INTERNATIONAL WORKSHOP
BBVA Foundation – Ivie

KNOWLEDGE, INNOVATION AND REGIONAL DEVELOPMENT: NEW EVIDENCE

18 October 2019 - Faculty of Economics

Fundación BBVA

Ivie

In collaboration with:

VNIVERSITAT DE VALÈNCIA

Facultat d'Economia

Liza Jabbour

Dr. Liza Jabbour Senior Lecturer in Business Economics at the Department of Managemnet, Birmingham Business School, University of Birmingham (Birmingham, UK). She holds a PhD from the University of Paris I Pantheon-Sorbonne and her research interests are Empirical international trade, Outsourcing and offshoring, Firm level productivity, Link between international trade and firm performance, Innovation, Diplomacy and trade andMigration and entrepreneurship. She has published in prestigious journals such as the Journal of International Economics, Oxford Bulletin of Economics and Statistics, Canadian Journal of Economics, Review of International Economics, International Business Review or Wordl Economy, among others.

Global Knowledge Chains and the International Patenting Activity of Firms

Robert J.R. Elliott, Liza Jabbour, Enrico Vanino

Knowledge, Innovation and Regional Development
University Valencia, 18th October 2019

Introduction

Innovation and technological development play a key role in enhancing **firms' competitiveness**

Innovation strategies have evolved towards more **open and networked structures**

Globalization has fostered the **internationalization of innovative activities** and the creation of **Global Knowledge Chains (GKCs)**

Open innovation also reflects the growing complexity of innovation and the need to re-combine advanced knowledge from **specialized collaborators**

Open innovation is thought to stimulate collaboration with overseas subsidiaries, clients, suppliers and public research institutions

Introduction

An important consideration is how firms can **protect and exploit** the results from **open innovation activities**

Patent registration allows for the protection and exploitation of new innovation and is considerd a good proxy for the development of new products and processes (Hall et al., 2005; Yang and Kuo, 2008)

Another important consideration is **where to register a new patent**

The choice of patent office is thought to be linked to **the main markets of interest** of the firm and the **quality of the innovation**

Our Contribution

We analyse the impact of GKCs, more specifically the relationship between **R&D offshoring and international patenting** at the firm level using data for France

We distinguish between three modes of offshoring; **captive** (to overseas affiliates), **contract** (to foreign independent firms) and **third sector** (to foreign public research organizations or universities)

We link these modes of offshoring to patenting activities at the **domestic** level (French Patent Office), **regional** level (European Patents Office) and **international** level (US Patents Office)

In France, 36% of patents are registered domestically and 64% are divided between European and extra-European Patents offices. 22% of French innovating firms jointly register patents at the domestic, regional and international levels (PATSTAT database)

International Patenting

An application for a patent at a **foreign** patent office is more expensive than the domestic equivalent

An underlying assumption is that firms consider inventions registered in foreign offices to be more **important** and to have a **greater global significance**
(Licht and Zoz, 2000; De Rassenfosse and Van Pottelsberghe de la Potterie, 2013; Alkemade et al., 2015)

The decision to patent domestically, regionally or internationally is therefore the result of different economic processes
(Paci et al., 1997)

Domestic patenting provides a **broad** measure of innovative expertise while international patenting provides a measure of the **perceived quality** of an innovative output
(Paci et al., 1997; Eaton and Kortum, 1999; Hafner, 2008)

International Patenting

International patenting provides protection to innovations destined for foreign markets (exporting or FDI)
(Eaton and Kortum, 1999; Yang and Kuo, 2008; Hu and Png, 2013)

Stronger protection for IPRs can also motivate firms to patent internationally particularly at the EPO and USPTO
(Kortum and Lerner, 1998; Hall and Ziedonis, 2001; Yang and Kuo, 2008)

Growing competition can trigger strategic patenting to ensure the protection of future innovations and ward off potential competing patents
(Hu and Png, 2013)

R&D Offshoring and International Patenting

A resource-based view of the firm highlights the importance of **resource heterogeneity**

R&D offshoring allows firms to access and recombine heterogeneous resources to create new and more complex knowledge (Nooteboom et al., 2007)

Heterogeneous resources increase a firm's in-house capabilities and are important for firms that seek to protect their knowledge globally (Alkemade et al., 2015)

New forms of innovation, as captured by patents, tend to involve heterogeneous knowledge that is new to the firm (Kogut and Zander, 1992; Briggs and Buehler, 2018)

R&D Offshoring and International Patenting

R&D offshoring:

