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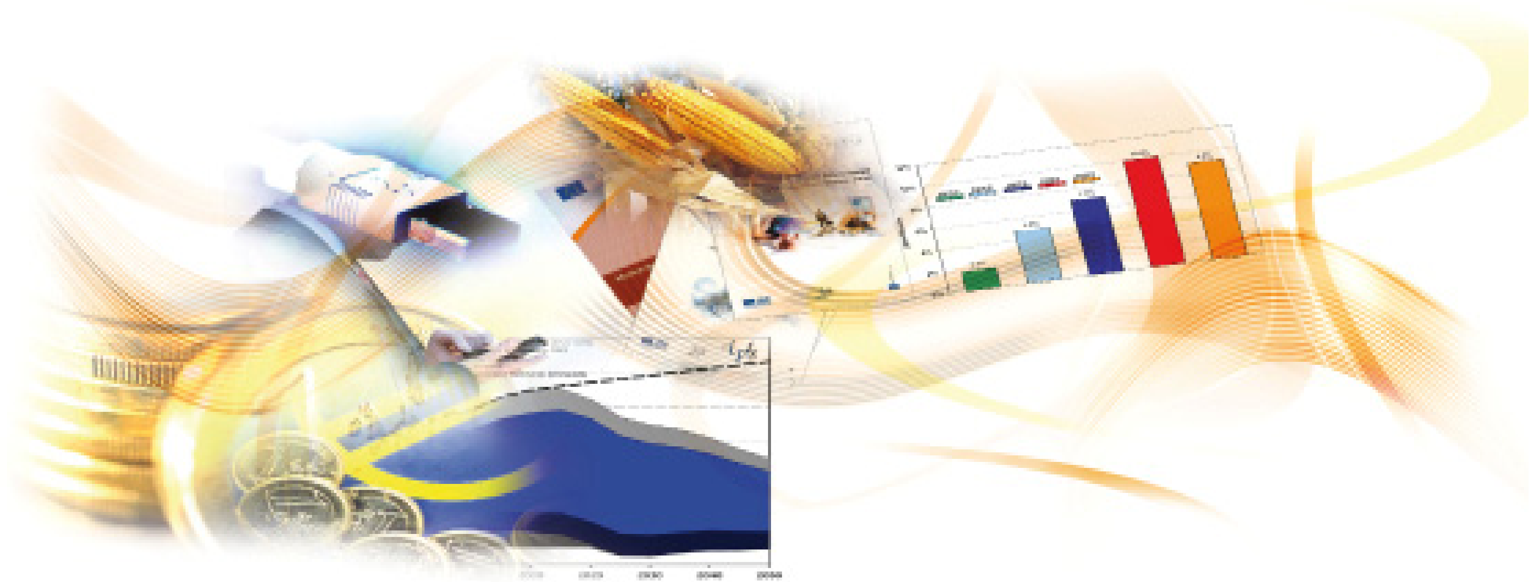

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International technology transfer between China and the rest of the world

Authors: Giuditta De Prato and Daniel Nepelski

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Contact information
Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

http://ipts.jrc.ec.europa.eu
http://www.jrc.ec.europa.eu

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Preface

The European ICT Poles of Excellence (EIPE) research project at the Institute for Prospective Technological Studies is investigating the issues of growth, jobs and innovation, which have become main priorities of the European Union's growth strategy programme 'Europe 2020'.

The overall objectives of the EIPE project are to set the general conceptual and methodological conditions for defining, identifying, analysing and monitoring the existence and progress of current and future EIPE, in order to develop a clear capacity to distinguish these among the many European ICT clusters, benchmark them with non-European poles, observe their dynamics and offer a thorough analysis of their characteristics.

The EIPE project started late in 2010 and has, since then, developed a large database of original ICT innovation indicators, enriched with geographical information in order to allow localisation and aggregation at NUTS 3 and NUTS 2 level. The tool helps us to answer such questions as: How is ICT innovation and economic activity distributed and how is it evolving in Europe? What locations are attracting new investments in ICT R&D or manufacturing? What is the position of individual locations in the global network of ICT activity?

