empresas y comportamiento innovador a nivel sectorial. En este artículo, la pregunta que guía la investigación es ¿el patrón de generación/absorción de conocimiento de cada sector afecta su capacidad para crear nuevas empresas?

Este artículo tiene por objetivo establecer si existe alguna relación entre el esfuerzo innovador de los sectores productivos y su dinamismo en la creación de nuevas empresas. De forma más específica, se analiza si el patrón de creación/adquisición de conocimiento de cada sector económico guarda alguna relación con la tasa de creación de nuevas empresas en esos sectores.

Para responder a estas preguntas, se utiliza el enfoque del "*embodied knowledge*", basado en la aplicación de un modelo input-output combinado con intensidades de innovación tecnológica y con tasas de creación bruta de empresas a nivel sectorial. Este enfoque permite obtener las fuentes específicas de innovación de cada sector, distinguiendo si éstas son internas o externas (inputs o bienes de capital).

La relación entre innovación y emprendedurismo, y su vínculo con el crecimiento ha sido un tema ampliamente estudiado en la teoría económica. Los trabajos seminales de Joseph Schumpeter (1934 y 1942), dieron inicio a este campo de análisis. Sin embargo, estos modelos fueron mejorados y los actúales aportes denominados post-schumpeterianos incorporan otros dos factores claves de crecimiento económicos:

i) el conocimiento (creación y protección) y
ii) la difusión del *emprendedurismo* -o en otras palabras del *management emprendedor*- (Burton, 1999).

Sin embargo no todos los sectores económicos presentan un mismo comportamiento en la relación entre el grado o intensidad de innovación y el ritmo de creación de empresas (Aghion, 2009; Callejón y Ortún, 2009; Stam y Wennberg, 2009; Deeds, 2001; Aghion y Howit, 1992). Es en este campo donde este artículo pretende realizar su aportación, incorporando a dicha relación un patrón de innovación sectorial, que distingue si los sectores económicos recurren principalmente a fuentes internas o a fuentes externas de conocimiento.

Los resultados sugieren que diferentes patrones de generación/adquisición de conocimiento se relacionan con distintos niveles de creación de nuevas empresas y a su vez, dichos patrones se encuentran estrechamente relacionados al tamaño medio empresarial.

1.3. Bibliografía

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Capítulo 2

¿Cuánto contribuyen los KIBS a la generación y difusión de innovación

Capítulo 2

¿Cuánto contribuyen los KIBS a la generación y difusión de innovación?

Artículo

How much does KIBS contribute to the generation and diffusion of innovation?

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How much does KIBS contribute to the generation and diffusion of innovation?

Abstract:

This paper aims to estimate the contribution of KIBS to the innovation system. Data on innovation gathered from national and European databases are analyzed using a methodology based on an input-output framework to estimate the drive for innovation in the Spanish economy and the contribution of KIBS. KIBS are found to be crucial to both the creation and diffusion of innovation. From among the four classifications of sectors analyzed herein, KIBS is found to be the only significant net generator of innovation.

Keywords: KIBS, innovation diffusion, embodied knowledge.

2.1. Introduction

The term "knowledge intensive business services" (KIBS) has been in use for more than 15 years, but has recently become an important subject of investigation and empirical research. KIBS can be identified as knowledge enhancers in multilevel contexts (Strambach 2008). They play a key role in the development and marketing of new products, processes and services (Muller and Doloreux 2009).

There is no one definition of KIBS that is universally accepted (Wood 2002). Among the more widely accepted definitions are those of Miles et al. (1995), den Hertog (2000) or Bettencourt (2002). Miles et al. (1995) define the KIBS industries as: a) private companies or organizations, b) based on professional knowledge (related to a specific technical discipline or technical functional domain), and c) supplying knowledge based intermediate inputs. Den Hertog (2000, pp 504-505) states that "KIBS form a category of service activities which is often highly innovative in its own right, as well as facilitating innovation in other economic sectors, including both industrial and manufacturing sectors"

Finally, the Bettencourt's definition (2002) proposes KIBS to be "enterprises whose primary value-added activities consist of the accumulation, creation, or dissemination of knowledge for the purpose of developing a customized service or product solution to satisfy the client's needs (e.g., information technology consulting, technical engineering, software design)"

Furthermore some classifications distinguish between P-KIBS (purely professional) and T-KIBS (with a technological base) such as R & D services (Miles et al. 1995). More recently, some authors (Martínez-Fernández et al. 2006) talk about C-KIBS to indicate certain ICT-related services.

The services provided by KIBS enterprises are heterogeneous**,** and thus the relationships established with other sectors are also different, and with different degrees of orientation towards innovation (Freel 2006; Corrocher et al. 2009). The KIBS include a variety of types of services, from marketing to legal services through consultancy, engineering and technical analysis.

In relation to the process of innovation (den Hertog 2000; Tether 2005, Camacho and Rodríguez 2008; Naranjo-Valencia et al. 2011; Zortea-Johnston et al. 2011), KIBS develop three types of functions. First, they are innovative activities themselves (new services, new technological applications, etc.). Secondly, KIBS are sources of innovation and act as facilitators of innovation for others sectors. Thirdly, the KIBS act as carriers of innovation when perform knowledge transfer.

However, KIBS do not only transfer knowledge and information to users of their services: their activities can be considered as "collaborative learning processes" (Aslesen and Isaksen 2010). In fact the resolution of specific problems of client firms may lead to the development of new knowledge, as a result of this collaboration (Den Hertog 2002). Thus, the KIBS have **an intermediary role** of relevant knowledge, understood in a broad sense: from the scientific and technical information to the tacit knowledge.

There are two key aspects of KIBS that deserve attention as knowledge drivers (Alvesson 1995; Miles 2005). Firstly, these services are typically addressed to other productive sectors, and not produced for private consumption. Secondly, knowledge, a keyword in KIBS, has a scope that is diffuse and multidimensional. Therefore, organizations that provide such services develop complex operations in which the generation and dissemination of knowledge are produced through intense user/ producer interactions in which human capital (Leo et al. 2010; Fuglsang et al. 2011) plays a critical role[2]. Knowledge intensive services are provided not only by specific organizations but also through chains or networks of suppliers with different sub specializations. More specifically, KIBS incorporate inputs of a knowledge-intensive nature absorbed by a variety of production processes in other sectors

While research on KIBS has mainly focused on the firm and sector level, less attention has been paid to provide empirical evidence on its impact on the generation and dissemination of innovation in the overall economy. Along these lines, the research presented herein considers KIBS as crucial for economic development from a systemic point of view and not only as key contributors to innovation at the firm level. This paper measures the knowledge flows that are generated and transferred by KIBS in the Spanish innovation system.

[2] On the relationship between knowledge management and the improvement of levels of human capital in KIBS see Palacios-Marques (2011)

After a review of the literature (section 2), a methodology based on the input-output framework is proposed to calculate the direct and indirect innovation intensities, with an empirical application to the Spanish economy (section 3), followed by the presentation of the results (section 4), followed by discussion and conclusions (section 5).

2.2. KIBS and innovation flows

KIBS are vectors of information and knowledge, and their contribution to the creation of competitive advantage and development is receiving increasing attention in the literature (Simmie and Strambach 2006; Aslesen and Isaksen 2007, Chadwick and Glasson 2008, Doloreux 2008 and Doloreux et al. 2010). KIBS develop three types of innovative functions (den Hertog 2000; Tether 2005, Camacho and Rodríguez 2008; Corrocher 2009). Firstly, they are innovative activities themselves (new services, new technological applications, etc.). Secondly, KIBS are sources of innovation and facilitate innovation in other sectors. Thirdly, KIBS are carriers of innovation when they involve knowledge transfer, and provide inputs (intermediate services) to other firms as knowledge-based solutions.

The existing literature has emphasized the complementarity between customer resources and capacities, and external knowledge provided by KIBS (Muller and Zenker 2001; Tether and Tajar 2008; Cambra-Fierro et al. 2011). By providing expertise, KIBS represent an interface between its customers and the knowledge base available in the entire economy, becoming a catalyst for innovation (Castellacci 2008; Castaldi 2009). In any case, the provision of knowledge (tacit and codified) by KIBS is carried out through a strong supplier/client interaction (Muller and Zenker 2001; Mas-Verdú 2007). Indeed, the impact on innovation potential will depend on the type and intensity of the relationship established between the organization providing the services and user sectors. For this reason, it seems particularly appropriate to use input-output methodology to identify intersectoral linkages and estimate the contribution of KIBS to the innovation effort across the economy.

Dissemination of technologies can be broken down into two major kinds of flows: "disembodied" and "embodied" flows (Papaconstantinou et al. 1996). In general, the study of disembodied flows has been done through patents and scientific publications while embodied flows have been analyzed through the input-output framework. Both approaches allow the classification of using and providing industries of technology (Hauknes and Knell 2009; Pavitt 1984). Following the -seminal research by Schmookler (1966), disembodied flows are measured through matrices of technological flows based on R & D efforts, sometimes using patent data (Scherer 1982b; Johnson and Evenson 1997; Jaffe and Trajtenberg 1999; Maurseth and Verspagen 2002; Scherer 2003; Verspagen 2004; Nomaler and Verspagen 2008). Some authors have also related those matrices of spillovers with productivity at the firm level (Scherer 1982a; Jaffe, 1986).

Embodied innovation flows are analyzed by combining statistical information on R & D spending with input output matrices, following the pioneering study by Terleckyj (1974) and Scherer (1982b). Most recent studies have applied the methodology to OECD countries, allowing us to distinguish between intermediate inputs and capital goods as sources of embodied R & D efforts (Papaconstantinou et al. 1996; Sakurai and Papaconstantinou 1997; Papaconstantinou et al. 1998). Other applications based on the input output framework have focused on knowledge transfers between sectors of high and low technology (Hauknes and Knell 2009), the role of services at a European level (Amable and Palombarini 1998), the knowledge linkages of the Spanish economy compared to other European countries (Camacho and Rodríguez 2005) and the role of KIBS as facilitators of technology compared to other service activities (Rodríguez and Camacho 2008). Our research also draws on this input output framework with some improvements in the way that innovation flows involving KIBS are considered. Firstly, we estimate the overall contribution of KIBS as a source or user of technology in the Spanish economy; secondly, we identify the source of the innovation flows involving KIBS and other sectors, either as intermediate consumption or capital goods, or as domestic or imported inputs; and, finally, we measure total innovation intensities rather than just R & D intensities.

2.3. Empirical design

The methodological basis for measuring innovation flows is built upon a large body of literature (Terleckyj 1974; Scherer 1982a, 1982b; Papaconstantinou et al. 1996; Papaconstantinou et al. 1998; Hauknes and Knell 2009) [3], which rests on two assumptions:

a) R&D expenditure is used as a proxy for technology. By contrast, this paper considers innovation expenditures as a more comprehensive proxy of innovation intensity.
b) Inter-sectoral transactions are assumed to be the carriers of innovation across industries and territories.

Innovation flows are approximated through combining innovation expenditure data combined with input-output and investment data. The procedure allows us to measure the extent to which industries use inputs (intermediate inputs and investment goods) where innovation is embodied in those inputs. Moreover, this approach allows us to know whether the origins of innovation lie in the

[3] See the Appendix for a full mathematical derivation presentation

industry itself or if it is acquired through purchases of intermediate inputs and investment goods. Acquired innovation is further broken down into domestic and foreign suppliers.

Industries acquire intermediate and investment goods as inputs into their production processes. Those intermediate and investment goods embody the innovation of the industries where they originate. The innovation embodied in the output of a certain industry is the sum of its own innovation expenditures and of those embodied in its purchases from other industries. More specifically, the methodology used in this paper models innovation diffusion and acquisition through four separate channels: 1) Purchase of domestic intermediate inputs; 2) Purchase of domestic investment goods, 3) Purchase of imported intermediate inputs and 4) Purchase of imported investment goods.

The analysis can be conducted either by using actual innovation flows or by innovation intensities, which are obtained by normalizing these innovation flows (flows per unit of output or value added).

The total innovation intensity of an industry j (defined as in_j^t) is the sum of five components (1):

$$in_j^t = r_j + p_j^d + p_j^m + c_j^d + c_j^m \tag{1}$$

Where:

r_j (R_j / X_j) is industry *j*'s own innovation intensity (Expenditure on innovation activities/Output of industry j)

p_j^d (P^d_j / X_j) is the innovation embodied in domestic intermediate inputs per unit of output of *j*;

p_j^m $(P^m{}_j / X_j)$ is the innovation embodied in imported intermediate inputs per unit of output of *j*;

c_j^d $(C^d{}_j / X_j)$ is the innovation embodied in domestic investment inputs per unit of output of *j*

c_j^m $(C^m{}_j / X_j)$ is the innovation embodied in imported investment inputs per unit of output of *j*.

Furthermore, every component that makes up the sources of embodied innovation can be broken down according to industry *i* that supply to industry *j*. Thus, the purchases of embodied innovation of industry j from industry i (per unit of output of j) will be (2):

$$in_{ij}^t = p_{ij}^d + p_{ij}^m + c_{ij}^d + c_{ij}^m \tag{2}$$

p_j^d Is the weighted sum of the innovation intensities of the industries from which industry *j* purchases inputs. Weightings are constructed using the total (direct plus indirect) domestic intermediate input requirements from each industry per unit of output of industry *j* obtained from a modified version of the Leontief inverse matrix, which eliminates elements of the diagonal to avoid double accounting of its own innovation intensity.

The innovation embodied in domestic investment input purchases c_j^d is the weighted sum of the same innovation intensities, using industry *j*'s investment purchases from other industries as weightings, and multiplied by the total input requirements per unit of the final demand of industry *j*.

Compared with domestic innovation flows, the formulation of imported innovation does not take into account the inter-sectoral transmission effects (which, in domestic cases, are gathered through the modified Leontief inverse). Of the two embodied innovation components that relate to imported innovation, p_j^m is a weighted sum of foreign sectoral innovation intensities, where the weightings are the intermediate demand of industry *j* from each of the other foreign industries. Similarly, c_j^m is defined analogously as the weighted sum of foreign sectoral innovation intensities, where weightings are the investment demands by industry *j* from each other foreign industry.

Along the same lines as the study by Hauknes and Knell (2009) it is possible to express the defined components in terms of (i) total innovation content (by multiplying intensities by total output of sector j), (ii) value added intensities (by breaking down the industrial contribution to innovation in industry j according to j's value added), and (iii) share of total innovation expenditure.

The relationship between the total intensity and the direct intensity of innovation produces the innovation multiplier (technological multiplier in Papaconstantinou et al. 1998 and Hauknes and Knell 2009). When this multiplier has a value of 2, it implies that the total intensity is made up of equal parts of direct innovation and induced innovation. If the value is greater than 2, the absorbed induced innovation will be greater than the directly generated innovation. When the sector object of analysis has a low multiplier, it implies that it is a net knowledge generator, and when it has a high multiplier, it is a net knowledge user.

Four sources of information were used in for the empirical analysis of the innovation flows related to the KIBS in Spain 1) Input-Output Tables for Spain (INEa 2009), which display the economic transactions between 73 sectors, the last available version for 2005; 2) Spanish Survey of Technological Innovation in Companies (INE 2007) which shows data on innovation in firms and is available for 54 economic sectors; 3) European Community Innovation Survey (CIS), which is carried out by Eurostat and shows several indicators related to innovation in companies in European countries, sharing the same methodology as the Spanish Survey of Technological Innovation in Companies, and is available for 70 sectors; and 4) Gross fixed-capital formation matrices in Spain (INEb 2009), including investment by supplier and purchaser industries.

Data availability and equivalences between economic activity classifications are shown in table 1. Innovation intensity embodied in imported inputs can be approximated through data relating to imported inputs provided by the intermediate consumption table. Data in the Spanish table are available at two levels according to the origin of imported products: 1) European Union (EU) and 2) rest of the world. Given the importance of the EU in Spain's trade, we have assumed innovation intensities for all imports as given by the values from the European survey (CIS). To estimate the embodied innovation in investment goods, the gross fixed-capital formation matrix for Spain is combined with the sector structure and the investment demand data to approach the investment matrix that shows the sales of investment goods and services, from sector i to sector j.