- Increases the diversity and heterogeneity of sources of knowledge (Narula and Zanfei, 2006; Paju, 2007)
- Allows firms to access a pool of high skilled and analytical talent that may not be available domestically (Manning et al., 2008; Lewin et al., 2009)
- But may increase costs associated with the geographical and organizational dispersion of R&D (Kogut and Zander, 1992; Lauren et al., 2001; Estrada et al., 2016; Filiou and Massini, 2018)

We expect R&D offshoring to have a **positive effect** on domestic, regional and international patenting

Modes of R&D Offshoring and International Patenting

The choice of mode of R&D offshoring is closely related to the patenting strategy

Trade off between:

- Domestic or regional strategy that keeps R&D activities close to the core business
- International strategy associated with non-core innovations that are dependent on heterogeneous sources of knowledge

Contract R&D Offshoring

Allows firms to access resources and strategic assets that are not available internally (Grant, 1993; Weigelt, 2009)

Compatibility with internal capabilities can improve firms' innovative performance (Cassiman and Veugelers, 2006)

May also be used for cost reduction purposes, therefore unlikely to provide firms with heterogeneous sources of knowledge (Sachwald, 2014)

The impact on the international patenting activity **depends on the nature and motivation** for R&D offshoring

Captive R&D Offshoring

Traditionally associated with support for the production process of foreign affiliates and the adaptation of products to local markets (Wortmann 1990; Blomkvist et al., 2010)

Over time this relationship may evolve into competence creation whereby foreign subsidiaries contribute to extending the knowledge and innovative capabilities of the firm (Pearce 1999, Blomkvist et al., 2010)

Captive R&D offshoring may correspond to two different innovative mandates:

- World product mandate
- Regional product mandate

We expect captive offshoring to have a **positive effect on the regional and international patenting activity of the firm**

Third Sector R&D Offshoring

Interaction between science and industry is a critical channel of technology diffusion (Etzkowitz and Leydesdorff, 19998, 2000)

Public research institutions and universities tend to engage in research activity close to the technological frontier. Third sector R&D offshoring enhances the access to new knowledge and latest technological developments (Belderbos et al., 2004)

Third Sector offshoring may help firms overcome limitations with their internal research capabilities (Laursen et al., 2011) and difficulties in attracting human capital from abroad (Beise and Stahl, 1999)

However, the objectives of public research institutions may diverge from those of private firms in terms of appropriability, knowledge dissemination and time horizons for any project (Robin and Schubert, 2013)

Data

R&D Inquiry Survey of French Firms:

- Firms actively engaged in R&D activities
- Period: 1999-2011
- Expenditures on internal and external R&D
  - Domestic and/or foreign sources
  - Affiliated firms, independent firms and universities and public research organizations
- A range of firm level controls: total employments, sales, R&D related employees, wages paid to R&D employees, affiliation to a domestic or foreign group, public funding of R&D