To date, the following additional publications have emerged from the research:

- A Framework for assessing Innovation Collaboration Partners and its Application to BRICs. G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- The global R&D network. A network analysis of international R&D centres, G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- Does the Patent Cooperation Treaty work? A Global Analysis of Patent Applications by Non-residents. G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- International Patenting Strategies in ICT. G. De Prato and D. Nepelski, JRC-IPTS Working Paper, (2013).
- Asia in the Global ICT Innovation Network. Dancing with Tigers, G. De Prato, D. Nepelski and J.-P. Simon (Eds), Chandos Asian Studies Series: Contemporary Issues and Trends, Chandos Publishing, (2013, forthcoming),
- Global technological collaboration network. Network analysis of international co-inventions, G. De Prato and D. Nepelski, Journal of Technology Transfer, 2012,
- Internationalisation of ICT R&D: a comparative analysis of Asia, EU, Japan, US and the RoW, G. De Prato and D. Nepelski, Asian Journal of Technology Innovation, (2012),
- A network analysis of cities hosting ICT R&D, G. De Prato and D. Nepelski, (2013 - forthcoming).

More information can be found under: http://is.jrc.ec.europa.eu/pages/ISG/EIPE.html

Table of Contents

1. Introduction

Due to the impressive growth in China's inventive output, scholars, policy makers and company executives are looking at China with great interest (Petti 2012, De Prato et al. 2012, Nepelski and De Prato 2012). To a large extent, their attention has been attracted by China's growing power as a competitor in knowledge intensive activities. In contrast, hardly any attention is devoted to the issue of international technology transfer from and to China. However, it seems to be a natural step that China will become an important producer of technology demanded by other countries, on the one hand, and that China will increase its demand for technology developed abroad to complement its own technological resources, on the other hand.

To cast some light on China's role in the international technology transfer process, we focus on two questions. First, we analyse the drivers of technology transfer from China to the rest of the world. In other words, we study the main characteristics and drivers of foreign entities seeking technological resources in China. Second, reversing the direction of technology flow, we investigate what motivates Chinese individuals to seek and transfer technology from outside of China. In addition, we show the balance for China in international technology transfer and which countries are its main partners.

One of the reasons why there is no complete picture of the position and dynamics of China in the process of international technology transfer is lack of information. We solve this issue by using measures and data that provide comprehensive coverage of the technological linkages between China and the rest of the world. Our empirical analysis uses patent-based indicators of international technology transfer to and from China. In particular, we use measures of technology internationalisation that capture the issue of cross-border ownership of inventions as defined by Guellec and Van Pottelsberghe de la Potterie (2001), i.e. where an applicant holding proprietary right over an invention resides in a different country than the inventor who developed this invention. These measures allow us to capture the phenomenon of technology transfer, which is defined as either a transaction or a long-term collaboration between two parties, in which the acquirer and supplier of technology are involved (Bennett 2002). As our source, we use PATSTAT, the most comprehensive patent dataset provided by the European Patent Office (EPO) containing information on a worldwide coverage of patent applications submitted to 59 patent offices in the world. Querying the entire database allows us to map and quantify the intensity of technology transfer between China and the rest of the world.

In order to explain the drivers behind the international technology transfer to and from China, we make use of the gravity model. Drawing on the findings of previous research on international technology transfer, we include the most relevant aspects that were identified as the key drivers of this process. These aspects include the geographic and economic and inventive potential.

We chose China for analysis, because it belongs to the group of economies that are expanding the most at present and, more interestingly, it is also a destination for R&D-related investments by foreign companies and countries (Nepelski et al. 2011). Despite the interest that China attracts (Abraham and Moitra 2001, Simon 2011, Ernst 2005, Liu and White 2001, Yang 2012), little attention is devoted to the process of China's outward internationalization. Notable exceptions include, for example, studies of the recent corporate evolution in China and the focus of these studies on the increased internationalization of firms in the form of significant outward foreign direct investment flows and overseas mergers and acquisitions (Athreye and Kapur 2009). However, to our knowledge, there has been no comprehensive attempt to assess the prowess of this country as a producer of technology transferred to other countries and as a procurer of technology developed outside of China. One of the studies focused on the case of China and international technology include Zhang et al. (2007) and de la Tour et al. (2011). Unlike our approach, the former study concentrates on a limited number of companies, and the latter addresses only one narrowly defined technological field. Thus, due to its scope, i.e. the whole world and its focus on China, our study complements the existing evidence and extends our understanding of the role of China in the process of international technology transfer in a global context.