Sectoral contributions to innovation flows estimated through the methodology explained above are summarized by calculating averages and aggregates for the four sectors in which the economy is classified: 1) KIBS, 2) Other services, 3) Manufacturing and 4) Other activities (see table 1). Our particular interest in this classification is to assess the contribution of KIBS compared to manufacturing. Some authors have demonstrated that patterns of innovation in KIBS differ from manufacturing (Wong 2005; Ojanen 2009). Furthermore, contrasting high-tech manufacturing and knowledge intensive services, other authors found that the former is relatively more significant than KIBS for regional innovation performance (Abubakar and Mitra 2010). Our research moves forward in the measurement of those contributions, adding indirect sources of innovation, thereby adopting an overall vision of analysis.

A standard classification of KIBS was taken in the study, including science-based services such as computer and related activities (ISIC3 72), research and development (ISIC3 73), and other business activities (ISIC3 74). This last industry includes some services less intensive in knowledge, but there is no disaggregated data in the input-output tables. This classification is consistent with Miles et al. (1995), Robinson et al. (2003) and Hauknes and Knell (2009). Post and telecommunications (included in "high-tech service" classification) are not included in the group because they are considered not as specialized services suppliers but as supplier dominated services, very much orientated to retailing (Robinson et al. 2003). ISIC REV 4 provides a more precise classification of KIBS and has been used by Rodríguez and Camacho (2010), but existing input output matrices are not updated with such classifications.

Table 1 Classification of economic sectors and availability of data on innovation intensities

Classification				Available data on direct innovation intensity (year 2006)	
Our classification	Input output table classification (Spain)		ISIC REV 3	SPAIN*	EU 15 **
KIBS	Computer and related activities	58	72	x	x
	Research and development,	59	73	x	x
	Other business activities.	60	74	x (average with 70 and 71)	x
Other services	Wholesale and retail trade, repairs	41-43	50 - 52	x (average 50, 52, 55)	x
	Hotels and restaurants,	44-45	55		x
	Transport,	46-51	60-63	x	x
	Post and telecommunications,	52	64	x	x
	Finance and insurance,	53-55	65-67	x	x
	Real estate activities,	56	70	Average with 71 and 74	x
	Renting of machinery,	57	71	Average with 70 and 74	x
	Public administration,	67	75	No data	No data
	Education,	61-68	80	Average 80, 85, 90-93	No data, we considerate the same level of Spain
	Health and social work,	62-69	85		
	Other community, social and personal services	63-65, 70-73	90-93		
Manufacturing	Food products, beverages and tobacco	12-16	15-37	x	x
	Textiles,	17	17	x	x
	Wearing apparel	18	18	x	x
	Leather and footwear,	19	19	x	x
	Wood and products of wood,	20	20	x	x
	Pulp, paper, Printing and publishing	21-22	21-22	x x	x x

Classification				Available data on direct innovation intensity (year 2006)	
Our classification	Input output table classification (Spain)		ISIC REV 3	SPAIN*	EU 15 **
	Chemicals,	23	24	x	x
	Rubber and plastics products,	24	25	x	x
	Other non mineral products,	25-28	26	x	x
	Basic metals,	29	27	x	x
	Fabricated metal products	30	28	x	x
	Machinery and equipment	31	29	x	x
	Office, accounting and computing machinery	32	30	x	x
	Electrical machinery	33	31	x	x
	Radio, television and communication equipment	34	32	x	x
	Medical precision and optical instruments	35	33	x	x
	Motor vehicles, trailers and semi-trailers	36	34	x	x
	Other transport equipment	37	35	x	x
	Manufacturing nec, Recycling	38- 39	36- 37	X x	X x
Other activities	Agriculture, hunting, forestry and fishing	1-3	1-5	x	No data, we take the same level of Spain
	Mining and quarrying	4-7	10-14	x	x
	Coke, refined petroleum product and nuclear fuel,	8	23	x	x
	Electricity, gas, and water supply	9-11	40-41	x	x
	Construction	40	45	x	x

* INE 2007; ** EUROSTAT 2010

2.4. Results

From among the four sectors analyzed in this paper, the KIBS industry sector is found to be the only significant net generator of innovation. Its direct effect is much greater than the effect it induces through purchases from other sectors (multiplier value of 1.35, see table 2). In terms of the percentage of its total output, KIBS appear to be the most innovation-intensive sector (7.35 %), however they rank in second place when innovation efforts are measured with respect to value added, with values very close to the manufacturing sector (see tables 1 and 2). While manufacturing stands out due to its innovative strength, its pattern of generation and absorption differs from KIBS because, in manufacturing, the absorption (Warren et al. 2009) of embodied innovation is estimated to be the main technological source.

With regard to other services and activities, both direct and indirect innovation intensities are below the average. It should be noted that their main source of innovation is the absorption of indirect embodied innovation (see tables 1 and 2).

Table 2 Innovation intensities

Industry	r_j	Embodied innovation					in_j	Output		Innovation Multiplier
		p^d	p^m	c^d	c^m	Absorption		Billions €	%	
Per cent of industry output										
KIBS	5.46	0.95	0.13	0.68	0.13	1.89	7.35	113. 3	6.4	1.35
Other services	0.83	0.70	0.13	0.27	0.17	1.28	2.10	811.1	46.0	2.54
Manufacturing	1.46	1.22	0.80	0.06	0.09	2.17	3.63	442. 9	25.1	2.48
Other activities	0.43	0.62	0.29	0.07	0.09	1.07	1.49	394.8	22.4	3.50
Total economy	1.20	0.83	0.34	0.20	0.13	1.49	2.69	1.762	100.0	2.25
Per cent of industry value added										
KIBS	9.44	1.64	0.23	1.17	0.23	3.27	12.71	65. 5	8.0	
Other services	1.37	1.16	0.22	0.46	0.28	2.12	3.49	488. 4	59.9	
Manufacturing	5.23	4.35	2.88	0.23	0.30	7.76	12.99	123. 8	15.2	
Other activities	1.23	1.79	0.83	0.21	0.25	3.07	4.31	137.0	16.8	
Total economy	2.59	1.79	0.73	0.44	0.27	3.23	5.81	814.8	100.0	

Source: Drawn from the Input-Output frame of the Spain (INEa 2009) and Innovation Surveys (INE 2007; Eurostat 2010).

In terms of the question, how much do KIBS contribute to the innovation effort in the Spanish economy? 29.4 % of the generated direct innovation and 8% of embodied indirect innovation in the system is carried out by KIBS, its total system contribution being 17.6%. Given its share in the gross value added (8 %), for each 1 % that KIBS contributes to the economy's added value, it provides: (i) 3.7 % of the generation of innovation; (ii) 1 % of the absorption of innovation; and (iii) 2.2 % as the overall contribution, taking into account both generation and absorption (see table 3).

The contribution of the manufacturing sector to the total generation of innovation is similar to that estimated for KIBS (30.8 %); however, its absorption capacity (Mas-Verdú et al. 2009; Park 2011) is much higher, reaching 36.5 % of the system. For every 1 % contributed by manufacturing to the gross value added, KIBS contribute to 2 % of the generated innovation and to 2.4% of the absorbed innovation (see table 3).

Other services (Chamberlin et al. 2010) have a much higher share of the economy's gross value added, close to 60 %. This weighting is reflected in absolute large contributions to the innovation system, accounting for 31.8% of the total of generation of innovation, and 39.3 % of the total absorption of innovation. Its contribution per unit of value added is the smallest among the four sectors considered (see table 3).

Table 3 Contribution of KIBS: generation and absorption of innovation

(Percentage of total embodied innovation flows)

Sector	R_j	Absorption of embodied innovation					Total innovation contribution	Innovation contribution % / value added contribution %		
		P^d	P^m	C^d	C^m	Total		Total	R_j	Abs.
KIBS	29.4	7.4	2.6	21.5	6.7	8.1	17.6	2.2	3.7	1.0
Other services	31.8	38.9	18.4	62.6	60.9	39.3	36.0	0.6	0.5	0.7
Manufacturing	30.8	36.9	60.0	8.0	17.0	36.5	34.0	2.2	2.0	2.4
Other activities	8.0	16.8	19.1	8.0	15.4	16.0	12.5	0.7	0.5	1.0
Total economy	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1.0	1.0	1.0

Source: Drawn from the Input-Output frame of the Spain (INEa 2009) and Innovation Surveys (INE 2007; Eurostat 2010).

Finally, we estimated the overall contribution of KIBS, as well as the other sectors, as sources of innovation disseminated by the effect of the demand of intermediate inputs and capital goods in the whole economy. If the question in Table 2 was how much innovation is absorbed and generated by different sectors, in Table 4 we look at the contribution of each sector to the embodied innovation absorbed by the rest of the economy through intermediate linkages. The results indicate that 25% of embodied innovation is disseminated from KIBS as a source. This contribution focuses on domestic inputs (36%), which highlight the role of KIBS in Spanish economic growth. Compared to KIBS, the contribution of manufacturing is higher; 45.3% of embodied innovation is disseminated from manufacturing, but mainly through imported inputs (74%) and imported investment goods (94%) (See table 4).

Table 4 Diffusion of innovations: KIBS contribution (% of total embodied innovation diffusion)

Sector	Diffusion of embodied innovation				
	P^d	P^m	C^d	C^m	Total
KIBS	36.1	7.3	24.1	5.8	25.4
Other services	27.1	3.9	18.2	0.3	18.4
Manufacturing	28.2	74.3	36.5	94.0	45.3
Other activities	8.6	14.6	21.2	0.0	10.9
Total economy	100.0	100.0	100.0	100.0	100.0

Source: Drawn from the Input-Output frame of the Spain (INEa 2009) and Innovation Surveys (INE 2007; Eurostat 2010).

2.5. Discussion and conclusions

This article aims to estimate and measure the contribution of KIBS to the Spanish generation and absorption of innovation system through input-output linkages. KIBS have been found to be a key sector to both the creation and diffusion of innovation.

Our estimation of the contribution of KIBS to innovation that is directly generated and indirectly absorbed reveals values of 29.7% of the innovation generated and 8.1% of the innovation incorporated. These results show the importance of KIBS as innovation enhancers in the productive system. Such a contribution is even more evident when it is compared with the share of KIBS in Spain's gross value added. Thus we found that every 1% of KIBS' share in the overall economy is more than doubled by its contribution to the innovation system, and that direct efforts are significantly greater than the indirect intermediate linkages. Manufacturing also significantly contributes to innovation. However, its contribution is mainly channelled through its absorption capacity rather than innovation generation, and largely through imported inputs, differently from KIBS, which are mainly based on domestic sources.

In fact, the view of KIBS has changed significantly over time. During the 1970s, producer services were regarded as parasitical with respect to primary and secondary sectors (Cohen and Zysman 1987). In subsequent decades, services came to be regarded as a sign of the increasing complexity and functional specialization of the economy (Illeris 1996; Akehurst 2008). Today's opinion is that these sectors play a key role in the transmission of knowledge, exchange of information and, by extension, innovation processes (Wood 2002).

Our paper suggests that such role can be reflected through (i) inter-sectoral linkages with focus on KIBS (other studies look at different classifications of services, eg. Rodríguez and Camacho 2008); and (ii) innovation intensities rather than R&D intensities, as in other previous studies (Papaconstantinou 1996 and 1998; Camacho and Rodríguez 2005; Rodríguez and Camacho 2008; Hauknes and Knell 2009). Our conclusions support the idea that KIBS and manufacturing are both relevant in spreading innovations through the economic system, but following a different pattern. They also indicate that the private sector always plays a key role, which is consistent with previous research obtained via different methods (Tether 2005; Tajar 2008).

The quantitative findings of this study support the idea of such a role in the Spanish economy, the innovation multipliers being significantly higher than R&D multipliers obtained in previous comparative studies (Papaconstantinou et al. 1996; Hauknes and Knell 2009). As policy implications, public policies are justified both in terms of supply and demand. On the supply side, by improving the quality of the supply KIBS as an innovation generator; and for demand, by enhancing the role of KIBS as an innovation disseminator through the whole productive system, possibly though incentives for hiring KIBS.

This study is not without limitations. One of them is the possible generalization of results. This research has been done for one country (Spain). But the characteristics and role of KIBS may vary according to cultural and institutional characteristics of each context (Doloreux et al. 2010). The global economy is subdivided into smaller systems at a national and/or regional level. These systems have certain institutional settings (educational system, corporate culture, etc) provided by their own specific characteristics. Thus, each system works differently, and the role played by KIBS is not necessarily the same in each national context.

Future research should focus on ways of improving the measurement of indirect innovation intensities related to imported goods. In addition, comparative assessments of innovation linkages should be undertaken, at international or subnational levels.

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Appendix

Methodology

Let us consider the Leontief equilibrium equation (Leontief, 1936) (3):

$$x = \mathrm{A}x + y \tag{3}$$

Where ***x*** is the vector of output, **A** is the domestic matrix of technical coefficients and ***y*** is the vector of final demand. The system is resolved in the following expression (4):

$$x = (\mathrm{I} - \mathrm{A})^{-1}\ y \equiv \mathrm{B}y \tag{4}$$

Where **B** is the Leontief inverse matrix of **A.** The element b_{ij} of the matrix **B** indicates the direct and indirect effects on the production of sector **i** when final demand of sector **j** is increased by one unit (i, j = 1... N, with N sectors). The innovation content in sector **j** will include their own expenditure on innovation activities as well as expenditure on innovation incorporated in inputs purchased from other sectors. Then, direct innovation intensity for sector **i** (r_i) is defined as direct expenditure on innovative activities R_i per unit of output X_i (5).

$$r_i = R_i / Xi \tag{5}$$

Multiplying the direct innovation intensities of sectors **i** by elements b_{ij} of the matrix B, we will obtain the matrix P^d whose elements p_{ij} indicate the total domestic innovation incorporated per unit of final demand of the sector **j** (6):

$$P = \hat{r}B \tag{6}$$

Where $\hat{r}$ is a diagonal matrix whose elements are the direct innovation intensities r_i. Matrix **P** presents a problem of double accounting when measuring the intensity of innovation by unit of production and not by unit of final demand. To avoid it, according to Hauknes and Knell (2009), modified matrix **B** called **B*** was obtained by dividing the elements of each column by the element of the main diagonal and eliminating the elements of the diagonal to avoid to count twice the direct effect of its own innovation intensity (7).

$$P^d = \hat{r}B* \tag{7}$$

Thus, the matrix P^d whose elements p^d_j measure the intensity of innovation embodied in domestic inputs purchased by sector **j** in terms of its production as follows (8):

$$p_j^d = \sum_{i=1, i \neq j}^{N} \left(r_i \frac{b_{ij}}{b_{jj}} \right) \tag{8}$$

In this way, we obtain the intensity of total domestic innovation content of sector **j** r^d_j which can be defined as the sum of the direct innovation intensity of sector **j** r_j plus the intensity embodied innovation in inputs acquired in the domestic economy p^d_j.

The estimation of direct and indirect innovation intensities generated within the domestic economy can be improved by adding the intensity of innovation embodied in: a) imported inputs, b) domestic capital goods and c) imported capital goods. Direct innovation intensities in each sector of origin were approached by the average values for EU 15 according to CIS (63% of Spain's imports come from the EU). Indirect innovation embodied in imported inputs is expressed by elements of the matrix P^m obtained by multiplying the diagonal $\hat{r}^m$ (foreign innovation intensities) by the matrix of imported inputs in terms of unit of output of sector j (M) (9):

$$P^m = \hat{r}^m M \tag{9}$$

The elements p_{ij} from matrix P^m, show the innovation embodied in imported inputs by sector j from the all foreign sectors i . So total innovation embodied in imported inputs by sector j is (10):

$$p_j^m = \sum_{i=1}^{N} r_i^m \, m_{ij}$$

(10)

Where p_j^m is the innovation intensity of sector **j** due to the imported inputs, r_i^m is a vector of direct innovation intensities of foreign sector **i** (in our case, the average of intensities in sector **i** in EU 15), and m_{ij} is the vector of imported inputs from all foreign sectors **i** to the domestic sector **j**, measured in units of total output of the domestic sector **j**.

To incorporate capital goods, a matrix of investment was built to show sales of investment goods and services from sector i to sector j. Given that this information is not directly observable in the Spanish input output tables, we built this matrix D^d by based on the matrix of gross fixed capital formation (available for 5 supplier and 30 buyer sectors) and the vector of final demand in input-output table (available for 72 supplying and one buying sectors) [4]. This matrix shows the sectoral structure of investment process by each sector.

[4] To pass from 5 to 72 supplier sectors, we take the information available in the investment vector in the input output tables. We maintain the same share in each 30's buyer sectors. After that, to pass from 30 to 72 investment buyer sectors we take the participation of each 72' sectors in the output of each 30's buyers sectors.

