International Collaboration and the Likelihood of Obtaining a Patent

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Abstract

We examine whether patent applications with international inventor collaborations are more likely to be awarded a US patent than applications without. We focus on the 28 EU member countries and explicitly distinguish between countries with high and low number of patent applications. Of special interest is the collaborations between innovative laggard countries and top innovative countries as evident by patent applications. We draw data from various patent datasets available from the Office of the Chief Economist at the USPTO. Preliminary results show that for certain countries, collaborations are associated with increased likelihood of a patent grant.

Keywords: International inventor collaborations, likelihood of patent grant, patent prosecution, USPTO.

JEL classification: O31, O32

Introduction

The literature in patent prosecution has increased dramatically over the last twenty years. There are two simple reasons for this increase in scholarly work. First, there has been an ever increasing tendency of organizations and inventors to pursue patents as a means of protecting and appropriating their inventions. In 1995 global patent applications marginally exceeded 1 million, while in 2015 this figure has risen to almost 2.9 million (source: WIPO).

Second, patents have been shown to be related closely with a number of economy-wide variables. Since the study of Griliches (1981) scholars have shown that patents positively contribute to firm's market value (see for instance Blundell *et al* 1999). Further, patents have been linked to the successful acquisition of venture capital by startups (Mann and Sager 2007). Perhaps the most important contribution of patents has been shown in the studies by Lerner (2009) and Moser (2005) where they provide some evidence that patents and patent laws may spur innovation; however, more work needs to be done to establish a causal relationship between the two.

The literature on patent prosecution examines characteristics and behavior of the two parties involved: i) the patent office, representing the central planner, and ii) the innovators. While recently, there has been significant progress in understanding the incentives and organization of the patent office,[1] these is considerably less work from the side of the innovators. In this paper, our focus is on the latter.

Our objective is to examine whether international inventor collaboration in a patent application is more likely to result in a patent than no such collaboration. Our focus is on the 28 EU member countries and we explicitly distinguish between countries with high and low innovative activity as evident by patent applications.

We draw information primarily from the PatEx dataset maintained by the Office of the Chief Economist at the USPTO. The PatEx dataset has detailed information for all patent applications that are published at the USPTO. We obtain information on virtually all patent applications filed between 2001 and 2009 and disclose at least one EU located inventor.

We find that patent applications stemming from teams, rather than individual inventors, are more likely to be issued a patent. We find, for both high and low innovative countries, patent applications which have international teams to be more

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[1] See for instance Frakes and Wasserman (2016), Lemley and Sampat (2012) and Schuett (2013).

likely to be issued a patent. The most interesting finding of this paper is that the composition of international collaborations that deliver higher propensities of patent grant vary for the two groups. For the high innovative countries, collaborations with other high innovative EU countries and the US are more likely to result in a patent grant. For the low innovative countries, collaborations with other high innovative EU countries and the US are more likely to result in a patent grant.

One of the EU's core problems is the income inequalities across its countries and regions. On the one hand, many Northern EU countries experience a high GDP per capita and low unemployment rates while most of the EU South faces a number of challenges. Further, and perhaps more importantly, convergence between these regions is still elusive and faced with many challenges. Both policy makers and scholars have identified that innovation activity is the engine of growth and a key in achieving a larger degree of economic coherence across countries.

However, for the innovator to devote time and money to a risky project, s/he needs to have an understanding on how to protect his/her invention. In countries where knowledge about the patent system is limited, the incentives to perform innovation activity are further diminished. To make matters worse, patent prosecution is costly and infused with many hidden costs. Berger (2005) estimated that the cost of obtaining a single patent from the European Patent Office could reach up to 30,000 Euros when legal counsel and drafting services are included to the fees required to be paid.

This project seeks to provide comprehensive insights on whether collaborations play a role in patent grant propensity and which types of such collaborations are more successful both for high and low innovative EU countries.

The next section describes the Data construction and provides some summary statistics. The Results section discussed the findings of the paper and finally the paper concludes.

Data Construction

Our primary source of data is the Office of the Chief Economist at the USPTO and in particular the PatEx database which describes in detail the prosecution history of all patent applications that opted for publication after November 20, 2000.[2] We extract

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[2] https://www.uspto.gov/learning-and-resources/electronic-data-products/patent-examination-research-dataset-public-pair

detailed information for 438,378 patent applications filed between 2001 and 2009 that disclose at least one inventor from one of the 28 EU countries.

Given that the dataset runs through 2015, our decision to stop at 2009 is to credibly identify patent applications that have been abandoned and have not been issued a patent and most likely will not be issued a patent in the future.