The rest of this paper proceeds as follows: Section 2 reviews the available literature on the globalization of innovation and technology transfer. Section 3 formulates a gravity model used to explain the patterns of international technology transfer from and to China. Section 4 introduces the data and measures used in the study. Section 5 presents and discusses the empirical findings. Section 6 concludes and formulates some policy implications. This section is followed by a technical appendix.

2. Literature review

Over the last few decades, an intensive process of redistribution of production across the world has been observed (Meyers et al. 2008, UNESCO 2010, Van der Zee 2006). As part of the process of spatial division of economic activity, a number of large corporations have begun to seek new knowledge opportunities worldwide (Bartlett and Ghoshal 1990, Dunning 1994, Teece 1977). Through sourcing R&D activities outside of the home country, or accessing knowledge and technology resources abroad, companies increasingly build a new kind of competitive advantage by discovering, accessing, mobilising, and leveraging knowledge from a number of locations across the globe (Doz et al. 2001). One of the important developments is the entry of new countries that are becoming both important players in the field of knowledge and technology development and potential sources of knowledge and technology. China belongs to the group of countries (De Prato and Nepelski 2012).

Concerning the drivers of the international technology transfer, they have been placed in the context of the globalization of economic and inventive activity. Conceptualising the issue technology internationalization, among the most important drivers are non-transferable and location-specific resources (Kuemmerle 1999, Boutellier et al. 2008, Narula 2003, Dunning 1988, Dunning 1994). Examples of such resources include inputs to R&D activity, e.g. scientists and universities, or the knowledge about customers and markets (Dunning 1988, Dunning 1994). Another reason to engage into international technology transfer is the access to the market and hence, the potential size of the economy should be also taken as a predictor of link formation among countries.

Empirical research studying the motives behind international technology sourcing can be ordered according to two dimensions. The first one is the unit of observation, i.e. firm versus country. The second one is the geographic scope. For example, at the firm level, Belderbos et al. (2012) examine the drivers of international technology transfer strategies of Flemish firms. They show that technology transfer is practiced by firms that face resource limitations. Also Song and Shin (2008) and Penner-Hahn and Shaver (2005) perform studies at the firm level and find that effective transfers require a sufficient 'absorptive capacity' of a firm to utilize foreign know how and R&D results. Similarly, Grevesen and Damanpour (2007) use a survey data to study at the company level innovative performance in the overseas R&D. Considering the issue of technological complementarity in technological collaboration, Chen et al. (2011) illustrate how technological life-cycle and competencies impact joint-venture.

At a more aggregate level that includes a larger number of countries, a number of studies describe the process of international technology production and their drivers (Kuemmerle 1999, Boutellier et al. 2008, Narula 2003, Dunning 1988, Dunning 1994). Their conclusions show that international R&D activity can help multinational firms to exploit their firm-specific resources, improve their local responsiveness, and ensure sustainable competitive advantages globally.

Summing up, the determinants of the international technology transfer can be grouped into two blocks: economic capacity and inventive performance of countries involved in technology exchange and innovative collaboration (Picci 2010, Patel and Pavitt 1991, Dachs and Pyka 2010, Guellec and Van Pottelsberghe de la Potterie 2001). Building on the existing studies explaining the motives behind international technology transfer, in the following section, we formulate an empirically testable model of technology transfer from and to China.