To measure direct and indirect effects of the acquisition of these investment goods and services, we multiply matrix B by matrix D^d. The resulting is matrix E, whose elements e_{ij}, tell us the direct and indirect effects on sector i derived from investments of sector j. To express elements in terms of unit of output of sector j, elements of the matrix are divided by X_j. Embodied innovation intensities are obtained by multiplying the matrix $\hat{r}$ by matrix E, thus obtaining the matrix C^d, which shows the intensity of innovation embodied in domestic capital goods per unit of output of the sector j (11).

$$C^d = \hat{r}\, E \tag{11}$$

Elements c^d_{ij} in matrix C^d, show the intensity of innovation embodied in domestic capital goods from sector i to sector j. Thus, the intensity of innovation incorporated in domestic investment goods acquired by the sector j will be (12):

$$c_j^d = \sum_{i=1}^{N} r_i \left(\sum_{k=1} b_{ik}\, D_{kj}^d \right) \tag{12}$$

Where k corresponds to the industries producing capital goods.

To incorporate procurement of foreign investment, a matrix of imported investment per unit of output of sector j (D^m) was built. As in the case of imported inputs, the average of direct intensity of innovation for EU15 for each industry was taken (matrix $\hat{r}^{m}$)[5]. Innovation intensities incorporated in imported capital goods are then defined as (13):

$$C^{m} = \hat{r}^{m} \ D^{m}$$

(13)

Elements c^{m}_{ij} of matrix C^{m}, show the intensity of innovation embodied in imported capital goods from foreign sector i to domestic sector j. Thus, the total intensity of innovation incorporated in imported capital goods purchased by j sector shall be (14):

$$c_j^{m} = \sum_{i=1}^{N} r_i^{m} \ D_{ij}^{m}$$

(14)

The matrix of total flows of embodied innovation (matrix IN) is obtained by adding matrices P^d,P^m,C^d,C^m (15). The elements of the matrix IN_{ij}, express the total flow of innovation from the industry i to the industry j in terms of the output of sector j.

[5] 73 % of imported capital goods come from Europe, and most of the rest from other OECD countries with technological level not very distant from that of Europe.

$$IN = P^d + T^m + C^d + C^m$$

(15)

Then, the total intensity of innovation in the sector j (in_j^t) per unit of output j, will be (16):

$$\mathrm{in}_j^t = \mathrm{r}_j + \mathrm{p}_j^d + \mathrm{p}_j^m + c_j^d + c_j^m$$

(16)

The contribution of innovative effort from sector i to the output of sector j is calculated by multiplying the IN_{ij} elements by the output of sector j (see tables 3 and 4).

Anexo: Imagen de la primera página de la publicación

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EMPIRICAL ARTICLE

How much does KIBS contribute to the generation and diffusion of innovation?

Francisco Mas-Verdú · Anthony Wensley · Martin Alba · José María García Álvarez-Coque

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Abstract This article aims to estimate the contribution of KIBS to the innovation system. Data on innovation gathered from national and European databases are analyzed using a methodology based on an input–output framework to estimate the drive for innovation in the Spanish economy and the contribution of KIBS. KIBS are found to be crucial to both the creation and diffusion of innovation. From among the four classifications of sectors analyzed herein, KIBS is found to be the only significant net generator of innovation.

Keywords KIBS · Innovation diffusion · Embodied knowledge

1 Introduction

The term "knowledge intensive business services" (KIBS) has been in use for more than 15 years, but has recently become an important subject of investigation and empirical research. KIBS can be identified as knowledge enhancers in multilevel

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Capítulo 3

Innovación y vínculos sectoriales en el sistema agroalimentario de la Comunidad Valenciana

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Innovación y vínculos sectoriales en el sistema agroalimentario de la Comunidad Valenciana

Artículo

Innovation and sectoral linkages in the agri-food system in the Valencian Community

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Innovation and sectoral linkages in the agri-food system in the Valencian Community

Abstract

This paper aims to analyze the innovative effort of the agri-food system (AFS) in the Valencian Community, Spain (VC), estimating the intensity of innovation in each subsector of the AFS. The analysis distinguishes between the direct innovation intensity and indirect (or induced) intensity incorporated by the acquisition of inputs from other subsectors produced in the VC or in the rest of Spain. The methodology employed is based on the input output framework combined with data of technological innovation in enterprises. This methodology provides the novelty of been applied to a region -the VC- and not a country as it is usually done. The results show that the weight of intersectoral flows in the total innovation effort of the AFS is significant with marked differences between primary and food industry. In most activities, embodied knowledge in inputs purchased from Spain is greater than embodied knowledge of inputs produced inside the region.

Key Words

Primary sector, Food industry, Valencian region, Spain, Embodied knowledge, Input-output, inter-sectoral linkages

Resumen

Este artículo pretende analizar el esfuerzo innovador del sistema agroalimentario de la Comunidad Autónoma de Valencia, España (CAV), estimando la intensidad de innovación de cada subsector del sistema. El análisis distingue la intensidad de innovación directa y la intensidad indirecta (o inducida) incorporada en los inputs adquiridos por el sistema agroalimentario indicando si es originada dentro o fuera de la región. La metodología empleada se basa en la utilización del marco input output combinado con datos de innovación tecnológica en las empresas. Esta metodología aporta la novedad de ser aplicada a nivel regional --en la CAV- y no a nivel nacional, como se ha realizado hasta ahora. Los resultados muestran que el peso de los flujos intersectoriales en la innovación total del sistema agroalimentario es apreciable y muestra diferencias importantes entre la agricultura y la industria alimentaria. En casi todos los casos el conocimiento incorporado en insumos originados fuera de la región supera a los producidos dentro de la región.

Palabras clave

Sector primario, Industria alimentaria, España, Conocimiento incorporado, Input output, Vínculos inter sectoriales.

3.1. Introduction

This paper deals with flows of innovation among the agri-food system in a region and other sectors and territories[6]. The premise is that agri-food firms, in both the primary sector and the food industry, generate an effort in innovation that can be approximated in a direct way through the spending in innovation per unit of production (or value-added). But, in the context of "open innovation" (Chesbrough, 2003), a business activity also generates an indirect effort in innovation that appears incorporated into the products acquired from firms of other sectors or other territories. Thus, firms in the agri-food system may not show an innovative behaviour on their own but could be adopters of innovation through the acquisition of innovation intensive products. This is the hypothesis considered for the agri-food system in the Valencian Community, Spain (here in after VC), considering both agricultural and food industry activities.

The literature classifies the agri-food system as a low R&D intensity sector (Connor and Schiek, 1997), which has also proven to be true in the case of Spain (Garcia and Briz, 2000). However it seems that, according to Lopez *et al*. (2003), the sector conducts as a "free user" adopting innovation generated in other sectors. Some studies dealing with the Spanish agriculture pointed to similar results highlighting the increasing dependence on imported technology (Rivas and Herruzo, 2003).

The data from the Survey on Technological Innovation in Enterprises (INE, several years)[7], despite its limitations, indicate low intensity of direct innovation both in the primary sector (sectors 01 to 05, ISIC Rev. 3) and the food industry (sectors 15 and 16, ISIC Rev. 3) in relation to other sectors. At this point two questions arise regarding the generation of technology in the agri-food, a sector that is

[6] A preliminary and shorter summary of this research has been presented in the "International Conference on food innovation, 2010".
[7] INE is the National Statistical Service of Spain.

supposed to be strategic due to its functions of food supply and occupation of territory.

The first question is whether the low direct intensity of innovation that is shown in the statistics, that will be discussed later, corresponds as well to a low indirect intensity of innovation in the relationships of agri-food with other sectors. Empirical evidence suggests that inputs from other sectors could represent the main source of R&D incorporation in the agri-food system like other traditional sectors (Hauknes and Knell 2009).

As Garcia-Martinez and Burns (1999) indicate, national and international suppliers of machinery and equipment contribute considerably to the technological level of the Spanish food and beverages industry. Therefore, the interdependence between sectors can be an important source of knowledge.

In this way, innovation in a sector could be performed by the use of improved inputs produced by other sectors. If this were the case the agri-food system would act as an "absorber" of innovations through the products acquired from sectors that perform direct innovation. Another point is that there may be differences between primary and agro-industrial sectors regarding the absorption of innovation that will be identified in the paper.

Assuming that technology incorporated in the agri-food through acquisition of products from other sectors could be significant, the second question would be where are those products made. That is, do products come from the same territory or are they imported from other regions or other countries? This question is especially relevant in agriculture and agri-food industry because they are considered closely linked to the territory. Therefore, the growth of these sectors is supposed to promote the development of the region in which they are located.

The purpose of this paper is to estimate how much innovation is generated in the agri-food system of the VC by direct innovation intensity and how much is due to indirect innovation intensity that in turn may come from the same region or from different ones.

The input-output framework has traditionally been used to measure knowledge flows among sectors. Former works of Terleckyj (1975) and Scherer (1982) combined macroeconomic data and data from R&D surveys. More recently Papaconstantinou´s *et al.* (1998) developed a method to estimate inter-sectoral technological flows that has been applied to OECD countries (Knell, 2008; Hauknes and Knell, 2009) and also to Spain (Camacho and Rodríguez, 2005). However, papers quoted are quite limited regarding the role of the agri-food in the generation and use of knowledge and on the effects of indirect innovation in sub national areas. This has led us to address this study to measure direct and indirect innovation in the agri-food system of the VC.

3.2. Methodology

The method is based on the open model of Leontief that allows the estimation of input-output multipliers matrix (Leontief, 1936, 1937). The multipliers measure the direct and indirect effects on the production system resulting from a change in a unit of final demand. The applications of this approach to the Spanish agri-food system are abundant (Encisó and Sabaté, 1995; López, 1995; Titos *et al*., 1996).

At a regional level multipliers of Leontief´s inverse matrix have been used to analyze productive impacts of exogenous changes in demand for agri-food products (De la Grana and Azaceta, 1990; Pérez y Pérez and Feijoo, 1993; Artis *et al*., 1994; Iraizoz and Rapún, 2001). Other authors (García Álvarez-Coque and Enguídanos 1999) have analyzed the inter-sectoral relationships of the agri-food sector and subsectors in the VC. And finally, in the field of innovation, Camacho and Rodríguez (2005) estimated indirect technological efforts induced in the productive sectors of the Spanish economy from a national approach, not a regional one as it is proposed in this paper.

The approach used in this paper is based on the methodology proposed by Hauknes and Knell (2009) that is also focused in a national level. They conducted a study comparing countries that has been adapted in this paper to analyze inter-sectoral linkages within a region and the relations between the region and the rest of Spain. The paper quoted combines the input-output framework with the *Analytical Business Enterprise Research and Development Database* (ANBERD) and it collects data on R&D intensity for eight industry groups although agriculture is not included among them. In this research regional and national statistics on innovation, focusing on agri-food sector, have been used.

The Leontief model is based on the equilibrium equation for the production system:

$$x = \mathbf{A}x + y \tag{1}$$

Where ***X*** is the output vector, **A** is the regional matrix of technical coefficients and ***y*** is the final demand vector. Assuming there is the inverse matrix (**I-A**), the system is resolved by the following expression:

$$x = (\mathbf{I} - \mathbf{A})^{-1}\; y \equiv \mathbf{B}y \tag{2}$$

Where **B** is the Leontief inverse matrix. The element $\mathbf{b}_{ij}$ of the **B** matrix indicates the direct and indirect effects on the production sector **i** when final demand of sector **j** is increased by one unit (*i, j = 1, … ,N,* with *N* sectors).

Total innovation in sector **j** would include its own expenditure on innovation activities as well as the expenditure in the acquisition of innovation embodied in inputs from other sectors in the same region or in the rest of Spain. Then, the direct innovation intensity for sector **i** at a regional level ($\mathrm{r_i}$) is defined as the direct expenditure on innovative activities ($\mathrm{R_i}$) per unit of output ($\mathrm{X_i}$):

$$\mathrm{r_i} = \mathrm{R_i} / \mathrm{Xi} \tag{3}$$

Multiplying the direct innovation intensities of sectors **i** by the elements (b_{ij}) of the matrix **B**, matrix **T** is obtained. Elements of matrix **T** (t_{ij}) indicate the total regional innovation incorporated per unit of final demand of the sector **j**:

$$\boldsymbol{T} = \hat{r}\boldsymbol{B} \tag{4}$$

Where $\hat{r}$ is a diagonal matrix whose elements are the direct innovation intensities (r_i). However, matrix **T** presents a problem of double accounting when measuring the intensity of innovation by unit of production and not by unit of final demand. In order to correct this problem, according to Hauknes and Knell (2009), a modified matrix **B** called **B*** has been obtained by dividing the elements of each column by the element of the main diagonal and later on by eliminating the elements of the diagonal to avoid double accounting of the direct effect of its own innovation intensity.

$$\boldsymbol{T^r} = \hat{r}\boldsymbol{B}^*$$

(5)

In this way matrix (T^r), whose elements (t_j^r) measure the innovation intensity induced regionally in sector **j** in terms of production, has been obtained. Then, innovation intensity incorporated in inputs of sector **j** in the regional level is:

$$t_j^r = \sum_{i=1, i \neq j}^{N} \left(r_i \frac{b_{ij}}{b_{jj}} \right)$$

(6)

In this way, total innovation intensity of sector **j** (r_j^r) in the regional level could be defined as the sum of the own innovation intensity of the sector **j** (r_j) plus the innovation intensity embodied in the products and services acquired inside the region (t_j^r), as follows:

$$r_j^r = r_j + t_j^r$$

(7)

Moving forward, the estimation of the direct and indirect innovation intensities generated within a region can be accurate by adding the indirect innovation intensity found in the products imported from the rest of Spain. In order to consider them it is necessary to know the innovation intensities of each sector and territory where the products come from. Note that this paper takes into account the products coming from the rest of Spain considering only their direct innovation and not including the indirect innovation induced by them.

Then indirect innovation due to products imported from Spain is:

$$t_j^E = \sum_{i=1}^{N} r_i^E \; m_{ij}^E \tag{8}$$

Where (t_j^E) is the innovation intensity of sector **j** due to the inputs imported from the rest of Spain, (r_i^E) is the direct innovation intensity of sector **i** at the Spanish level and (m_{ij}^E) are the elements of matrix M^E. Each element of this matrix is the coefficient of imports that sector **j** of the VC acquires from Spain, expressed in units of output of sector **j**.

Therefore, the total innovation intensity of sector **j** (r_j^t) is the sum of the direct innovation intensity (r_j), plus the indirect innovation intensity induced at regional level (t_j^r), plus the indirect innovation intensity incorporated by its imports from the rest of Spain (t_j^E).

$$r_j^t = r_j + t_j^r + t_j^E \tag{9}$$

The relationship between the total innovation intensity and the direct innovation intensity is indicated by the technological multiplier. A value of the multiplier around 2 implies that the total innovation intensity is made up fifty-fifty of direct and indirect innovation intensity. If the multiplier is greater than 2 it means that the indirect innovation is larger than the direct innovation. In this way the technological multiplier reflects the productive structures of the region or the sectors analyzed indicating how technical knowledge is created and used. If a sector (or the region) has a low multiplier it implies that the sector (or the region) generates knowledge. In the same way a high multiplier indicates that the sector (or the region) uses knowledge generate by other sectors or regions.

It is worth to indicate that, in this analysis, technological effort is considered in terms of innovation intensity, that is to say, total direct expenditure on innovation activities over the turnover of the sector. Apart from the direct technological effort of the sectors in the VC the estimation also considers the indirect technological effort induced by intermediate products purchased both in the region and in the rest of Spain. It has to be noted that other sources of innovation such as imports from outside Spain or knowledge embedded in capital goods, either regional or imported, have not been considered in the present exercise. Another limitation would be the innovation performed by entities such as cooperatives, professional associations, foundations, etc, that are not reflected in the sources of information used. In this way the paper offers an exploratory analysis of the capacity of the agri-food system in the VC to generate innovation through sectoral linkages related to transactions of intermediate products. Future work is needed in order to overcome these limitations.

Regarding the data used in the analysis, two main sources of information have been used:

i) The input-output matrix of the VC. The latest one available is from 2000, updated in May 2008.
ii) The Survey on Technological Innovation in Enterprises of 2006, which is the first year that the survey takes into account agriculture. The data for the VC comes from IVE (*Instituto Valenciano de Estadística*, Valencian Statistics Service) and the data for Spain comes from INE (*Instituto Nacional de Estadística*).