We further extract information on whether a patent application has generated subsequent continuing applications. In the US, applicants have the option of filing full applications claiming priority of a parent application; these latter applications are called continuing applications and are of three types: Continuations, Continuations-in-part and Divisionals. One of the main reasons, applicants opt for continuing applications is to secure patent grant of a variation of the original invention (for a more detailed discussion see Quillen and Webster 2001 and Quillen et al 2002). Therefore, such information will be useful in the following analysis. While the reasons can vary on whether the applicant will opt for the one type of continuing versus the other (Hegde et al 2009), this is beyond the scope of the paper. We further compile information of how many patents the patent application has generated when adding up the patents from continuing applications, and whether the patent application itself is a continuing application.

The average propensity of a patent application to be issued a patent is 64.2%. This number however masks significant variation across countries and types of collaboration. Table 1 displays the average propensity of a patent application to be issued a patent by country and further distinguishes by type of collaboration: single inventor patent applications, teams where all the inventors are from the same country, teams where at least one inventor is from a different country.

As can be seen there is considerable variation across countries both on the overall patent grant likelihood and when accounting for the composition of the research team.

Results

Table 2 shows the propensity of patent grant by teams' composition. Column 1 includes all patent applications. The coefficient of Team shows that on average patent applications stemming from teams are 4.8% more likely to result in a patent grant than applications that stem from single inventors. This finding is consistent with studies that show that patents from teams of inventors are of higher value than patents stemming

from single inventors (Agiakloglou et al 2016, Drivas et al 2013, Singh and Fleming 2010).

Column 2 considers inventions where at least one inventor is from a TOP10EU country. The coefficient of *InternationalCoInv* shows that patent applications with at least one inventors from a foreign country are 2.5% more likely to be issued a patent. The story is similar when considering LOW18 EU countries in Column 3.

Column 4 again considers inventions where at least one inventor is from a TOP10EU country. The coefficient of TOP10EU shows that patent applications with collaboration within the TOP10EU countries are 1% more likely to be issued a patent than patent applications from TOP10 EU countries without international collaboration. Also, collaborations with US inventors are associated with higher likelihood of obtaining a patent but collaboration with LOW18EU is associated with lower likelihood. When we consider inventions where at least one inventor is from a LOW18 EU country, the findings are somewhat different. While international collaborations are still associated with higher likelihood of patent grant, collaborations with TOP10EU countries are also associated with higher likelihood. This latter finding is in stark contrast with the finding from Column 4.

To further delve into our findings, we keep only the patent applications that have not generated a patent application (Table 3). The first three columns show the same picture as in the previous case. However, when decomposing by the type of international collaboration, we see that only US collaborations are associated positively with patent grant in both cases. This finding implies that the type of application prosecution depends on the type of international collaborations. To examine this further we examine the likelihood of patent applications generating continuing patent applications (Table 4). The first three columns show that collaborations, and international collaborations associated with higher probability of generating continuing applications. Column 4 and Column 5 show that international collaborations similar to those of Table 3 are associated with higher probability of generating a continuing patent application. Overall, our results show that international collaborations are associated with higher likelihood of obtaining a patent. However, this increased likelihood can be, at least partly, attributed to different prosecution strategies; work that we leave for future versions of the paper.

Conclusion

At the forefront of protecting innovations, is the ability of inventors to obtain a patent for their inventions. Our setting is all patent applications filed at the USPTO over the period 2001-2009 and we explicitly focus on European based inventors. We find that teams and international collaborations are strongly associated with higher probability of obtaining a patent. However, part of this increased likelihood can also be attributed to patent prosecution strategies. It does appear that low EU countries benefit more from top EU countries in patent prosecution than the other way around; a finding that we will further explore and rigorously test in future versions of the paper.

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Table 1. Summary statistics of patent grant propensity by country and composition of research team.

cnt	Obs	Overall	Single Inventor	Whole Team Within Country	Foreign Collaboration
AT	29217	67.8%	66.7%	68.0%	67.9%
BE	45891	63.1%	57.5%	60.4%	65.1%
BG	1316	74.6%	69.5%	71.2%	77.0%
CY	255	62.4%	38.9%	56.3%	67.0%
CZ	3988	65.9%	64.4%	60.3%	68.4%
DE	509464	65.7%	66.5%	66.1%	64.6%
DK	27576	57.1%	61.4%	55.7%	57.6%
EE	664	66.0%	59.6%	66.5%	66.4%
ES	25100	59.2%	51.3%	58.4%	61.5%
FI	38509	63.1%	63.2%	64.2%	60.4%
FR	176760	66.2%	65.7%	68.0%	63.6%
GB	199284	60.4%	57.4%	59.0%	62.4%
GR	2601	59.1%	48.3%	58.8%	60.9%
HR	1071	52.1%	65.9%	47.6%	54.4%
HU	6622	57.3%	49.1%	57.6%	57.7%
IE	14998	60.9%	56.1%	56.8%	64.0%
IT	70848	66.0%	60.7%	68.2%	64.5%
LT	529	79.0%	100.0%	74.5%	79.6%
LU	2262	66.8%	60.7%	74.6%	65.6%
LV	730	49.7%	50.0%	73.6%	47.8%
MT	122	48.4%	57.6%	33.3%	49.2%
NL	82195	61.5%	57.3%	59.4%	64.7%
PL	3711	63.3%	48.4%	56.1%	68.0%
PT	1862	51.5%	49.0%	54.3%	50.3%
RO	1574	77.1%	71.9%	63.8%	80.1%
SE	56787	63.2%	64.9%	64.8%	60.1%
SI	1342	56.0%	50.0%	58.4%	54.2%
SK	921	62.0%	61.4%	66.2%	61.3%