Data Sources

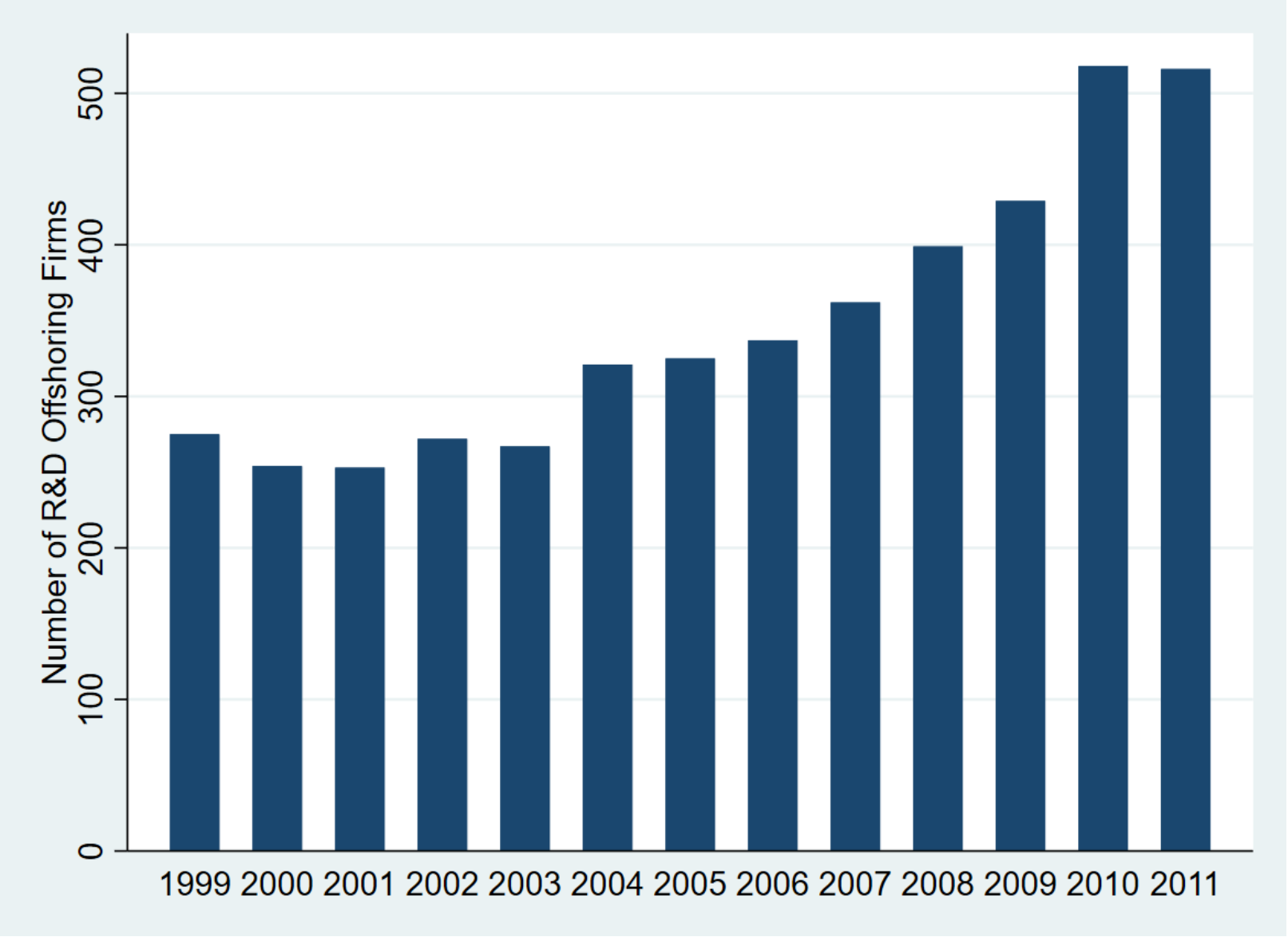
PATSTAT:

- We merge patent data with the R&D Inquiry using the PATSTAT-ORBIS dataset
- Patents granted by FPO, EPO and USPTO