The structure of innovation intensity data for the VC published by IVE is divided into 15 groups of economic activities. In order to be comparable with data for Spain (54 business activities), the table of the equivalence shown in Table 1 was elaborated. The analysis assumes that the innovation intensity average for a group can be assigned to each of the subsectors forming the group. This assumption implies a constraint on the accuracy of the innovation intensity considered for the subsectors but there are not easy alternatives given the information available.

Table 1 Available data on innovation intensities in the VC sectors. Equivalence with ISIC REV. 3

Group	Name	ISIC Rev. 3
1	Agriculture, hunting, forestry and fishing	01, 02, 05
2	Mining and quarrying; Electricity, gas and water supply	10-14 , 23 , 40, 41
3	Manufacture of food products, beverages and tobacco products	15-16
4	Manufacture of textiles, wearing apparel, Tanning and dressing of leather; manufacture of luggage, handbags and footwear	17, 18 , 19
5	Manufacture of wood and of products of wood and cork, except furniture; Manufacture of paper and paper products Publishing, printing and reproduction of recorded media	20 , 21 , 22
6	Manufacture of chemicals and chemical products	24
7	Manufacture of rubber and plastics products	25
8	Manufacture of other non-metallic mineral products	26
9	Manufacture of basic metals, and fabricated metal products, except machinery	27 , 28
10	Manufacture of machinery and equipment	29
11	Manufacture of office, accounting and computing machinery; Manufacture of electrical machinery and apparatus n.e.c.; Manufacture of radio, television and communication equipment and apparatus, Manufacture of medical, precision and optical instruments,	30 , 31 , 32 , 33
12	Transport equipment	34, 35
13	Manufacture of furniture; manufacturing n.e.c.; Recycling	36 , 37
14	Construction	45
15	Services	50 , 51, 52 , 55 , 60-67, 70-75 , 80 , 85 , 90-93

The induced innovation intensity from outside the region has been estimated trough the intermediate consumption matrix of products imported from Spain. This matrix has been calculated using the input-output framework of VC (total symmetric matrix minus interior symmetric matrix). Thus it is possible to estimate, for each sector **j**, the proportion of total imports coming from the rest of Spain. This ratio, applied to intermediate consumption products produced in each sector **i** and bought by each sector **j**, makes it possible to estimate the import matrix of sector **j** in Valencia (imports from the rest of Spain as has been indicated). Then, imports per unit of output of sector **j** are obtained dividing the elements of each row of the matrix by the total production of every sector **j**.

3.3. Results and discussion

Results are presented in three sections from more to less aggregate. The first one refers to the agri-food system as a whole; the second one focuses on the two main subsectors: primary sector (including agriculture, livestock, fisheries and forestry) and food industry; and the third one decompose main sectors in economic branches.

According to the results, total innovation intensity of the agri-food sector is greater than the average of all the sectors of the VC. Both components, direct and indirect innovation intensities, are greater in the agri-food sector than in the average of other sectors as it is shown in Table 2. These results would refute the generally accepted idea that the agri-food sector is scarcely innovative (see for example Connor & Schiek, 1997; Garcia & Briz, 2000). Besides, it is worth to highlight the capacity of agri-food sector of the VC to induce innovation in the own region compared to the whole Valencian economy. From this perspective, the agri-food sector would be strategic for the territory as it induces more innovation in the region than the rest of the sectors.

Table 2 Innovation intensities for agri-food system and other sectors (% of value added) in the Valencian Autonomous Community (VC)

Innovation intensity	Agri-food system	Other sectors	Total VC
R	1.53	1.06	1.08
$\mathbf{t^r}$	0.46	0.29	0.30
$\mathbf{t^E}$	0.76	0.72	0.72
$\mathbf{r^{total}}$	2.75	2.07	2.11
Technological multiplier	1.79	1.96	1.94

Source: Drawn from the Input-Output frame of the VC (IVE, 2008) and Innovation Survey (IVE, INE).

In an attempt to deeper analyze the agri-food system it has been broken down into primary sector on the one hand and food industry on the other. The rest of the sectors of the VC have been grouped according to the technological classification used by Hauknes and Knell (2009)[8] which identifies the follows groups of industries: Energy, Materials, Traditional, Scale-intensive, Science-based, Specialized-suppliers, and Services (the industries included in each group are shown in the Table 3). Results are shown in Table 4.

[8] This classification is a modified version of technological taxonomy developed by Pavitt (1984)

Table 3 Industries included in the Hauknes and Knell (2009) classification (ISIC REV.3)

	Sector	ISIC Rev. 3
	Traditional	
1	— Agriculture, hunting, forestry and fishing	01, 02, 05
2	— Manufacture of food products, beverages and tobacco products	15, 16
3	— Other traditional sectors	17-22, 36, 37, 45
4	Energy	10-12, 23, 40
5	Materials	13, 14, 25,-26, 41
6	Scale-intensives	24, 27, 28, 34, 35
7	Specialized-supplier	29, 31
8	Science based	30, 32, 33
9	Services	50-52, 55, 60-67, 70-75, 80, 85, 90-93

Source: Hauknes and Knell, 2009

Note: The Hauknes and Knell 2009 classification distinguishes the Knowledge intensive business services -KIBS- from services. This paper does not because there is no data on innovation intensities in KIBS in the VC.

Table 4 Innovation intensities of sectors in the VC (per cent of value added) and total value added

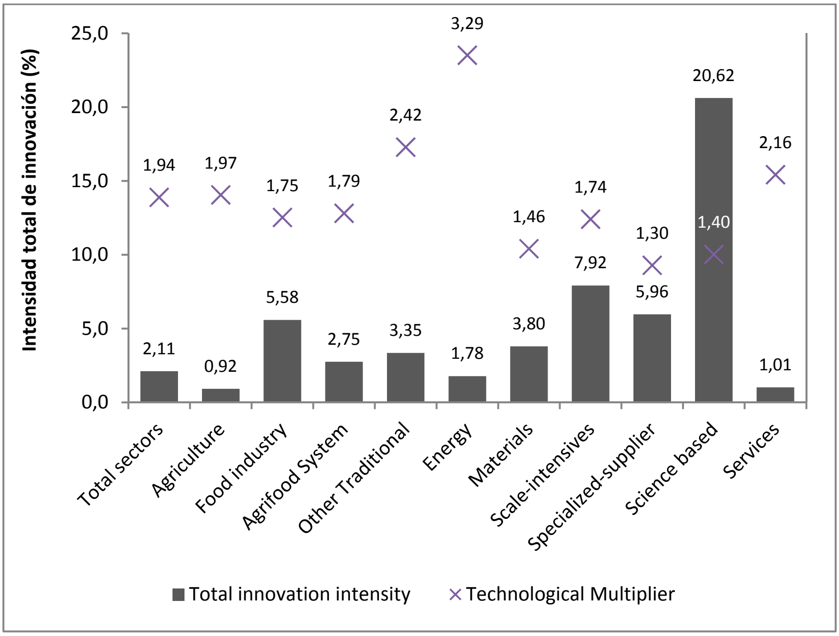
Sector	r	t^r	t^E	r^{total}	Value added (%)	Multiplier
Agriculture	0.47	0.14	0.31	0.92	3.3%	1.97
Food Industry	3.18	0.95	1.45	5.58	2.1%	1.75
Other Traditional sectors	1.38	0.55	1.42	3.35	17.2%	2.42
Energy	0.54	0.20	1.04	1.78	1.4%	3.29
Materials	2.61	0.63	0.57	3.80	5.7%	1.46
Scale intensives	4.56	0.44	2.92	7.92	4.5%	1.74
Specialized suppliers	4.58	0.58	0.80	5.96	1.6%	1.30
Science based	14.69	0.94	4.99	20.62	0.2%	1.40
Services	0.47	0.18	0.37	1.01	64.1%	2.20
Average	1.08	0.30	0.72	2.11	100%	1.94

Source: Drawn from the Input-Output frame of the VC (IVE, 2008) and Innovation Survey (IVE, INE).

Deeper analysis on subsectors forming the agri-food system show no positive results for the primary sector. This subsector (including agriculture, livestock, forestry and fishing) shows the lowest innovation intensity, even smaller than services. These results follow the same trend found in other studies (Connor & Schiek, 1997; Garcia & Briz, 2000; Garcia-Martinez *et al.*, 2010). Its composition is made fifty-fifty by direct and indirect innovation and follows the same pattern as the average in the region. The indirect innovation induced by imports from the rest of Spain is bigger than indirect innovation induced in the region through inter-sectoral linkages.

However, the food industry shows a value of innovation intensity (5.58%) bigger than other sectors that *a priori* are expected to be higher (for instance Materials is 3.8%, and other traditional sectors is 3.35%). Moreover, food processing stands out as the sector that induces more innovation inside the region (0.95%), even more than science based sectors (Table 4 and Figure 1).

Figure 1 Innovation intensities by industry in the VC and the technological multipliers



Source: Drawn from the Input-Output frame of the VC (IVE, 2008) and Innovation Survey (IVE, INE).

These results may question the classification of food processing as a traditional sector (Hauknes & Knell, 2009; Eurostat, 2011). The innovation intensities obtained are close to those of other innovation-intensive sectors such as scale-intensive sectors and specialized suppliers. In this sense Robinson *et al.* (2003) consider food industry as a scale-intensive industry in the taxonomy of innovation they developed (Table 3 and Figure 1).

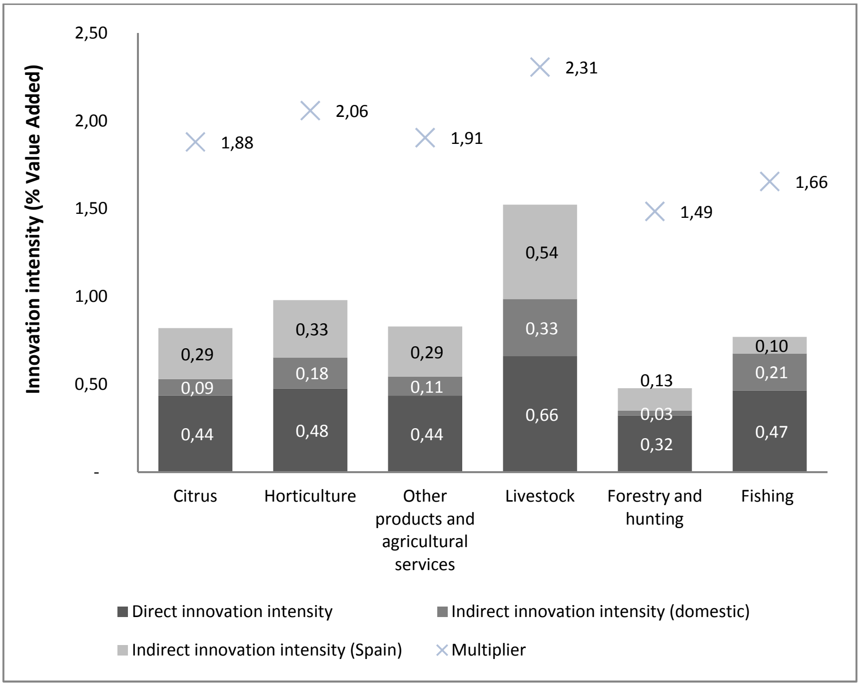
The international study of economic sectors made by Knell (2008) was compared with the results obtained here for the VC (Table 5). Knell considered R&D intensity as a component of the innovation intensity. In order to solve this inconvenient the R&D intensity for the VC was estimated. Another difference between Knell's and our approach is the scope of the territory considered in the study: countries in Knell's paper and regions in this one. As countries are larger economies they integrate more inter-sectoral linkages and, consequently, countries would induce more innovation intensity than regions. Despite these limitations the comparison makes it possible to place Valencia food industry in an international context in order to appreciate its dimension.

From these data it can be inferred that: i) direct R&D intensity and total R&D intensity of food industry are higher in the VC than in Italy, Portugal or Greece but lower than in Spain; ii) induced R&D intensity in the territory is higher in Spain than in the VC, to certain extent because Spain is a bigger economy and therefore has more inter-sectoral linkages, as it has been mentioned; iii) total R&D intensity of food industry in the VC is similar to Italy, lower than Spain, The Netherlands, Ireland or France and higher than Greece and Portugal.

There are substantial differences between the primary sector and the food industry. First of all, innovation intensity is around six times higher in the food industry than in the primary sector (see Table 4 and Figures 1 and 4). Lower skill levels in rural areas may be a factor limiting innovation. In most OECD countries the performance of students in the International Student Assessment-PISA (OECD, 2006) shows a significant gap between urban and rural students. Populations in rural areas tend to be older and less well educated than in metropolitan regions. Rural regions rely on traditional skills with a weak position in skills needed for modern services and the use of advanced technologies (OECD, 2009).

Focusing on agriculture, citrus —the main subsector in terms of value added— has quite low innovation intensity, around 0.8% (Table 6). Besides, induced innovation in the region is very limited, around three times lower than induced innovation in Spain. Livestock has the highest total innovation intensity in the primary sector (1.52%). These results are in line with other studies that characterize this sector as an innovation subsystem with the meat industry (Pitt & Nelle, 2008). The value of the multiplier, greater than 2, indicates that induced innovation is bigger than direct innovation. Horticulture follows the same pattern (Table 6 and Figure 2) with a lower innovation level in Spain as found in other studies (Garcia-Martinez *et al*., 2010.

Figure 2 Innovation intensities in the primary sector (agriculture, livestock, forestry and fishing)



Source: VC Input-Output matrix (IVE, 2008) and Innovation Survey (IVE, INE).

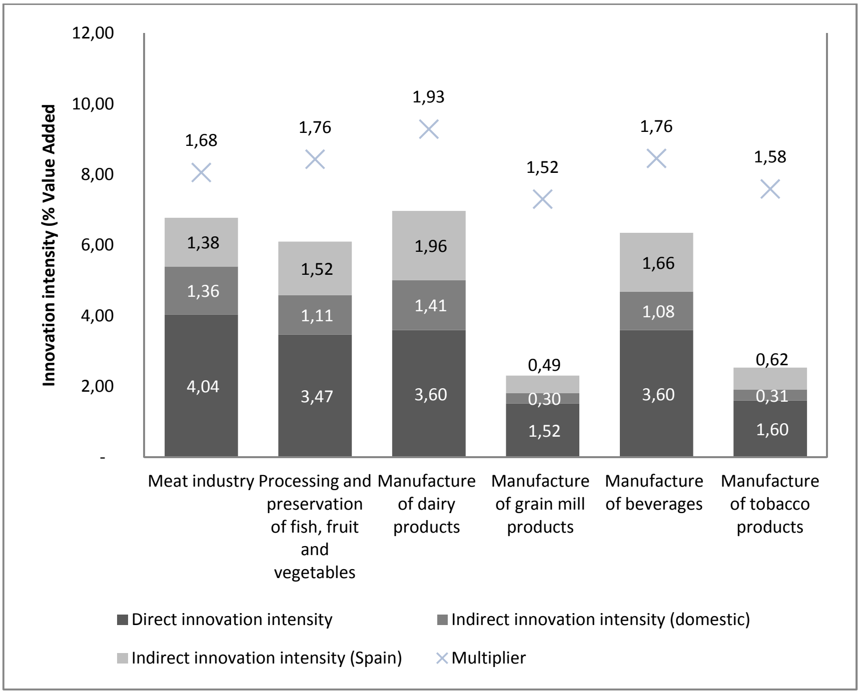
Regarding food industry, grain mill manufacture -the main subsector in terms of value added- has the lowest innovation intensity (2.31%). On the opposite side, the dairy industry shows the highest innovation intensity (6.97%) followed by meat industry (6.78%) (Table 5 and Figure 3).

Table 5 Food industry R&D intensity in VC and some European countries (Per cent of value added)

Country/ region	r	t^r	r^{total}	Size value added food industry in 2000 (VC = 100)
VC	0.46	0.34	**0.79**	100
Spain	0.70	0.73	**1.43**	488
Netherlands	2.44	1.03	**3.47**	370
France	1.28	1.72	**3.00**	1,070
Italy	0.42	0.34	**0.76**	732
Ireland	1.22	0.23	**1.45**	117
Portugal	0.08	0.24	**0.32**	111
Greece	0.34	0.26	**0.60**	95

Source: VC Input-Output matrix (IVE, 2008); Innovation Survey (IVE, 2002,; Knell, (2008)

Figure 3 Innovation intensities in the food industry



Source: VC Input-Output matrix (IVE, 2008) and Innovation Survey (IVE, INE).