Table 2. Probability of obtaining a patent.

VARIABLES	All countries (1)	TOP10 EU Countries (2)	LOW18 EU Countries (3)	TOP10 EU Countries (4)	LOW18 EU Countries (5)
Within TOP10EU				0.0107***	
				(0.00345)	
TOP10EU_LOWEU18				-0.0222***	0.0157*
				(0.00807)	(0.00905)
TOP10EU_US				0.0536***	
				(0.00785)	
TOP10EU_NonUS				0.00422	
				(0.00421)	
Team	0.0482***				
	(0.00156)				
InternationalCoInv		0.0251***	0.0598***		
		(0.00198)	(0.00615)		
LOWEU18					0.0188*
					(0.0110)
LOWEU18_US					0.0521***
					(0.00736)
LOWEU18_NonUS					-0.0102
					(0.00753)
Constant	0.615***	0.675***	0.667***	0.650***	0.606***
	(0.00235)	(0.00283)	(0.00538)	(0.00253)	(0.00747)
Observations	438,378	292,544	49,969	292,544	49,969
R-squared	0.089	0.088	0.102	0.088	0.103
USPC Class FE	YES	YES	YES	YES	YES
Application Year FE	YES	YES	YES	YES	YES

Notes: The estimation method is Ordinary Least Squares (OLS). Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3. Probability of obtaining a patent. Consider only patent applications that have not generated a patent application.

VARIABLES	All countries (1)	TOP10 EU Countries (2)	LOW18 EU Countries (3)	TOP10 EU Countries (4)	LOW18 EU Countries (5)
Within TOP10EU				0.00561	
				(0.00378)	
TOP10EU_LOWEU18				-0.0127	0.0154
				(0.00878)	(0.00989)
TOP10EU_US				0.0319***	
				(0.00859)	
TOP10EU_NonUS				0.00823*	
				(0.00471)	
Team	0.0441***				
	(0.00165)				
InternationalCoInv		0.0156***	0.0421***		
		(0.00220)	(0.00675)		
LOWEU18					0.0129
					(0.0125)
LOWEU18_US					0.0324***
					(0.00813)
LOWEU18_NonUS					-0.00574
					(0.00891)
Constant	0.605***	0.656***	0.633***	0.641***	0.590***
	(0.00250)	(0.00310)	(0.00621)	(0.00273)	(0.00832)
Observations	382,786	251,350	38,297	251,350	38,297
R-squared	0.101	0.102	0.120	0.102	0.121
USPC Class FE	YES	YES	YES	YES	YES
Application Year FE	YES	YES	YES	YES	YES

Notes: The estimation method is Ordinary Least Squares (OLS). Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4. Probability a patent application to generate continuing patent applications.

VARIABLES	All countries (1)	TOP10 EU Countries (2)	LOW18 EU Countries (3)	TOP10 EU Countries (4)	LOW18 EU Countries (5)
Within TOP10EU				0.0212***	
				(0.00269)	
TOP10EU_LOWEU18				-7.69e-05	0.0139**
				(0.00621)	(0.00700)
TOP10EU_US				0.0986***	
				(0.00616)	
TOP10EU_NonUS				0.0246***	
				(0.00351)	
Team	0.0271***				
	(0.00103)				
InternationalCoInv		0.0734***	0.103***		
		(0.00164)	(0.00480)		
LOWEU18					0.0473***
					(0.00944)
LOWEU18_US					0.0962***
					(0.00591)
LOWEU18_NonUS					0.0202***
					(0.00709)
Constant	0.104***	0.187***	0.243***	0.112***	0.138***
	(0.00161)	(0.00222)	(0.00497)	(0.00184)	(0.00617)
Observations	438,378	292,544	49,969	292,544	49,969
R-squared	0.046	0.054	0.043	0.059	0.048
USPC Class FE	YES	YES	YES	YES	YES
Application Year FE	YES	YES	YES	YES	YES

Notes: The estimation method is Ordinary Least Squares (OLS). Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.