- Time period: 1975 to 2017
- We are unable to detect any overlap between patents registered in multiple patent offices

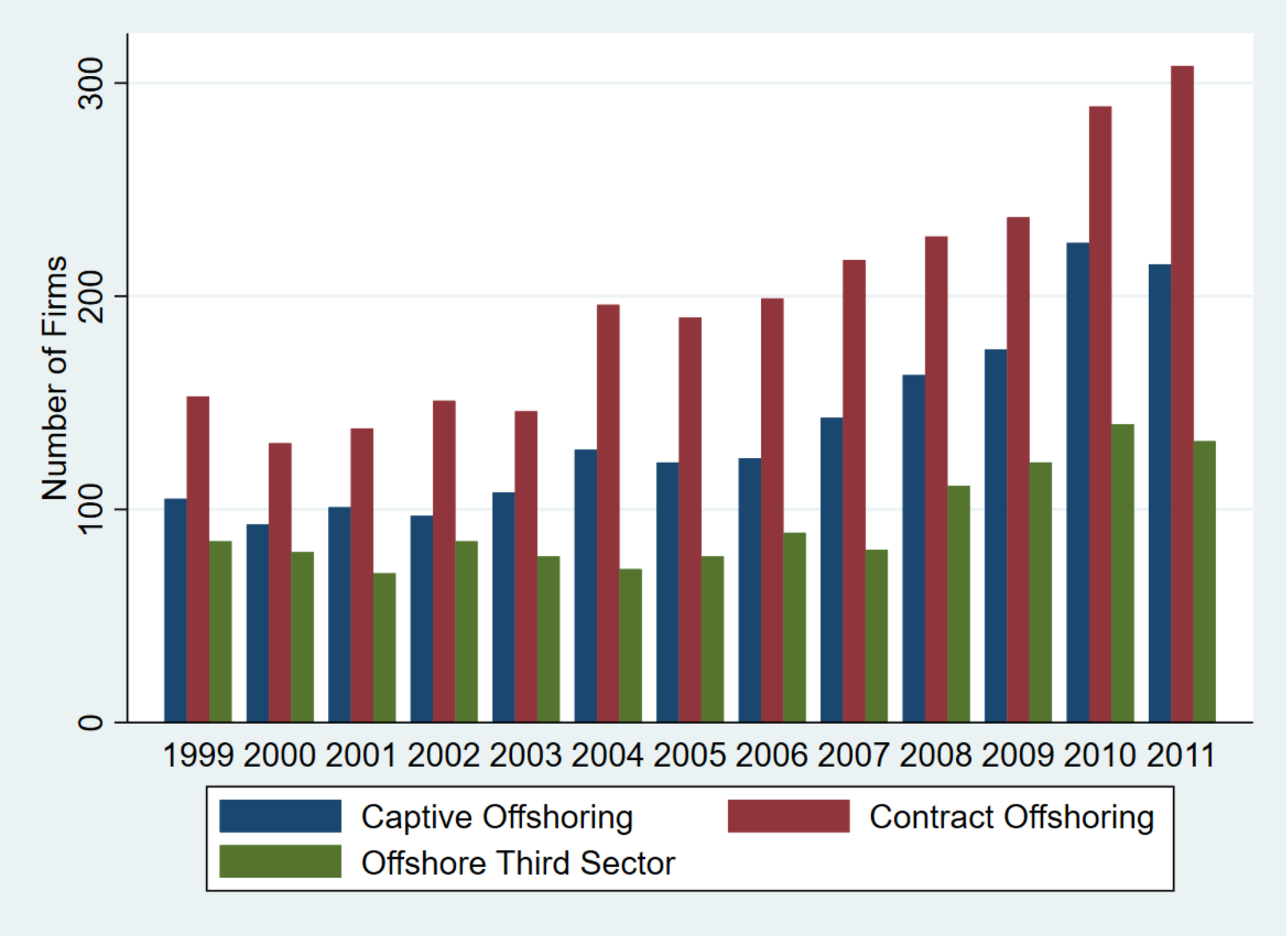
French Customs Agency:

- Data on firm level import and exports transactions

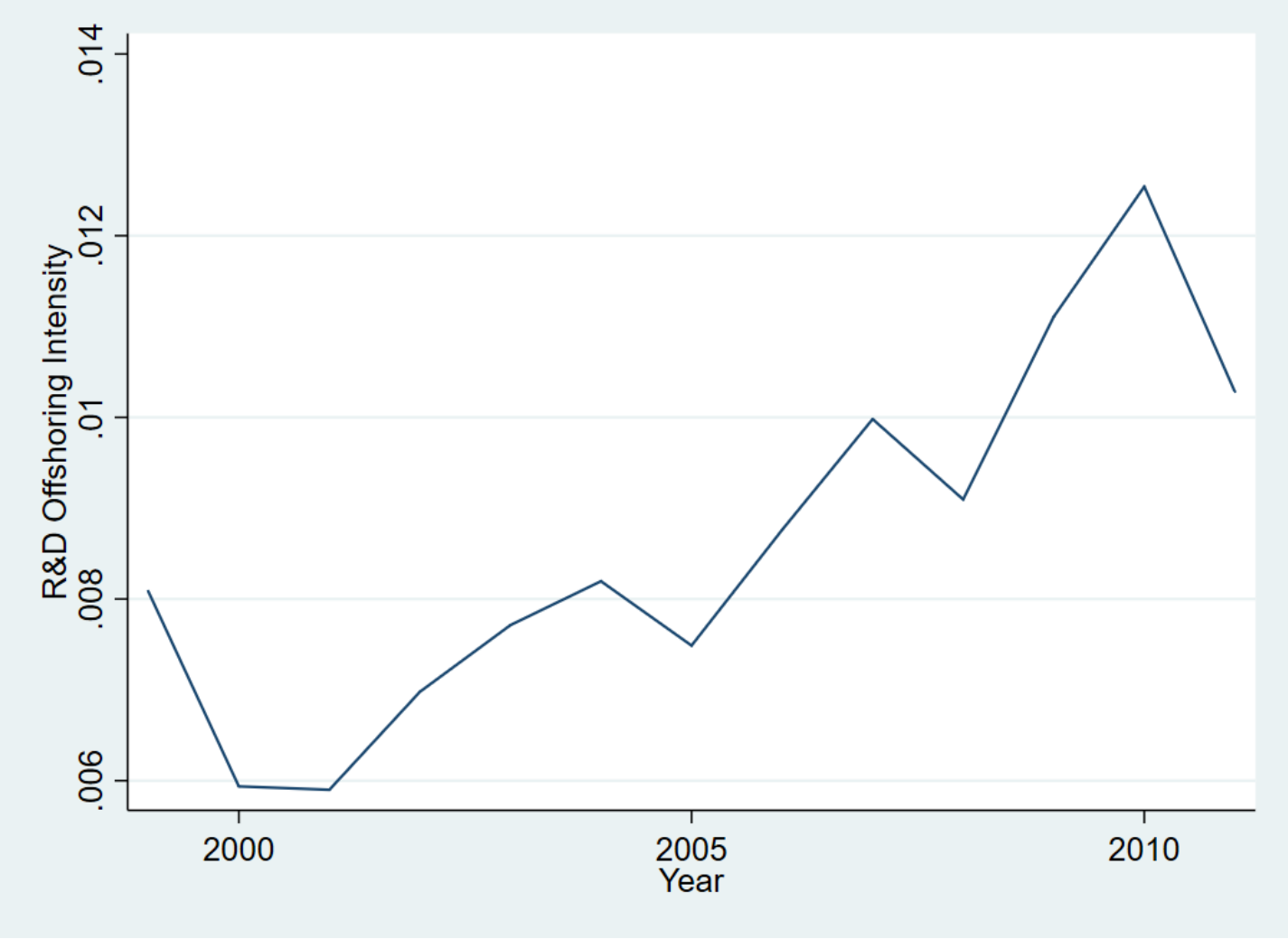
The trend in R&D offshoring



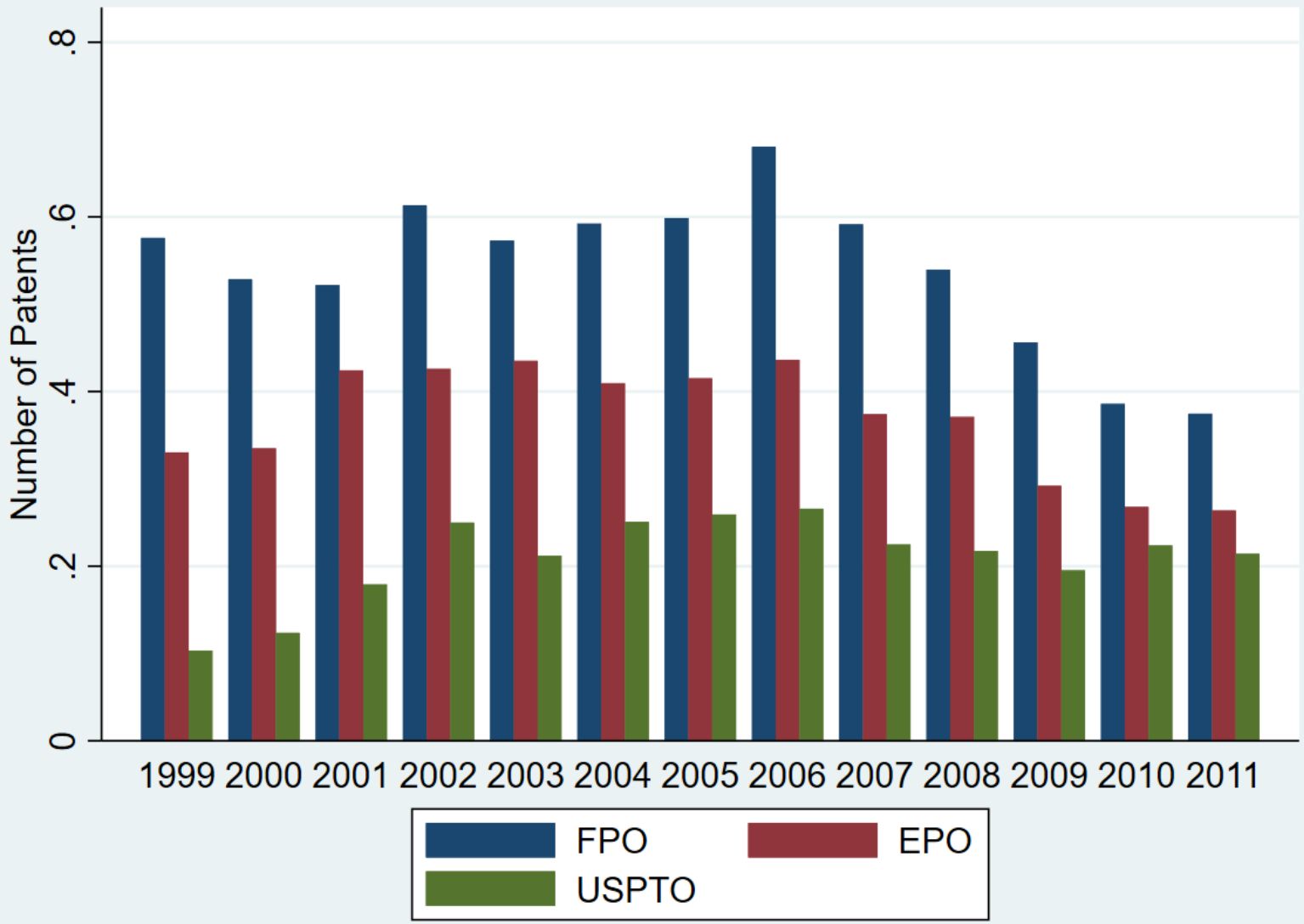
R&D offshoring by mode