The direct innovation intensity is higher than the induced innovation in most of the sub-sectors in the primary sector and the food industry. It implies that the technology multiplier is generally lower than 2, except for two sectors highly dependent on intermediate and imported inputs from outside: horticulture and livestock (Table 6). The induced innovation in the region measures the contribution of each sector to the innovation effort within the economy. The induced innovation at the national level (Spain) is found to be higher than induced innovation within the region for most subsectors, except fishing and meat industry. Livestock and dairy industry show the highest values for induced innovation in the primary sector and the food industry respectively (Table 6).

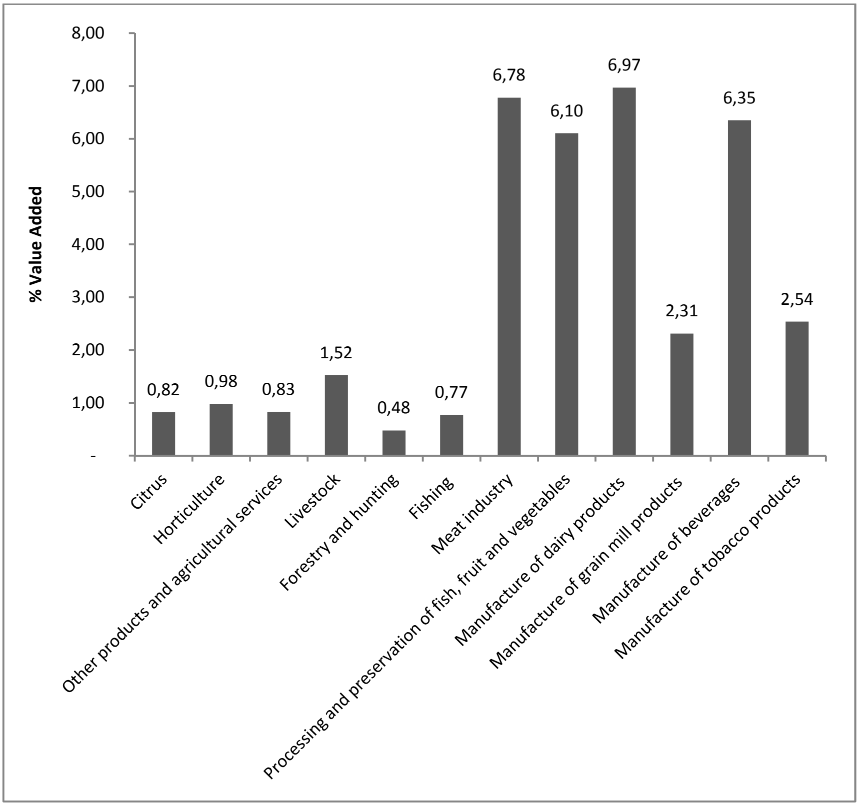
Table 6 Innovation intensities in the primary sector and the food industry (%/value added), Total value added (% of agrifood sector), Technological multiplier

Sector	r	t^r	t^E	r^{total}	% Value added	Technological multiplier
Citrus	0.44	0.09	0.29	0.82	26%	1.88
Horticulture	0.48	0.18	0.33	0.98	9%	2.06
Other products and agricultural services	0.44	0.11	0.29	0.83	15%	1.91
Livestock	0.66	0.33	0.54	1.52	7%	2.31
Forestry and hunting	0.32	0.03	0.13	0.48	0%	1.49
Fishing	0.47	0.21	0.10	0.77	4%	1.66
Meat industry	4.04	1.36	1.38	6.78	5%	1.68
Processing and preservation of fish, fruit and vegetables	3.47	1.12	1.52	6.10	3%	1.76
Manufacture of dairy products	3.60	1.41	1.96	6.97	4%	1.93
Manufacture of grain mill products	1.52	0.30	0.49	2.31	16%	1.52
Manufacture of other food products*	9.68	3.05	5.83	18.55	3%	1.92
Manufacture of beverages	3.60	1.08	1.66	6.35	7%	1.76
Manufacture of tobacco products	1.60	0.31	0.62	2.54	1%	1.58

Source: VC Input-Output matrix (IVE, 2008) and Innovation Survey (IVE, INE). Note: "Other products" has not been analyzed because is very heterogeneous and its ratio value added/production is so small that distorts the results

It is paradoxical that economic branches with significant share in the primary sector, such as citrus, horticulture and other agricultural activities (Figure 4) show relative low levels of innovation effort. This might be connected with several factors. One of them is the fact that there are some kinds of innovation that are not expressed in terms of innovation expenditure. Other one is the weak farm structures, based on small enterprises that limit innovation investment. Innovation, like critical grow factor in the agri-food system (Russo Spena & Colurcio, 2010) can be considered to certain extent as a public good and many farms are innovation takers rather than innovation enhancers. In this case, government action promoting innovation is more than justified.

Figure 4 Total innovation intensities in the agri-food system



Source: VC Input-Output matrix (IVE, 2008) and Innovation Survey (IVE, INE).

Possible measure to improve the innovation performance of the agri-food system is the strengthening of interactions between agents in the system. Two kinds of interactions can be taken into account (European Commission, 2007). One is to promote innovation through enhanced cooperation and exchange between firms. In particular, interactions with knowledge-intensive sectors, given their importance in the generation and diffusion of innovations, can be strengthened (Mas Verdú *et al.*, 2011). In this empowerment of innovation networks, the innovation brokers may have a key role (Batterink *et al.,* 2010). The other is to enhance partnership between the business sector and public support services to R&D activities. Such kind of services play an essential role in parts of the agro-food system still dominated by Small and Medium Enterprises, such as the primary sector and a large number of food processors.

As conclusions, the agri-food system has been considered strategic from a policy perspective because of its role in the provision of food and other functions as land use, environment protection and biodiversity conservation. This paper highlights its contribution to the generation of knowledge and innovation through inter-sectoral linkages established with other economic sectors.

The methodology used in this paper combines the input-output framework with innovation intensities data. The method, applied to the VC, makes it possible to distinguish between direct and induced innovation from a regional perspective. In turn, induced innovation is divided into innovation induced in the region and innovation induced in the rest of Spain. The contributions of this paper in regard to the pre-existing literature on the subject are: i) The estimation of inter-sectoral flows of innovation in the agri-food sector including both agriculture and agro-industry; ii) The estimation of inter-sectoral flows of innovation at the subnational level.

Both the primary sector and the food industry induce innovations through the acquisition of intermediate inputs produced in other sectors. Technological multipliers are found to be greater than 2 for horticulture and livestock. The food industry stands out for its innovation intensity higher than the one estimated for primary sector and also higher than most values calculated for traditional industries of the Valencian economy. The induced innovation by the food industry within the region is also remarkable. The innovation intensities for the Valencian food processing are estimated to be higher than those found in the literature for other Southern European countries.

Despite the limitations of the data bases used (input-output matrix and technological survey) the results are an attempt to approach the contribution of the agri-food system to the regional economy of innovation, through direct efforts or through intersectoral linkages. Particularly in agriculture, due to the great majority of micro, small and medium sized enterprises (SMEs), the primary sector reveal low levels of innovation efforts, which may justify government intervention promoting agricultural research and innovation. Innovation in the Valencian agri-food economy seems largely induced from other sectors in the region and in the rest of Spain.

Therefore this approximation on innovation in the agri-food system could be useful to guide public policies targeted to promote innovation. It is essential that these actions converge with agricultural policy instruments in order to foster the EU growth and become a sustainable, smart and inclusive economy.

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Anexo: Imagen de la primera página de la publicación

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Innovation and sectoral linkages in the agri-food system in the Valencian Community

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Abstract

This paper aims to analyze the innovative effort of the agri-food system (AFS) in the Valencian Autonomous Community (VC), Spain, estimating the intensity of innovation in each subsector of the AFS. The analysis distinguishes between the direct and indirect (or induced) innovation intensities incorporated by the acquisition of inputs from other subsectors produced in the VC or in the rest of Spain. The methodology employed is based on the input-output framework combined with data of technological innovation in enterprises. This methodology provides the novelty of been applied to a region —the VC— and not to a country as it is usually done. The results show that the weight of intersectoral flows in the total innovation effort of the AFS is significant with marked differences between primary and food industry. In most activities, embodied knowledge in inputs purchased from Spain is greater than embodied knowledge of inputs produced inside the region.

Additional key words: embodied knowledge; food industry; input-output; intersectoral linkages; primary sector; Spain; Valencian region.

Resumen

Innovación y vínculos sectoriales en el sistema agroalimentario de la Comunidad Valenciana

Este artículo analiza el esfuerzo innovador del sistema agroalimentario de la Comunidad Autónoma de Valencia (CAV), España, estimando la intensidad de innovación de cada subsector del sistema. El análisis distingue la intensidad de innovación directa y la intensidad indirecta (o inducida) incorporada en los inputs adquiridos por el sistema agroalimentario, indicando si es originada dentro o fuera de la región. La metodología empleada se basa en la utilización del marco input-output combinado con datos de innovación tecnológica en las empresas. Esta metodología aporta la novedad de ser aplicada a nivel regional —en la CAV— y no a nivel nacional, como se ha realizado hasta ahora. Los resultados muestran que el peso de los flujos intersectoriales en la innovación total del sistema agroalimentario es apreciable y muestra diferencias importantes entre la agricultura y la industria alimentaria. En casi todos los casos el conocimiento incorporado en insumos originados fuera de la región supera a los producidos dentro de la región.

Palabras clave adicionales: conocimiento incorporado; España; industria alimentaria; input-output; Región Valenciana, sector primario; vínculos inter sectoriales.

Introduction

This paper deals with flows of innovation among the agri-food system in a region and other sectors and territories[1]. The premise is that agri-food firms, in both the primary sector and the food industry, generate an effort in innovation that can be approximated in a direct way through the spending in innovation per unit of

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Capítulo 4

Creación de nuevas empresas e innovación: patrones sectoriales y vínculos intersectoriales

Capítulo 4

Creación de nuevas empresas e innovación: patrones sectoriales y vínculos intersectoriales

Artículo

New firm creation and innovation: industrial patterns and inter-sectoral linkages

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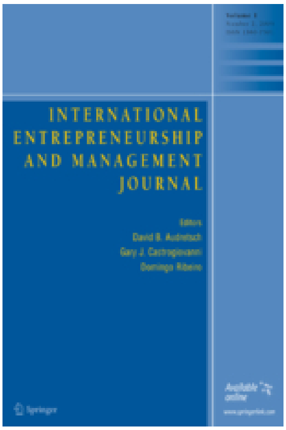

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New firm creation and innovation: industrial patterns and inter-sectoral linkages

Abstract:

This article analyzes the linkages between entrepreneurship and innovation behaviour at an industrial level. The research question refers to the extent that the industrial pattern of generation/absorption of knowledge affects the industrial ability to create new firms. An embodied knowledge approach has been applied, by combining the input-output framework with innovation and new firm creation data. As a result, four industrial patterns of innovation/new firm creation have been identified, taking into account the firm size and the model of generation and absorption of knowledge.

Keywords: New firm creation, entrepreneurship, innovation pattern, embodied knowledge, sectoral linkages, input-output.

4.1. Introduction:

This article attempts to investigate the linkages between innovation (Baregheh et al. 2009) and the dynamics of creation of new firms in each industry. The relation between innovation behaviour and firm creation is far from obvious. This is due to the fact that innovation has many ways of affecting the economic system, sometimes encouraging economic growth but sometimes becoming a barrier to entry. Low direct innovation intensities can, in turn, be consistent with significant indirect innovation induced through inter-sectoral linkages with the rest of the economic system. This underlines the role of some low-tech sectors, which show dynamic entrepreneurship behaviour. This work identifies industrial patterns of innovation reflecting four features, measured at the level of industry: a) the industry's technological level; b) innovation intensities and knowledge intersectoral linkages; c) firm creation dynamism; and d) the average size of the firm. Each pattern is characterized by an entrepreneurial activity and an innovation drive that has to be interpreted according to the industries' market structure and the way innovation is generated and spread through the economic system.

The relationship between entrepreneurship, innovation and economic growth has been largely considered in economics. The seminal work by Joseph Schumpeter (1934, 1942) supplied some of the more widely used concepts in this area, such as "creative destruction" and "entrepreneur" (Schumpeter 1942). The so-called post-Schumpeterian contributions incorporated two key factors of growth: a) knowledge (creation and protection) and b) provision of entrepreneurship or entrepreneurial management (Burton 1999). Entrepreneurship has been placed as the missing link between investment in knowledge and economic growth (Acs et al. 2004). These authors show that a filter exists between investments in new knowledge and its marketing, and this filter consists of starting new firms (the knowledge-spill over entrepreneurship) that serve as channels for knowledge spillovers. Acs et al. (2008) show that knowledge spillovers enable entrepreneurs to identify and exploit new business opportunities. Knowledge-based entrepreneurship appears to have a positive effect on economic performance, thus becoming the way that innovation affects economic growth (Audretsch et al. 2008, Audretsch and Keilbach 2008, Alpkan et al. 2010, Acs et al. 2011).

However, not all industries behave the same in the way, and innovation efforts are linked to the creation of new enterprises (Aghion and Howit 1992, Deeds 2001, Aghion 2009, Callejón and

Ortún 2009, Stam and Wennberg 2009, Houthoofd et al. 2010, Lin et al. 2010). This article intends to make a contribution by characterizing industrial innovation patterns that consider, in addition to the innovation made by each industry, the distinction between the main sources of innovation that can be internal or external for each industry. Based on the input-output framework, innovation intensities were estimated for the Spanish industries and, together with the firm size and new firm creation data, were used to characterize industrial innovation/firm creation patterns.

This article is developed in four sections. Section 2 discusses the relationship between entrepreneurship and both innovation intensity and average firm size at industrial level. Section 3 presents the methodology and data used to approach the industrial innovation intensities (decomposed by sources of knowledge), new firm creation rate and the innovation taxonomy applied to identify industrial categories. Section 4 undertakes a characterization of the main industrial innovation/firm creation patterns. The final section provides the conclusions, policy implications and lines for future research.

4.2. Innovation and firm creation across industries

This article is framed within the industrial entrepreneurship analysis, exploring the kinds of patterns that exist in the relationship between innovation intensity and the dynamism for creating new businesses. In particular, we argue that the relationship between innovation and entrepreneurship largely depends on the characteristics of the industries involved. The two main characteristics with implications for entrepreneurship considered here are: (i) market structure and (ii) innovative behaviour, which refers to innovation efforts and the nature of such effort in terms of being internal or external to the industry.

As for the first aspect, the positive impact of innovative activity on the creation of companies is affected by the market structure in which firms are included (Zhang and Duan, 2010). For example, increased competition through the entry of new firms can discourage investment in innovation in traditional industries but encourages this kind of effort in industries close to the technological frontier (Deeds 2001; Aghion et al. 2005; Aghion et al. 2009; Stam and Wennberg 2009). Moreover, many traditional sectors are found to have a large number of small companies with limited product differentiation, while more intensive technological industries compete with larger companies and higher product differentiation, being forced to be radically innovative in order to survive in the market (Callejón and Ortún 2009, Huang et al. 2010).

Economic growth and firm creation are also affected by the technological nature of the industries involved (Aghion et al. 2004). For instance, Mueller (2007) shows that an increase in innovative start-up firms is more effective that a general increase in entrepreneurship for promoting economic growth. Other studies find that in low-tech industries, the economic growth and new firm creation are not affected by the R&D intensity (Stam and Wennberg 2009), while in high–tech activities (particularly in biotechnology) there is a positive correlation between the R&D absorption capacity and entrepreneurial wealth creation (Deeds 2001).

Entrepreneurship is not only considered as a creation of new enterprises but also as a survival of them (Acs et al. 2007). Here, industrial differences exist too. Cefis and Marsili (2006, 2011) find that entrepreneurial firms in high-tech industries do not seem to improve their chances of survival through innovation. They argue that product innovation is a necessary condition to participate in the market in this type of industry but not a sufficient condition to ensure the survival of the company. In contrast, in low-tech industries, process innovation appears as a critical condition for the survival of a firm.