3. Modelling the determinants of international technology transfer

There is no comprehensive theoretical model explaining the formation of technology transfer between countries. Moreover, as explained above, there are different motives that drive actors from one country to look for complementary technological resources outside of their country. The closest theoretical concept suitable for an empirical analysis of technology seeking and transfer across borders is the gravity model, commonly applied to analyse the international trade between countries (De Benedictis and Tajoli 2011). As this approach has already been applied to study the issue of the internationalisation of technological activity (Picci 2010, Thomson 2011, De Prato and Nepelski 2012), we also use it in the current study. This specification allows us to define and test the importance of the predictors concerning the existence of trade relationships or technological collaboration between countries. The straightforward form of the gravity equation can be expressed by

$$L_{ij} = \frac{GDP_i \cdot GDP_j}{D_{ij}} \tag{1}$$

where two countries, c_i and c_j, with non-negative GDP included and the geographic distance D_{ij}, are expected to develop a positive exchange link (i.e. $L_{ij} = 1$).

Regarding the construction of the dependent variable, our analysis uses measures of internationalisation of technology transfer that are based on patent data. Each patent application has a list of inventors, i.e. persons who developed a particular invention, and a list of applicants, i.e. persons that own the property rights over this invention. Cross-border ownership of patents reflecting international flows of knowledge from the inventor country to the applicant countries (OECD 2009). In order to measure technology transfer from and to China, we look for patents with inventors and applicants residing in China and another country. As these measures capture the concept of cross-border ownership of inventions, we speak of technology transfer from China to another country whenever an invention developed by a Chinese inventor is owned by an applicant residing in a different country. In contrast, there is a technology transfer to China from another country whenever a Chinese applicant owns an invention developed by an inventor residing in a different country.

Concerning the drivers of international technology transfer, as illustrated by the available literature, the formation of technology transfer linkages between countries depends on more factors than their GDP and distance. To explain the relationships between the intensity of technology transfer between China and other countries both we use a number of variables that are related to a country' characteristics in the following areas: geographical proximity, economic size and openness to foreign investments and, finally, innovative potential of China and its partners. Thus, the function of the intensity of technology transfer to China from other countries takes the following form:

$$ApIn_{CNjt} = f(Dist_{CNj}, GDP_{CNt}, GDP_{jt}, FDI_{CNt}, FDI_{jt}, Inv_{CNt}, Inv_{jt}, Rg_j, \alpha, \varepsilon_{ijt}) \tag{2}$$

where $ApIn_{CNjt}$ represents the count of patented inventions owned by Chinese applicants and developed by inventors residing in country *j* in time $t \in (1990{,}2007)$. Error term is given by ε_{ijt}. In a similar fashion, our function of the intensity of technology transfer from China to the rest of the world can be represented by:

$$ApIn_{jCNt} = f(Dist_{jCN}, Rg_j, GDP_{CNt}, GDP_{jt}, FDI_{CNt}, FDI_{jt}, Inv_{CNt}, Inv_{jt}, Rg_j, \alpha, \varepsilon_{ijt}) \quad (3)$$

where $ApIn_{jCNt}$ represents the count of patented inventions developed by Chinese inventors and owned by applicants residing in country *j* in time $t \in (1990,2007)$.

The variables listed above, can be explained as follows: Concerning the geographical proximity, we use a variable controlling for the distance between China and country $j, Dist_{CNj}$. Moreover, we include a dummy variable Rg_j, indicating from which region, i.e. Europe, the US, Japan, Asia or the rest of the world (RoW), country *j* is. It is worth mentioning that we considered using a variable controlling for the presence of common language as a proxy for cultural proximity. However, China shares common language only with Taiwan we decided to discard this idea. Moreover, due to the political situation of Taiwan and the resulting problem with obtaining official statistics for this country on, for example, GDP or FDI, we excluded it from our analysis.

Regarding economic size of countries linked through technological transfer, information on GDP (in current US$) of both China and country *j* in period *t* is included. In order to control for the internationalisation of economic activity, we also include measures of incoming foreign direct investment (FDI) for each country (in current US$). Measures of GDP and FDI are supposed to account for the economic attractiveness and openness of both countries.

In addition, expecting that not only distance hinders and economic factors facilitate international technology transfer, we control for the innovation performance of both China and its partners proxied by the total number of patented inventions developed by Chinese and country's *j* inventors at time *t*. This has a double interpretation. On the one hand, from the perspective of one country, the measure of its inventive performance indicates the inventive capacity which might attract technological collaboration partners. On the other hand, from the perspective of another country, it might be a proxy of its absorptive capacity captured by the total number of patented inventions developed by inventors residing in a country.