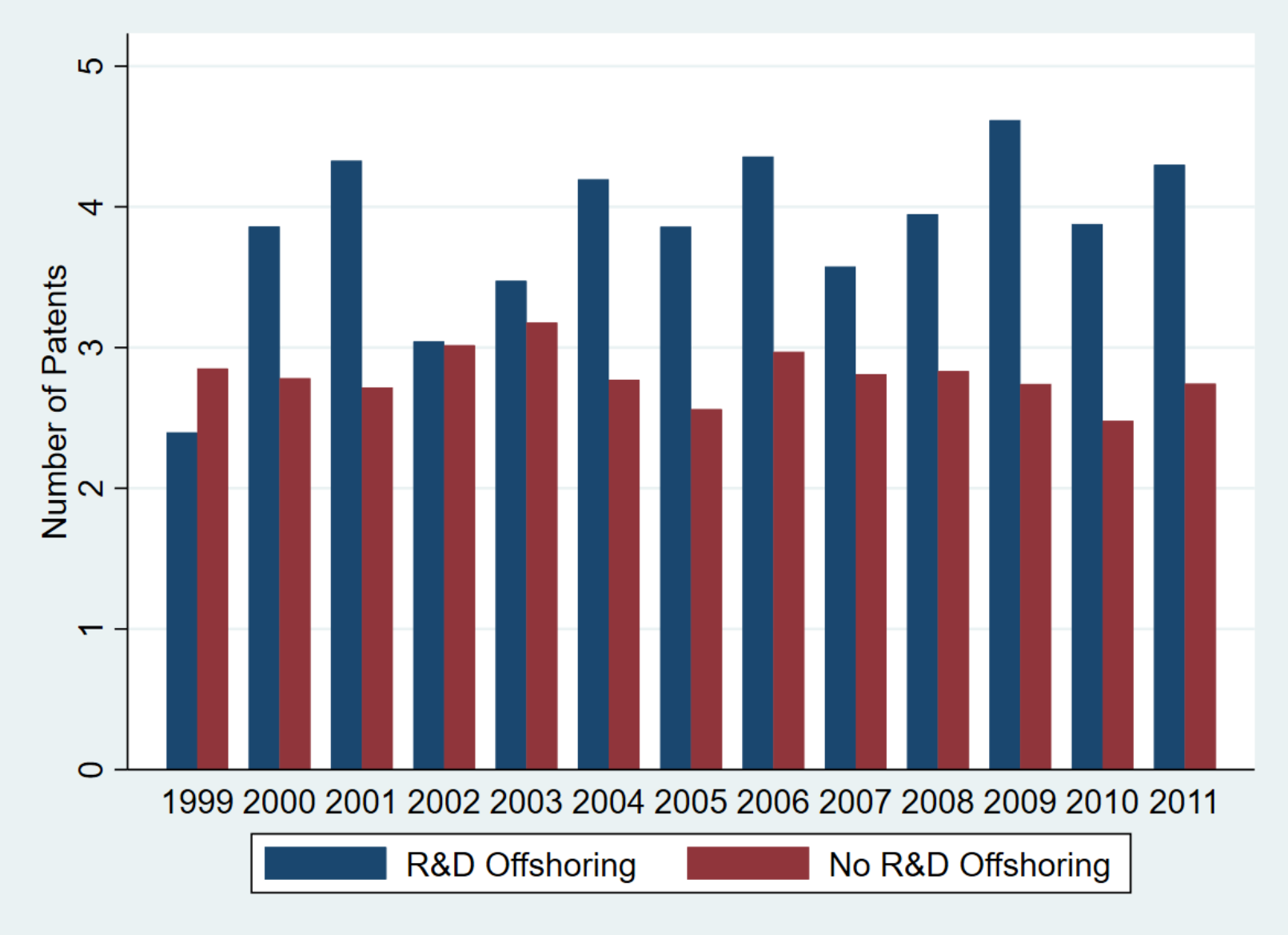
Growing trend but low intensity



Trend in patenting



Patenting and R&D offshoring: EPO



Sources of Bias

Selection issue:

- Not all firms engage in R&D offshoring
- Decision to engage in R&D offshoring depends on firm's observable and unobservable characteristics (Jabbour and Zuniga 2016)
- R&D offshoring may be endogenous to innovation performance

Simultaneous System of Equations allows the modeling of R&D offshoring and Innovation while taking into account the endogeneous nature of these decisions (Veugelers, 1997; Belderbos et al, 2004; Becker and Dietz, 2004)

R&D Offshoring and Patenting

$$Log(Total\ \ Patents_{iOt+1}) = \alpha_0 + \alpha_1 X_{it-1} + \alpha_2 R\&D\ \ Offshoring_{it-1} + k_i + k_t + \epsilon_{i1}$$

$$R\&D\ \ Offshoring_{Dit-1} = \beta_0 + \beta_1 Z_{it-1} + k_j + k_t + k_r + \epsilon_{i2}$$

- We consider a 2 year lag between R&D offshoring intensity and patenting to allow time for the R&D activity to result in the granting of a patent (Un et al., 2010; Bertrand and Mol, 2013)
- X is a vector of firm level controls that include: size, average salary of research staff, total internal R&D, labour productivity, affiliation to foreign or French groups, destination specific market share, and a dummy for the domestic outsourcing of R&D
- Offshoring equation includes variables in vector X, dummy for public R&D funding, dummy for patent protection and a full set time, region and industry (2-digit) fixed effects

Mode of R&D Offshoring and Patenting

$$
\begin{aligned}
Log(Total\ \ Patents_{iOt+1}) =& \alpha_0 + \alpha_1 X_{it-1} + \alpha_2 Captive\ \ Offshoring_{it-1} + \\
& \alpha_3 Contract\ \ Offshoring_{it-1} + \alpha_4 Offshore\ \ Third \\
& Sector_{it-1} + k_i + k_t + \epsilon_{i1} \\
Captive\ \ Offshoring_{Dit-1} =& \beta_0 + \beta_1 Z_{it-1} + \beta_2 Contract\ \ Offshoring_{Dit-1} + \beta_3 Offshore \\
& Third\ \ Sector_{Dit-1} + k_j + k_t + k_r + \epsilon_{i2} \\
Contract\ \ Offshoring_{Dit-1} =& \delta_0 + \delta_1 Z_{it-1} + \delta_2 Captive\ \ Offshoring_{Dit-1} + \delta_3 Offshore \\
& Third\ \ Sector_{Dit-1} + k_j + k_t + k_r + \epsilon_{i3} \\
Offshore\ \ Third\ \ Sector_{Dit-1} =& \gamma_0 + \gamma_1 Z_{it-1} + \gamma_2 Captive\ \ Offshoring_{Dit-1} + \gamma_3 Contract \\
& Offshoring_{Dit-1} + k_j + k_t + k_r + \epsilon_{i4}
\end{aligned}
$$

Descriptive Statistics

- 11% of firms are involved in R&D offshoring
  - 57% in contract offshoring, 40% in captive offshoring and 27% in third sector offshoring
- Firms register, on average, 0.52 patents with the FPO, 0.35 patents with the EPO and 0.21 patents with the USPTO
- Firms engaged in R&D offshoring register, on average, 2.5 times more domestic patents but 4 times more US patents
- Firms in our sample are relatively large (248 employees)

R&D Offshoring and International Patenting

	(1)	(2)	(3)
	FPO	EPO	USPTO
R&D Offshoring	2.368***	1.544	1.523*
	(0.895)	(0.943)	(0.785)
Internal R&D	0.14***	0.082**	0.04
	(0.047)	(0.038)	(0.04)
Domestic R&D Sourcing	0.04***	0.009	0.008
	(0.01)	(0.008)	(0.007)
Size	0.074***	0.033***	0.021**
	(0.013)	(0.011)	(0.009)
Average R&D Wage	0.008	-0.001	0.007
	(0.013)	(0.01)	(0.009)
Labor Productivity	0.038**	0.029**	0.033***
	(0.015)	(0.013)	(0.011)
Domestic Sales Share	-0.038		
	(0.044)		
EPO Sales Share		0.106**	
		(0.046)	
US Sales Share			-0.06
			(0.11)
Observations	22190	22190	22190