Market structure and innovation intensities can be measured for each economic branch. Measures can then be related to the new firm creation rate and these measures appear in section 4 where industrial patterns are identified according to firm size, technological level and the ability to create firms. According to such patterns, a direct link cannot be established between innovation intensity and firm creation.

This research also considers the difference between internal sources of (direct) innovation and external sources (Sonmez and Morhouse 2010), including here the intensity of innovation embodied in inputs and capital goods purchased by each sector. This distinction between direct and induced innovation is relevant because it may be the case of traditional industries with significant rate of firms' creation and low direct innovation intensities, but large indirect embodied innovation from other sectors through acquired inputs. This differentiation in the nature of innovation is considered in this paper by using an "embodied knowledge approach" through an input-output framework that is explained below (Papaconstantinou et al. 1996, 1998; Hauknes and Knell 2009)

The study draws on the taxonomy of innovation proposed by Robinsohn et al. (2003), which distinguishes eight groups of industries (both manufacturing and services). The average gross rates of new business creation are calculated for each group in Spain, considering the period 1999-2009. We subsequently adjust the taxonomy by estimating the innovation intensity and breaking it down according to the specific source of knowledge for each economic branch (direct or embodied in intermediate consumption or in capital goods, whether domestic or imported). In the next section we introduce the method for carrying out such decomposition of sources of innovation.

4.3. Methods and data

The industrial patterns of innovation/firm creation are based on four characteristics: a) the technological group according to a taxonomy of innovation; b) the innovation behaviour, measured by innovation intensities and their decomposition by innovation source; c) the rate of creation of new companies (firms with employees and all enterprises); and d) the added value per firm as an indicator of average firm size.

4.3.1. Technological taxonomy

We follow the taxonomy proposed by Robinson at al (2003) that combines the manufacturing classification proposed by Pavitt (1984) with the services classification proposed by den Hertog et al. (2003). The eight groups of industries are: supplier dominated goods (SDG); scale intensive industry (SII); specialized goods suppliers (SGS); science based innovators (SBI); supplier dominated services (SDS); specialized services suppliers (SSS); organizational service innovators (OSI); client-led services (CLS); and non-market services (NMS). This classification is useful not only because it is based on the technological content of the industries included but also because it provides for a qualitative insight of the type of relationship between the industries and the economic system (see table in the appendix).

4.3.2. Measuring innovation effort

The methodological basis for measuring the innovation effort is built upon a large body of literature (Terleckyj 1974; Scherer 1982a, 1982b; Papaconstantinou et al. 1996; Sakurai and Papaconstantinou

1997; Scherer 2003; Papaconstantinou et al. 2008; Hauknes and Knell 2009), which rests on the assumption that innovative behaviour can only be fully grasped through the inter-sectoral transactions that are the carriers of innovation across industries. Innovation flows are approximated by innovation expenditure data combined with input-output and investment data.

The procedure allows for the measurement of the extent to which innovation is embodied in intermediate inputs and capital goods. Moreover, this approach allows for innovation to be broken down by source, indicating whether the innovation source lies in the industry itself or if it is acquired through purchases of intermediate inputs and investment goods.

The innovation embodied in the output of a certain industry appears as the sum of its own innovation expenditures and those embodied in its purchases from other industries. More specifically, four separate channels of innovation were considered:

i) purchase of domestic inputs;
ii) purchase of domestic investment goods,
iii) purchase of imported inputs and,
iv) purchase of imported investment goods.

The analysis is conducted by normalizing innovation flows to innovation intensities (innovation flows per unit of output or added value) and draws upon research by Mas Verdú et al. (2011) for an application to the Spanish economy (see appendix). The total innovation intensity of an industry j (defined as in_j^t) is the sum of five components (1):

$$in_j^t = r_j + p_j^d + p_j^m + c_j^d + c_j^m \qquad 1$$

Where:

r_j (R_j/X_j) is industry *j*'s own innovation intensity (Expenditure on innovation activities/Output of industry j)

p_j^d (P^d_j/X_j) is the innovation embodied in domestic intermediate inputs per unit of output of *j*;

p_j^m (P^m_j/X_j) is the innovation embodied in imported intermediate inputs per unit of output of *j*;

c_j^d (C^d_j/X_j) is the innovation embodied in domestic investment inputs per unit of output of *j*

c_j^m (C^m_j/X_j) is the innovation embodied in imported investment inputs per unit of output of *j*.

p_j^d is the weighted sum of the innovation intensities of the industries from which industry j purchases inputs. Weightings are constructed using the total (direct plus indirect) domestic intermediate input requirements from each industry per unit of output of industry j obtained from a modified version of the Leontief inverse matrix, which eliminates elements of the diagonal to avoid double accounting for its own innovation intensity. The innovation embodied in domestic investment input purchases c_j^d is the weighted sum of the same innovation intensities, using industry j's investment purchases from other industries as weightings, and multiplied by the total input requirements per unit of the final demand of industry j.

Compared with domestic innovation flows, the formulation of the imported innovation does not take into account the inter-sectoral transmission effects (which, in domestic cases, are gathered through the modified Leontief inverse). Of the two embodied innovation components that relate to the imported innovation, p_j^m is a weighted sum of foreign sectoral innovation intensities, where the weightings are the intermediate demand of industry j from each of the other foreign industries. Similarly, c_j^m is defined analogously as the weighted sum of foreign sectoral innovation intensities, where weightings are the investment demands by industry j from each of the other foreign industries.

4.3.3. Firm creation

To analyze the level of industrial entrepreneurship, the rate of creation of new firms in each sector has been taken into account as a proxy variable. Although this rate does not consider other determinants of entrepreneurship it allows an approximation to the dynamics of each production sector in this aspect. The rate of new business creation is constructed as the ratio of new firms to total firms in each sector in the period analyzed:

$$nfc_j = \frac{NF_j}{TF_j} \qquad (2)$$

Where, nfc_j is the rate of new firm creation in industry j; NF_j is the average of new firms in each industry and TF_j is the average of total firms in industry j. Both variables are built taking into account the average of new and total firms in the period between 1999 and 2009 in the Spanish economy (the firm creation rate has been estimated for firms with employees and for all firms). Calculations are made for the industrial groups considered in the proposed technological taxonomy.

4.3.4. Data sources

Five sources of information were used for the empirical analysis:

i) the Spanish Survey of Technological Innovation in Companies (INE 2007) shows data on innovation intensities at the industry level and is available for 54 economic sectors;

ii) the Input-Output Tables for Spain (INEa 2009) display the economic transactions between 73 sectors, the last available version is that of 2005;

iii) the European Community Innovation Survey (CIS) is carried out by Eurostat and shows several indicators related to innovation in companies in European countries (Eurostat, 2010), sharing the same methodology as the Spanish Survey of Technological Innovation in Companies, and is available for 70 sectors;

iv) the gross fixed-capital formation matrices in Spain (INEb 2009), including investment by supplying and purchasing industries; and

v) the Spanish Companies Central Directory (INE 2010), which gathers data on new and total firms between 1999 and 2009.

Source i) is used for the calculation of direct innovation intensities; source ii) allows for the estimation of embodied innovation through the acquisition of domestic intermediate inputs; source iii) provides information of embodied innovation intensities through imported inputs; source iv) provides structural data to estimate innovation intensities through capital goods; and source iv) supplies the basic information for the new firm creation rates.

Data in the Spanish input-output tables are available at two levels according to the origin of imported inputs, the European Union (EU) and the rest of the world. Given the importance of the EU in Spain’s trade, we assume innovation intensities for all imports as given by the values from the European survey.

To estimate the embodied innovation in investment goods, the gross fixed-capital formation matrix for Spain is combined with the industrial structure and the demand for investment in each industry in order to approach the investment matrix that shows the sales of investment goods and services, from industry i to industry j.

4.4. Main findings and discussion

An estimated Pearson correlation coefficient of 0.007 suggested a low degree of correlation between the new firm creation rate and innovation intensities for the 63 industries included in this study. This indicates that the innovation intensity is far from being an accurate indicator of firm entrepreneurship, approximated by the new firm creation rate. Consequently, economic policy needs a better base to discriminate industries and a possible conflict appears when innovation and entrepreneurship goals are jointly pursued. We subsequently consider the aforementioned four characteristics to identify industrial patterns of innovation/firm creation that would supply criteria for better targeting economic activities in industrial policies.

Industries were broken down into 8 groups according to their technological level following the taxonomy proposed by Robinson et al. (2003) as indicated in section 3. Then the average values for innovation intensities, firm size and firm creation were estimated for each group. Table 1 presents the results for the 8 groups of industries. This table depicts: a) innovation intensities by source of innovation (direct, domestic and imported intermediate inputs and capital goods), b) the rate of creation of new companies (firms with employees and all enterprises) and c) the average added value per firm (as indicator of the average firm size).

Note that an innovation multiplier has been included in the table. This indicator shows the ratio between the total intensity and the direct intensity (Papaconstantinou et al. 1998 and Hauknes and Knell 2009). When this multiplier is 2, the total intensity is made up of equal parts by direct innovation and induced innovation. If the multiplier is over 2, the absorbed induced innovation will be greater than the directly generated innovation. A large multiplier indicates that the innovation efforts caused by a given industry are mainly due to inter-sectoral linkages that spread over the economy through embodied knowledge. Thus a sector can contribute to the generation of innovation as a knowledge user rather than as a direct knowledge generator.

The calculated indicators support the idea that significant innovation efforts are consistent with large new firm creation rates only for certain groups of industries (mainly in SSS) but not for others. In fact, the most innovation intensive manufacturing sectors SBI, SII, SGS show the lowest rates of new firm creation which, in turn, relates to relatively large firm sizes. These results are in line with other studies that find that the relationship between innovation and the creation of new firms is not homogeneous (Aghion 2009, Cefis and Marsili 2011, Deeds 2001, Marsili 2002, Salavou 2010, Stam and Wennberg, 2009, Visscher and Visscher-Voerman, 2010).

Table 1: Innovation effort and new firm creation by industries

	GROUP	Percent of industry added value							I.M.	*nfc* (%)		*Added value per firm(M€)*
		r	p^d	p^m	c^d	c^m	Innovation absorption	Total innovation intensity (in_j)		Firms with employees	Total firms	
Manufacturing	Supplier dominated goods (SDG)	1.48	**2.15**	0.51	0.15	0.18	3.00	4.48	**3.02**	**9.4**	**14.5**	0.24
	Scale intensive industry (SII)	**4.72**	**4.30**	**3.21**	0.31	**0.44**	**8.25**	**12.97**	**2.75**	4.7	8.2	0.79
	Specialized Goods Suppliers (SGS)	**6.39**	**4.90**	**4.57**	0.13	0.20	**9.80**	**16.20**	**2.53**	4.7	9.4	0.51
	Science based innovator (SBI)	**8.67**	**5.59**	**5.31**	0.24	**0.32**	**11.46**	**20.13**	**2.32**	3.5	5.9	1.82
Services	Supplier dominated services (SDS)	2.49	1.60	0.43	0.39	**0.45**	2.86	5.35	2.15	6.6	11.0	0.11
	Specialized services suppliers (SSS)	**9.44**	1.64	0.23	**1.17**	0.23	**3.27**	**12.71**	1.35	7.1	**13.3**	0.15
	Organizational service innovators (OSI)	1.32	0.99	0.13	**0.71**	**0.31**	2.14	3.46	**2.62**	6.6	11.1	0.34
	Client-Led Services (CLS)	0.93	1.48	0.18	0.32	0.27	2.24	3.17	**3.42**	**8.1**	**13.0**	0.20
	Non-Market Services (NMS)	1.45	0.82	0.30	0.34	0.17	1.63	3.08	2.12	5.0	12.1	0.78
	All sectors	**2.61**	**1.81**	**0.74**	**0.44**	**0.28**	**3.26**	**5.87**	**2.25**	**7.4**	**12.4**	0.27

* Higher than average values appear in bold.

Source: INE (2009a, 2009b, 2010a, 2010b) and Eurostat (2010)

The most dynamic sectors in the creation of new companies are (i) SSS with large rates of new firm creation, but also high levels of innovation intensities, mainly of a direct nature and low multipliers; and (ii) manufacturing activities dominated by providers (SDG) and client-led services (CLS). Both sectors show low total innovation intensities but, equally, a relatively significant reliance on external sources of knowledge, which is reflected by significant innovation multipliers. In SSS, SDG and CLS, firm sizes are below the average, suggesting competitive environments. On the other hand, sectors with lower rates of new firm creation are SBI, SII and SGS. These sectors are very intensive in innovation (both direct and indirect) but show relatively large firm sizes, which suggest a less competitive market behaviour.

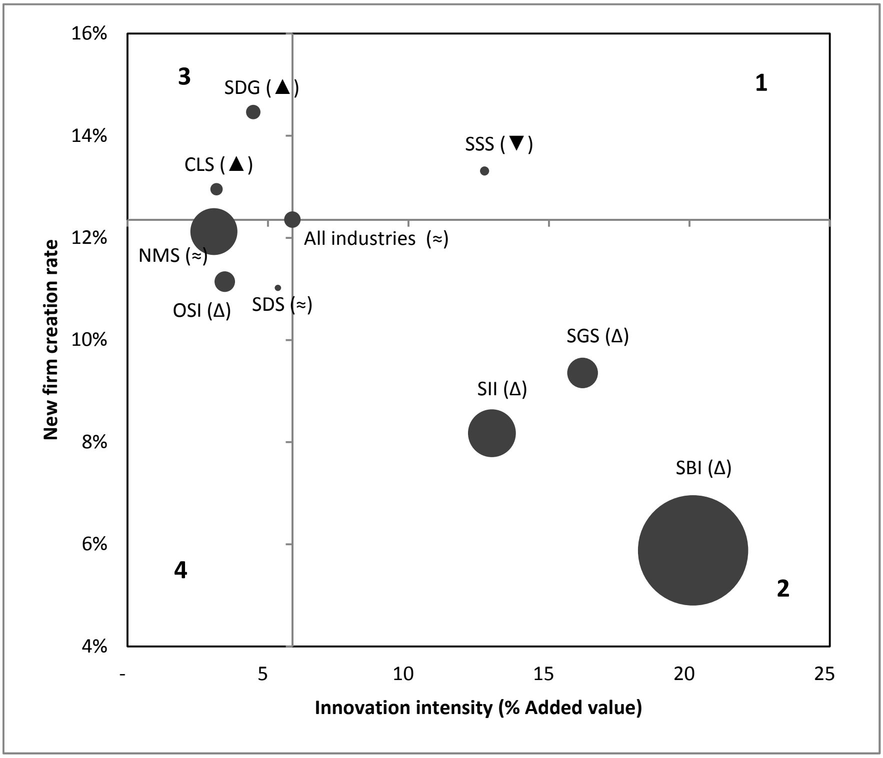
Calculations allow for industries to be classified in 4 groups of patterns, following two dimensions corresponding to above and below average innovation intensities and firm creation rates. This classification is shown in figure 1 and Table 2, where the main characteristics related to innovation behaviour (total efforts, direct effort and innovation multiplier), the firm size (approximated by the average added value) and the new firm creation rate are also reflected.

Table 2 Industrial patterns of innovation and new firm creation rate

Industrial patterns of innovation and new firm creation		**1. Innovation**			**2. Firm size** (added value per firm)	**3. New firm creation**	**Group of industries**
		Total innovation effort (in)	Direct innovation effort (r)	Innovation Multiplier			
1	Higher innovator/new firm creator	High (>10%)	High (>4%)	Low (<2)	Low (<0,27)	High (>13%)	SSS
2	Higher innovator and lower new firm creator	High (>10%)	High (>4%)	Medium -High (2.3>IM<3)	High (>0.3)	Low (<9.5%)	SBI, SII, SGS
3	Lower innovator and higher new firm creator	Low (<5%)	Low (<2%)	High (>3)	Low (0.27)	High (>13%)	SDG, CLS
4	Lower innovator/new firm creator	Media (5-6%)	Low-Medium (2.5%)	Medium	Low (<0.15)	Low	SDS
		Low	Low	Medium-high (2.6)	Medium-high	Low	OSI
		Low	Low	Medium	High (>0.7)	Low-Medium	NMS

Source: INE (2009a, 2009b, 2010a, 2010b) and Eurostat (2010)

Figure 1 Industrial innovation effort and new firm creation rate



The innovation multiplier value is shown in brackets: High (▲); Medium-High (Δ); Medium (≈) and Low (▼). Bubble dimension indicates the firm size
Source: INE (2009a, 2009b, 2010a, 2010b) and Eurostat (2010)

These patterns show the following characteristics:

- Pattern 1. These sectors are highly innovative and are dynamic creators of new firms (specialized services suppliers- SSS-). Average company size is relatively small and the main source of innovation is internal (innovation multiplier below 2). This implies that these sectors do not depend on (relatively) external suppliers of embodied knowledge (either inputs or capital goods). Technological change does not seem to constrain the firm creation process but rather to encourage it.

- Pattern 2. These industries are highly innovative with little dynamism in the creation of new companies (manufacturing science-based, scale intensive industries and specialized goods suppliers -SBI, SII, SGS-). Firm size is over the average and innovation efforts are large for both the internal and external sources. These factors (large size and significant direct and indirect innovation efforts) are typically constraining the entry of new firms in these sectors.

- Pattern 3. Sectors appear here with an under-average intensity of innovation but with a greater rate of creation of new firms. This pattern includes traditional manufacturing sectors dominated by providers (SDG) and client-led services (CLS). Average firm size is below the average as well as the total intensity of innovation, but the sources of innovation are primarily of an external nature (two of the groups involved show relatively large innovation multipliers). However, both groups differ in the sense that manufacturers are more dependent on suppliers of inputs, while services depend not only on these inputs but also on suppliers of capital goods.

- Pattern 4 includes sectors with a relatively small intensity of innovation and a low rate of new firm creation. Three groups of service sectors are included here: organizational innovation services (OSI), non-market services (NMS) and supplier dominated services (SDS). All have in common low-medium direct innovation intensities and heterogeneous behaviour in the other factors (multiplier and firm size)

Figure 1 summarizes the classification of sectors in the four groups. Sectors with a higher rate of firm creation are located at the top, above the horizontal axis (patterns 1 and 3). They are positioned as the sectors where policies promoting entrepreneurship could be targeted.

In addition, SSS (pattern 1) is considered a sector that shows significant entrepreneurship but also larger innovation intensities. It is a promising sector, which appears to be a priority of industrial and innovation policies.

Traditional industries such as SDG and CLS (pattern 3) also show significant rates of firm creation. Here the question arises on their relatively small direct innovation intensities, which might suggest a potential contradiction between entrepreneurship and innovation policy. However, both industries show relatively large innovation multipliers (Table 2 and Figure 1), suggesting that the promotion of enterprises could attract a significant deal of embodied knowledge from the rest of the economy through inter-sectoral linkages, the CLS being more focused on capital goods.

Thus, policies promoting firm creation in SDG and CLS could also promote knowledge creation, though not directly but indirectly. Note that both sectors are mainly formed by traditional manufacturing activities (SDG) and demand-led services, such as hotel and catering, or community and social services (CLS). Both sectors show lower technological levels but the industrial policies targeted to them would not necessarily be contradictory to the spread of knowledge across the economy.

Sectors with lower rates of firm creation are located in the bottom part of figure 1. On the right-hand side, pattern 2 industries (SII, SGS, SBI) lead to significant innovation efforts, both from internal and external sources, but they don’t seem to drive much entrepreneurship (low rates of firm creation and significant firm sizes), possibly due to barriers to firm entry. They are still eligible for innovation policy for strategic reasons and for supplying knowledge to the rest of the economy. Finally, pattern 4 in the bottom left side include industries (OSI, NMS, SDS) based on the provision of services where firm creation and innovation efforts (both internal and external) do not appear as determinant, perhaps with the exception of OSI, with a medium-high multiplier.

4.5. Conclusions

The main objective of this study was to investigate the relationship between the drive for innovation of the productive sectors and its capacity to create new firms. More specifically, we contemplated the connection between the pattern of innovation creation / acquisition of each industry with the creation of new companies in these sectors. To shed light on such question a series of indicators was used, including a measurement of the innovation effort that incorporates an "embodied knowledge" approach.

The results suggest that such a relationship exists. However, it depends upon the sectoral pattern of innovation creation/acquisition and the market structure in which industries work. We identified the following patterns illustrating the linkage between industrial innovation behaviour and the rate of entrepreneurship:

a) Highly innovative / new firm creating industries, where company size is low and the main source of knowledge is mainly of an internal nature (multiplier less than 2). This implies that innovation does not seem to rest on external suppliers of embodied knowledge. This pattern includes the specialized supplier services (SSS).
b) Highly innovative industries with little dynamism in creating new companies. The business dimension increases, suggesting a less competitive market structure and sources of

knowledge are not only internal but also external to the industry. This pattern includes manufacturing sectors with a higher technological level (scale intensive industries, science based industries and specialized goods suppliers).

c) Low tech industries with significant levels of new firm creation. The firm size is relatively small and the sources of knowledge are primarily external (large innovation multipliers). This pattern includes traditional manufacturing, supplier dominated goods (SDG) and client-led services (CLS).
d) Relatively low innovation industries with a low rate of new firm creation. Firm sizes in this group are more heterogeneous, but all share a low direct innovation effort. Three groups of services sectors are included here: organizational innovation services (OSI), non market services (NMS) and supplier dominated services (SDS).

These findings have some important policy implications. First, the industrial patterns identified would allow the policy maker to build a balanced scorecard, which harmonizes the objectives of promoting entrepreneurship with the objective of promoting innovation at sectoral level. This scorecard could be helpful to adjust lines of action depending on the type of industry and policy objectives for each area (innovation and entrepreneurship).

Secondly, it would not be advisable to apply general policies without taking into account the specificities of each sector. Thus tailored policy packages (policy mixes) can be designed for each sectoral pattern identified. Those policy mixes would take into account the specificities of each industrial innovation/entrepreneurship pattern (total innovation intensities, innovation multiplier effects through inter-sectoral linkages, market structure and creation of new firms).

This research is not without limitations:

i) Firstly, it considers gross new firm creation rates (without considering the company exits). Secondly, the use of the current statistics about new firms limits the study to manufacturing and services sectors and does not include data on primary activities.
ii) Thirdly, with regard to the intensities of innovation, the technological innovation survey only investigates companies with over 10 employees, so the results for some branches may not be fully representative.
iii) Fourth, we mention the limitations inherent in the use of an input output framework and the exclusion of other sources of knowledge not considered in the methodology.
iv) Fifth, conclusions would require a deepening of the research by taking into account other ways of measuring the variables considered, such as entrepreneurship indicators and other measurements regarding the type of innovations.
v) Finally, the policies to enhance both the creation of new firms and the innovation activities remain to be developed, though some criteria to targeting policies have been established in the paper.

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4.6. Appendix

4.6.1. Innovation taxonomy

Table 3 Innovation Taxonomy (Robinsohn et al. 2003)

Group	Characterization	Industries (ISIC REV 3)
Supplier dominated goods (SDG)*	Mainly traditional sectors of manufacturing. Generally firms in this classification are small and in-house R&D and engineering capabilities are thought to be weak.	Textiles (17); clothing (18); leather and footwear (19); wood & products of wood and cork (20); pulp, paper & paper products (21); printing & publishing (22); furniture, miscellaneous manufacturing; recycling (36-37); construction (45).
Scale intensive industry (SII)	The source of technology is mainly from (in-house) R&D, producing goods that are price sensitive, and with innovation being largely process driven.	Mining and quarrying (10-14); food, drink & tobacco (15-16); mineral oil refining, coke & nuclear fuel (23); rubber & plastics (25); non-metallic mineral products (26); basic metals (27); fabricated metal products (28); motor vehicles (34); other transport equipment (35), electricity, gas and water supply (40-41).
Specialized Goods Suppliers (SGS)*	Production intensive firms characterised by division of labour and the simplification of production tasks, decreasing production costs. These industries tend to be oriented towards process innovations arising from in-house R&D.	Mechanical engineering (29); office, accounting and computing machinery (30); radio, television and communications equipment (32); medical, precision and optical instruments (33)
Science based innovator (SBI)*	Main sources of technology are the R&D that the firms themselves carry out, based on the development of the underlying sciences.	Chemicals (24), electrical machinery and apparatus. (31)
Supplier dominated services (SDS)	Service innovations are largely based on technological innovations as supplied by hardware manufacturers.	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52); water transport (61); communications (64).
Specialized services suppliers (SSS)*	The innovation process takes place within a client firm. Firms may provide knowledge services that support the innovation process. Industries are usuallt referred to as KIBS in other studies (knowledge intensive business services)	Computer and related activities (72); research & development (73); other business activities (74)
Organizational service innovators (OSI)	The primary source of innovation is mostly a combination of organisational and technical innovations.	Sale, maintenance and repair of motor vehicles and motorcycles (50); inland transport (60); air transport (62); financial intermediation, except insurance and pension funding (65); insurance and pension funding, except compulsory social security (66) real estate activities (70); renting of machinery & equipment (71).

Group	Characterization	Industries (ISIC REV 3)
Client-Led Services (CLS)*	Innovation is based on specific needs by customers. In some cases the demand is expressed by segments of mass markets. In other cases it may come from a single client requiring a customised service, as is often the case in business services.	Wholesale trade and commission trade, except of motor vehicles and motorcycles (51); hotels and catering (55); supporting and auxiliary transport activities; activities of travel agencies (63); activities auxiliary to financial intermediation (67); other community, social and personal services (90-93); private households with employed persons (95);
Non-Market Services (NMS)	Social services that provide non-market outputs	Public administration (75); education (80); health (85).

* The industries included in these groups have been slightly modified from the original taxonomy for reasons of data availability.

4.6.2. *Innovation measuring methodology*

The methodology is based on the open model of Leontief that allows the estimation of input-output multipliers matrix (Leontief, 1936, 1937). The multipliers measure the direct and indirect effects on the production system resulting from a change in a unit of final demand. The approach used in this paper is based on the methodology proposed by Haukness and Knell (2009). The Leontief model is based on the equilibrium equation for the production system:

$$x = Ax + y \tag{3}$$

Where ***X*** is the output vector, **A** is the regional matrix of technical coefficients and ***y*** is the final demand vector. Assuming there is the inverse matrix (**I-A**), the system is resolved by the following expression:

$$x = (I - A)^{-1} y \equiv By$$

4

Where **B** is the Leontief inverse matrix. The element b_{ij} of the **B** matrix indicates the direct and indirect effects on the production sector **i** when final demand of sector **j** is increased by one unit (*i, j = 1, …,N,* with *N* sectors).

Total innovation in sector **j** would include its own expenditure on innovation activities as well as the expenditure in the acquisition of innovation embodied in inputs from other sectors. Then, the direct innovation intensity for sector **i** at a regional level (r_i) is defined as the direct expenditure on innovative activities (R_i) per unit of output (X_i):

$$r_i = R_i / X_i$$

5

Multiplying the direct innovation intensities of sectors **i** by the elements (b_{ij}) of the matrix **B**, matrix **P** is obtained. Elements of matrix **P** (p_{ij}) indicate the domestic innovation incorporated in inputs per unit of final demand of the sector **j**:

$$P = \hat{r} B$$

6

Where (^r) is a diagonal matrix whose elements are the direct innovation intensities (r_i). In order to correct a problem of double accounting when measuring the intensity of innovation by unit of production Hauknes and Knell (2009) suggest to use a modified matrix **B** called **B*** which is obtained by dividing the elements of each column by the element of the main diagonal and later on by eliminating the elements of the diagonal (7).

$$P^d = \hat{r} B^* \tag{7}$$

The matrix (P^d) is then calculated where elements (p_j^d) measure innovation intensities induced domestically in sector **j** in terms of production,(8):

$$p_j{}^d = \sum_{i=1; i \neq j} (r_i \frac{b_{ij}}{b_{jj}}) \tag{8}$$

The estimation of direct and indirect innovation intensities is completed by adding the intensity of innovation embodied in: a) imported inputs, b) domestic capital goods and c) imported capital goods. Direct innovation intensities in each sector of origin were approached by the average values for EU 15 according to CIS (63% of Spain's imports come from the EU). Indirect innovation embodied in imported inputs is expressed by elements of the matrix $\mathbf{P^m}$ obtained by multiplying the diagonal ^r^m (foreign innovation intensities) by the matrix of imported inputs in terms of unit of output of sector j (**M**) (9):

$$P^m = \hat{r}^m M$$

9

The elements p_{ij} from matrix $\mathbf{P^m}$, show the innovation embodied in imported inputs by sector j from the all foreign sectors i. So total innovation embodied in imported inputs by sector j is (10):

$$p_j^{\ m} = \sum_{i=1}^{n} r_i^{\ m} m_{ij}$$

10

Where p_j^m is the innovation intensity of sector **j** due to the imported inputs, $\mathbf{r_i^m}$ is a vector of direct innovation intensities of foreign sector **i** (in our case, the average of intensities in sector **i** in EU 15), and $\mathbf{m_{ij}}$ is the vector of imported inputs from all foreign sectors **i** to the domestic sector **j**, measured in units of total output of the domestic sector **j**.

To incorporate capital goods, a matrix of investment was built to show sales of investment goods and services from sector **i** to sector j. Given that this information is not directly observable in the Spanish input output tables, we built this matrix $\mathbf{D^d}$ by based on the matrix of gross fixed capital formation and the vector of final demand in input-output table. This matrix shows the industrial structure of investment process by each sector.

To measure direct and indirect effects of the acquisition of these investment goods and services, we multiply matrix **B** by matrix $\mathbf{D^d}$. The resulting is matrix E, whose elements e_{ij}, tell us the direct and indirect effects on sector i derived from investments of sector j. To express elements in terms of unit of output of sector **j**, elements of the matrix are divided by X_j. Embodied innovation intensities are obtained by multiplying the matrix **^r** by matrix **E**, thus obtaining the matrix $\mathbf{C^d}$, which shows the intensity of innovation embodied in domestic capital goods per unit of output of the sector **j** (11).

$$C^d = \hat{r}\,E \tag{11}$$

Elements $c^d{}_{ij}$ in matrix $\mathbf{C^d}$, show the intensity of innovation embodied in domestic capital goods from sector **i** to sector **j**. Thus, the intensity of innovation incorporated in domestic investment goods acquired by the sector **j** will be (12):

$$c^d{}_j = \sum_{i=1}^{N}\left(\sum_{k=1} b_{ik} D^d{}_{kj}\right) \tag{12}$$

Where k corresponds to the industries producing capital goods.

To incorporate procurement of foreign investment, a matrix of imported investment per unit of output of sector j ($\mathbf{D^m}$) was built. As in the case of imported inputs, the average of direct intensity of innovation for EU15 for each industry was taken (**^r**$^{\mathbf{m}}$)[9]. Innovation intensities incorporated in imported capital goods are then defined as (13):

[9] 73 % of imported capital goods come from Europe, and most of the rest from other OECD countries with technological level not very distant from that of Europe.

$$C^m = \hat{r}^m D^m$$

13

Elements $c^m{}_{ij}$ of matrix **C^m**, show the intensity of innovation embodied in imported capital goods from foreign sector i to domestic sector j. Thus, the total intensity of innovation incorporated in imported capital goods purchased by j sector shall be (14):

$$c_j{}^m = \sum_{i=1}^{N} r_i^m D_{ij}{}^m$$

14

The matrix of total flows of embodied innovation (matrix **IN**) is obtained by adding matrices $\mathbf{P^d}$**,** $\mathbf{P^m}$**,** $\mathbf{C^d}$**,** $\mathbf{C^m}$ (15). The elements of the matrix $\mathbf{IN_{ij}}$**,** express the total flow of innovation from the industry i to the industry j in terms of the output of sector j. Then, total intensities of innovation in the sector **j** (in_j^t) are based on the matrix $\mathbf{IN_{ij}}$**,** but expressed in per unit terms of output **j** (16):

$$in_j{}^t = r_j + p_j{}^d + p_j{}^m + c_j{}^d + c_j{}^m$$

15

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Anexo: Imagen de la primera página de la publicación

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New firm creation and innovation: industrial patterns and inter-sectoral linkages

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Abstract This article analyzes the linkages between entrepreneurship and innovation behaviour at an industrial level. The research question refers to the extent that the industrial pattern of generation/absorption of knowledge affects the industrial ability to create new firms. An embodied knowledge approach has been applied, by combining the input–output framework with innovation and new firm creation data. As a result, four industrial patterns of innovation/new firm creation have been identified, taking into account the firm size and the model of generation and absorption of knowledge.