R&D Offshoring and International Patenting

	(1)	(2)	(3)
	FPO	EPO	USPTO
Captive Offshoring	2.17	3.87**	2.88**
	(1.52)	(1.73)	(1.27)
Contract Offshoring	3.23***	0.17	2.48**
	(1.23)	(1.23)	(1.22)
Third Sector Offshoring	0.63	1.6	-1.78
	(1.54)	(1.7)	(1.701)
Internal R&D	0.14***	0.08**	0.04
	(0.04)	(0.04)	(0.04)
Domestic R&D Sourcing	0.04***	0.009	0.007
	(0.01)	(0.008)	(0.007)
Size	0.07***	0.03***	0.02**
	(0.01)	(0.01)	(0.009)
Average R&D Wage	0.008	-0.001	0.007
	(0.01)	(0.01)	(0.008)
Labor Productivity	0.04**	0.03**	0.033***
	(0.01)	(0.01)	(0.01)
Domestic Sales Share	-0.04		
	(0.04)		
EPO Sales Share		0.106**	
		(0.0462)	
US Sales Share			-0.06
			(0.11)
Observations	22190	22190	22190

Marginal Effects

We evaluate how the predicted number of patents vary for different combinations of R&D offshoring intensities

We consider three different intensities for each mode: zero, mean and maximum

Our findings highlight the importance of the depth of offshoring relationships (Laursen et al., 2011)

Increasing any of the modes of R&D offshoring from zero to the mean intensity has only a very limited effect on the number of new patents in a year

Marginal Effects

- Contract R&D offshoring has the strongest impact on domestic patenting:
  - Firms with the equivalent to the maximum level of contract R&D offshoring have almost three times the number of domestic patents
- For regional patenting, only captive R&D offshoring has a significant effect on patenting:
  - Firms with the equivalent to the maximum level of captive R&D offshoring have more than three times the number of regional patents
- For international patenting, combining captive and contract R&D offshoring at the equivalent of their maximum levels result in almost six times more patents granted by the USPTO

Conclusions

- Domestic patenting is positively affected only by contract R&D offshoring:
  - This mode seems associated with the rationalization of innovative processes and the outsourcing of standardised tasks
  - The aim seems to be improving the efficiency of the R&D activities aimed at patenting domestically-relevant inventions that are close to the firm's core-business (Francis and Mona, 1999; Sachwald, 2014)

Conclusions

- Regional patenting at the EPO is positively related to captive R&D offshoring but not contract:
  - This suggests that French firms tend to follow a regional R&D offshoring strategy especially with regard to patents most closely related to their core businesses
  - However they do not display a home-country bias for these innovations
  - Captive offshoring is more likely a strategy that supports the activity of their European subsidiaries (Narula, 2000; Criscuolo, 2003; Martinez and Rama, 2012)

Conclusions

- For international patenting both captive and contract R&D offshoring have a positive and significant effect
- Firms need both core internal capabilities and non-core diverse knowledge to increase the level of complexity and to achieve more valuable and globally relevant inventions worthy of being patented internationally

Conclusions

Our results tend to suggest that French firms pursue contract R&D offshoring for two distinct strategies and objectives:

- A cost and risk reduction strategy that improves the efficiency of the innovative process for core patents and increase the number of patents granted at the domestic level
- To access heterogeneous and diverse non-core knowledge not available in-house and increase the level of their innovation complexity resulting in new innovations characterised by a higher degree of complexity, higher potential value and global significance that increase firms' patenting activity at the international level

Conclusions

Our findings also tend to suggest that firms in our sample that engage in captive R&D offshoring do so for two distinct reasons:

- In the case of some firms, subsidiaries located abroad pursue a regional orientation and perform R&D activities to respond to the need of their local and regional markets
- In the case of some other firms, overseas located subsidiaries seem to have evolved into creative subsidiaries with a greater degree of independence. These technologically advanced subsidiaries are able to develop a capacity of exploiting local technology spillovers to generate unique technological capabilities that extend the innovative capabilities of the firm and result in more complex and globally relevant patents

Conclusions

We find that third-sector R&D offshoring has no significant impact on firms' domestic, regional or international patenting activity

One explanation is that the collaboration involves advanced scientific projects with higher-education institutions and may result in non-directly commercially-exploitable innovations with limited patentable opportunities

A possible mismatch in the objectives of public and private agents in terms of appropriability, knowledge dissemination and the time-horizon of R&D partnerships may also limit the gains from these collaborations

Thank You

INTERNATIONAL WORKSHOP
BBVA Foundation – Ivie

KNOWLEDGE, INNOVATION AND REGIONAL DEVELOPMENT: NEW EVIDENCE

18 October 2019 - Faculty of Economics

Fundación BBVA

Ivie

In collaboration with:

VNIVERSITAT DE VALÈNCIA

Facultat d'Economia