Keywords New firm creation · Entrepreneurship · Innovation pattern · Embodied knowledge · Sectoral linkages · Input–output

Introduction

This article attempts to investigate the linkages between innovation (Baregheh et al. 2009) and the dynamics of creation of new firms in each industry. The relation between innovation behaviour and firm creation is far from obvious. This is due to the fact that innovation has many ways of affecting the economic system, sometimes encouraging economic growth but sometimes becoming a barrier to entry. Low direct innovation intensities can, in turn, be consistent with significant indirect innovation induced through inter-sectoral linkages with the rest of the economic

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Capítulo 5

Discusión general de los resultados y conclusiones

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La presente tesis doctoral se ha estructurado en torno a 3 capítulos relacionados al estudio de la actividad innovadora de los sectores económicos y su relación con los vínculos de conocimiento que se establecen entre ellos. En este objetivo general, también ha cobrado gran importancia el territorio en el cual se encuentran estos sectores, siendo la Comunidad Valenciana y España los casos analizados. Como se ha mencionado previamente, cada capítulo ha sido publicado (o lo será próximamente), en revistas científicas reconocidas.

En este capítulo remarcaremos las principales conclusiones extraídas de estos capítulos así como las posibles implicaciones de política y las líneas futuras de investigación.

En primer lugar, como conclusión general de las investigaciones realizadas, podemos afirmar que la metodología utilizada ha mostrado una gran versatilidad en el estudio económico de la innovación, tanto para el estudio sectorial (en sectores claves para una economía, como el agroalimentario) como para el análisis de factores críticos como la creación de nuevas empresas, o la generación y difusión tecnológica (particularmente, el rol de los KIBS en un sistema de innovación).

Los fundamentos de esta metodología descansan en el supuesto principal de que los productos y servicios que se intercambian entre sectores contienen en mayor o menor medida cierto "conocimiento incorporado" (*embodied knowledge*) que los sectores productores trasladan aguas abajo a sus sectores clientes. Por lo cual, los inputs y bienes de capital pasan a ser otra fuente adicional de conocimiento que debe tenerse en cuenta cuando se quiera estudiar el comportamiento innovador de las empresas.

En segundo lugar, presentamos las principales conclusiones particulares de cada artículo. El **capítulo 2**, se centra en la contribución que los KIBS realizan al sistema de generación, absorción y difusión de innovaciones. Los datos analizados para la economía española, permiten aproximar dichas contribuciones en:

i. un 29,7% de la innovación generada,
ii. un 8,1% de la absorción de innovación y
iii. un 25,4 % de la innovación difundida.

Estos resultados muestran la importancia del sector como generador y difusor de innovación en el sistema productivo. Dicha importancia se hace aún más evidente cuando el peso del sector en el valor añadido total es de solo un 8%. Encontramos así que **por cada punto porcentual que los KIBS contribuyen al valor añadido total, contribuyen en 2,2% al sistema de innovación** (en 3,7% a la generación y en 1% a la absorción). Al analizar la importancia de los KIBS, para otros sectores productivos, los resultados refuerzan también su importancia. Contemplando todas las fuentes de innovación incorporada (inputs y bienes de capital) encontramos que los KIBS, son la segunda principal fuente de innovación (la primera es la industria manufacturera) para la industria manufacturera, para el resto de servicios y hasta para los propios KIBS. Por lo cual, se visualiza la importancia de los KIBS no solo para los sectores más intensivos en conocimiento, **sino también para los que tienen un menor esfuerzo en innovación,** indicando así una alta interdependencia entre los sectores de mayor intensidad innovadora y los de baja.

En términos de implicaciones de política, encontramos que se justificaría la implementación de políticas de demanda como de oferta. Por el lado de la oferta, podría fortalecerse la mejora de calidad en la oferta de KIBS como generadores de innovación; por el lado de la demanda, podría impulsarse la difusión de innovación en el sistema económico, a través de incentivos a la contratación de estos servicios.

Respecto a las limitaciones de este artículo, podemos mencionar la necesidad de trabajar en la generalización de resultados. Dado que el análisis se ha realizado sobre el sistema de innovación español, las conclusiones aquí extraídas, pueden no aplicarse a otros sistemas con instituciones, culturas y estructuras productivas diferentes.

Las líneas de investigación futuras pasarán por la mejora de la medición de los vínculos entre sectores productores y usuarios de conocimiento, como así también del conocimiento incorporado en inputs y bienes de inversión importados.

El **capítulo 3** se ha focalizado en el análisis del comportamiento innovador del sector agroalimentario a nivel sub-nacional. Este sector ha sido considerado políticamente estratégico por desempeñar un papel clave en el suministro de alimentos, en la ocupación del territorio, en la conservación del medio ambiente y la biodiversidad. Los resultados de nuestra investigación han puesto de manifiesto su contribución a la generación de conocimiento a través de los vínculos intersectoriales establecidos con otros sectores de la economía regional. La aplicación a la Comunidad Valenciana de un marco input-output combinado con datos de esfuerzo tecnológico ha permitido diferenciar entre intensidad innovadora directa e intensidad que se induce dentro y fuera del territorio valenciano.

Los resultados sitúan al sector primario y a la industria de alimentos y bebidas como **inductores de conocimiento** a través de los consumos intermedios que adquieren a otros sectores de la economía. Ahora bien, mientras ambos sectores absorben en torno al 50% tecnología originada fuera del territorio, el sector transformador destaca por tener unas intensidades tecnológicas superiores tanto a las estimadas para el sector primario como también a la **mayoría de los sectores tradicionales de la industria valenciana**. Además su capacidad de arrastre en términos de innovación en el territorio, también se destaca sobre el resto de sectores.

Aceptando que estos resultados ofrecen una aproximación a la innovación en el complejo agroalimentario, pueden resultar útiles a la hora de plantear líneas de política pública. En este sentido es fundamental que haya convergencia entre las medidas para el fomento de la innovación y los instrumentos de política agraria en línea con la estrategia Europa 2020 para un crecimiento sostenible.

Las limitaciones de este trabajo son propias de la representatividad del marco input-output como también de las encuestas sobre innovación. En el caso particular del sector primario agrario, con presencia mayoritaria de micro-pymes, los resultados obtenidos posiblemente sobreestimen las intensidades directas de innovación dado el sesgo de la Encuesta de innovación hacia medianas y grandes empresas. Si esto fuera así quedaría reforzada la conclusión de que el conocimiento tecnológico al sector primario se canaliza por la vía de la inducción de conocimiento en otros sectores dentro y fuera de la economía regional.

Finalmente, el **capitulo 4** se ha centrado en el estudio de la relación entre creación de nuevas empresas y comportamiento innovador a nivel sectorial. El principal objetivo ha sido responder a la pregunta de si el patrón de creación/adquisición de innovación de cada sector económico guarda alguna relación con la creación de nuevas empresas en esos sectores. Los sectores económicos se han clasificado siguiendo la taxonomía de innovación propuesta por Robinsohn et al. (2003), que distingue 8 grupos de industrias (tanto en manufacturas como en servicios). Además, para estudiar el dinamismo en creación de empresas de estos grupos de sectores, se han utilizado las tasas brutas promedio de creación de nuevas empresas en el periodo 1999-2009.

El análisis de los resultados aquí obtenidos permite establecer que:

- Sí, se sugiere una relación entre la intensidad de innovación y la creación de empresas de cada sector. Sin embargo, esta relación depende del patrón sectorial y de la estructura de mercado en que se desempeñan dichos sectores.
- Se han encontrado 4 patrones de funcionamiento en la relación innovación/creación de empresas

Estos patrones de funcionamiento son:

i. Sectores altamente innovadores y creadores de empresas (servicios más intensivos en conocimiento), donde la dimensión empresarial es reducida y la principal fuente de conocimiento es interna (multiplicador menor a 2). Esto implica que no dependen (relativamente) de proveedores externos de conocimiento (ya sea en inputs o bienes de inversión). Esta característica hace que no haya barreras a la entrada de dimensión ni de proveedores externos.
ii. Sectores altamente innovadores con poco dinamismo en creación de empresas (manufacturas basadas en ciencia, manufacturas intensivas en escala, y proveedores manufactureros especializados), donde la dimensión empresarial es importante, y las fuentes de conocimiento no solo son internas (que son importantes) sino también externas (incorporadas en inversiones y en inputs). Las dos variables son factores que limitan la entrada de nuevas empresas a estos sectores.
iii. Sectores con una reducida intensidad de innovación total pero con dinamización en la creación de empresas (manufacturas tradicionales dominadas por proveedores y servicios dirigidos al cliente –*Client led services*-). En estos sectores, la dimensión vuelve a ser reducida, y las fuentes de

conocimiento son principalmente externas (son los dos sectores con multiplicadores tecnológicos más altos). Sin embargo su patrón difiere, dado que los manufactureros dependen más de los proveedores de inputs, pero los servicios dependen no solo de estos inputs sino también (y en mayor medida) de los proveedores de bienes de capital.

iv. Sectores con baja creación de empresas y baja intensidad de innovación. En este grupo aparecen tres categorías de servicios: los de no mercado, los dominados por proveedores, y (en el caso español), los innovadores en organización. El tamaño empresarial en esta categoría es heterogéneo, pero todos comparten un bajo esfuerzo directo en innovación.

Estos resultados conllevan diversas implicaciones. En primer lugar, desde la política pública, los patrones encontrados permitirían al *policy maker* disponer de un cuadro de mando donde compatibilizar/armonizar los objetivos de promoción de creación de nuevas empresas con los objetivo de promoción de la innovación a nivel sectorial. En este cuadro de mando se podrían ajustar las líneas de actuación en función del tipo de sector y de los objetivos de política en cada área (innovación y creación de empresas).

En segundo lugar, no sería recomendable la aplicación de políticas generales sin tener en cuenta las especificidades de cada sector. Así la adecuación de las líneas de actuación conllevaría el diseño e implementación de paquetes integrados de políticas “a medida” de cada uno de los patrones sectoriales identificados. Esto implicaría el diseño de *paquetes de políticas*, teniendo en cuenta las especificidades de cada patrón innovación –creación de nuevas empresas (efectos multiplicadores de cada sector en relación al sistema productivo, su intensidad innovadora, la dimensión media y la tasa de creación de empresas).

En cualquier caso, este tipo de conclusiones requerirá una profundización de la investigación realizada, tomando en cuenta otras formas de medición de las variables consideradas (como otros indicadores de *entrepreneurship* y no solo la tasa bruta de creación de empresas), y otras medidas respecto a las tipologías de innovación (producto, procesos, etc.). Finalmente, entre las limitaciones de este trabajo, se pueden mencionar:

i. Se analiza solamente de creación bruta de empresas y no las tasas netas.
ii. La utilización del Directorio Central de Empresas –DIRCE- conlleva entre otras limitaciones, que solo analiza actividades manufacturas y servicios, sin presentar datos sobre actividades primarias.
iii. En lo que respecta a las intensidades de innovación, la Encuesta de innovación tecnológica, solo indaga en empresas con más de 10 empleados, por lo que los resultados en algunos subsectores pueden no ser totalmente representativos.

Respecto a las **líneas futuras de investigación,** éstas tendrán por objetivos:

i. Resolver algunas limitaciones metodológicas generales, como son:
   - Actualizar las tablas input output regionales utilizadas.
   - Mejorar la estimación del conocimiento incorporado en inputs y bienes de inversión importados, distinguiendo el país de origen de estos.
   - Mejorar la estimación de la utilización de bienes de capital (incluir no solo la compra, sino la utilización de los mismos).
   - La utilización del DIRCE.

ii. Ampliar la investigación hacia los siguientes ámbitos:

- Realizar comparaciones regionales por Comunidades Autónomas en España.
- Realizar estudios internacionales en sectores que no han sido debidamente estudiados (como el sector agroalimentario).

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Anexo

Presentaciones en congresos internacionales

Anexo

Presentaciones en congresos internacionales

García Álvarez-Coque, J.M.; Alba, M.; López-García Usach, T. (2011). Innovación directa e inducida en el complejo agroalimentario valenciano. VIII Congreso de Economía Agraria. Madrid, 14 al 16 de septiembre de 2011.

Resumen: Este trabajo tiene por objetivo analizar la intensidad de innovación del complejo agroalimentario de la Comunidad Valenciana en relación a la media española. Para tal fin se ha realizado una aproximación que combina el marco input-output con datos de la Encuesta de Innovación Tecnológica en Empresas. El artículo analiza tanto la intensidad de innovación directa como los flujos de innovación incorporada en los insumos que adquiere el sector, procedentes de la propia región o de fuera de ella. Entre los resultados se destaca que: a) el sector en la Comunidad Valenciana posee una menor intensidad que la media española, b) dicha diferencia se asocia a la baja capacidad de absorción de la propia región, c) la industria de alimentos y bebidas presenta un esfuerzo tecnológico superior a otros sectores, y d) el sector agrícola valenciano posee un reducido impacto como inductor de conocimiento originado en el propio territorio.

Alba M, López-García Usach, T.; García Álvarez-Coque, J.M.; Mas-Verdú, F. (2010). Conocimiento incorporado y vínculos sectoriales. El caso de una región con baja capacidad de absorción. *International meeting on regional science. The future of cohesion policy.* XVI reunión de estudios regionales. AECR. Badajoz, del 17 al 19 de noviembre de 2010.

Resumen: El presente trabajo tiene por objetivo realizar una estimación de los flujos intersectoriales de conocimiento incorporado en una región (la Comunidad Valenciana) mediante una aproximación input-output. Toda actividad productiva genera un esfuerzo en innovación que puede ser aproximado de manera directa a través de su propia intensidad de innovación. Pero, además de ésta, la capacidad de absorción de cada sector determinará la intensidad de innovación indirecta que aparece incorporada en los productos y servicios que adquiere de otros sectores del mismo o de otros territorios. Así, determinadas empresas de un sector pueden no manifestar un comportamiento innovador por sí mismas, pero podrían absorber conocimiento externo a través de la adquisición de productos y servicios más intensivos tecnológicamente.

El paper analiza la innovación directa que se produce en los sectores de la economía de la Comunidad Valenciana así como los flujos de innovación incorporada debidos a las adquisiciones de insumos procedentes de la propia región y del resto de España. Utilizando datos de Encuesta sobre Innovación Tecnológica en las empresas, el análisis emplea una metodología basada en el marco input-output.

García Álvarez-Coque, J.M.; Alba, M.; López-García Usach, T. (2010). Innovación y vínculos sectoriales en el complejo agroalimentario de la Comunidad Valenciana. VIII Coloquio ibérico de estudios rurales (CIER). Cáceres, 21 y 22 de octubre de 2010.

Resumen: Este trabajo tiene por objetivo estimar la intensidad de innovación del complejo agroalimentario de la Comunidad Valenciana. Para tal fin se ha realizado una aproximación que combina el marco input-output con los datos que se presentan en la Encuesta de Innovación Tecnológica en Empresas. El paper analiza tanto la intensidad de innovación directa que se produce en los subsectores del complejo agroalimentario de la Comunidad Valenciana como los flujos de innovación incorporada debidos a las adquisiciones de insumos procedentes de la propia región y del resto de España. En síntesis, este trabajo propone un método para estimar la innovación directa y la innovación inducida que se produce en un sector, el agroalimentario y lo aplica al caso de una región, la Comunidad Valenciana.

García Álvarez-Coque, J.M.; Alba, M.; López-García Usach, T. (2010). ***Innovation and sectoral linkages in the agrifood system in the Autonomous Community of Valencia. FOOD INNOVA 2010, International conference on food innovation.*** **Valencia, 25-29 de octubre de 2010.**

Abstract: This paper aims to estimate the intensity of innovation in the agri-food system in the Autonomous Community of Valencia. All economic activities strive to generate innovation, and this can be approximated through observing their own innovative intensity level.

In addition, the absorption capacity of each sector will determine the intensity of indirect innovation that appears incorporated in products and services purchased from other sectors in the same or different regions. Thus, some firms in a sector may not produce innovations by themselves, but could absorb external knowledge through the acquisition of goods and services intensive in research and development. Using data from Survey on Technological Innovation in Enterprises, this analysis uses a methodology based on an input-output framework to estimate the intensity of innovation. Along these lines, this paper attempts to analyze the intensity of direct innovation that takes place in each one of the subsectors of the agri-food segments of the Valencian region as well as the flows of indirect innovation fostered by the acquisitions of consumable products coming from other regions in Spain. To summarize, this paper proposes a methodology for estimating the direct innovation and the induced innovation that take place in a sector and applies it to the case of a region, the Autonomous Community of Valencia