4. Indicators construction and data sources

As mentioned in the previous section, we use patent-based data of technology transfer internationalisation. Thus, it must be mentioned that there is a number of shortcomings of patent data as a proxy of invention or technological progress and the internationalisation of technology production (De Rassenfosse et al. 2011). However, this source of data is still considered as one of the best measure of inventing capability and considered to be an important method of assessing various aspects of technological change (Griliches 1990), including the issue of internationalisation of R&D (Archibugi and Planta 1996, Patel and Pavitt 1997). This justifies the use of patent-based measures of international technology transfer in the current study. Moreover, the measures applied in this study allow us to capture the phenomenon of technology transfer, which is defined as either a transaction or a long-term collaboration between two parties, in which the acquirer and supplier of technology are involved (Bennett, 2002).

The patent-based indicators proposed in this study aim to provide the best measure of the inventive capability of countries, rather than of the productivity of patent offices. To achieve this objective, we consider only 'priority patent applications'; this means that, to avoid double-counting, only the first filing of an application is considered and all the possible successive filings of the same invention to different patent offices are not counted again.

Regarding the assigning patents to countries, there are two common methodologies (OECD 2008): it is possible to refer to either the declared country of residence of the inventor(s) ('inventor criterion') of a patent, or to that of the applicant(s) ('applicant criterion'). Several applicants could hold rights on a patent application, and they would have legal title to the patent once (and if) it is granted. In the same way, several inventors could have taken part in the development process of the invention, and be listed in the patent application. A fractional count is applied in order to assign patents to countries in cases where several inventors (or applicants) with different countries of residence have to be considered for the same application. In general, the choice of the criterion depends on the perspective from which innovative capability is being investigated. Thus, to study the cross-border technology transfer by a country, we count the number of inventions developed by foreign inventors owned by domestic applicants. This approach corresponds to variable $ApIn_{jCNt}$ and $ApIn_{CNjt}$ in equation (3) and (2). In order to compute the total number of a country's inventions, i.e. its inventive capacity, we apply the inventor criterion. This approach corresponds to Inv_{CNt} and Inv_{jt} in the above specified functions.

Our source of data is the European Patent Office (EPO) Worldwide Patent Statistical Database, known as PATSTAT, April 2009 version. This database provides a worldwide coverage of patent applications submitted to over 59 Patent Offices in the world and the analysis takes into account priority patent applications filed to all of them. The time period taken into account covers from 1 January, 2000 to 31 December, 2007.

Regarding the source of the remaining data, information on geographic distance stems from the CEPII bilateral trade data set (Head et al. 2010).[1] Data on GDP and FDI originates from the IMF.[2]

5. Empirical results

Further analysis of technology transfer between China and the rest of the world, proceeds in two steps. First, we analyse China's technology transfer balance and which countries are the main sources of technology transferred to China and which ones are the main destinations of Chinese technology. Second, we report the results of regressions estimating the models specified in section 3. Relevant descriptive statistics together with pair-wise correlations between variables used in the current study, which provide additional insights into the subject of our analysis, are reported in a technical Annex.

China's technology transfer balance and partners

In order to cast some light on the patterns of the international technology transfer from and to China, we first look at the trends in the international transfer of technology between China and the rest of the world. Table 1 and Figure 1 show China's partners in technology transfer and the size of individual relationship for the period between 1990 and 2007. According to the information presented, Chinese entities owned nearly two thousand inventions that were developed by foreign inventors. In the same time period, nearly six thousand inventions developed by Chinese inventors were owned by foreign applicants. Thus, in the language of international trade, China recorded 300% deficit in the international technology transfer.

Regarding China's main partners, Taiwan appears on the top positions both as a Chinese

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[1] For more information please refer to: http://www.cepii.fr/anglaisgraph/bdd/distances.htm

[2] For more information please refer to: http://www.imf.org/external/data.htm

source and destination of technology transfer.[3] In the case of technology transfer to China, it accounts for over 50% of all the foreign inventions owned by Chinese applicants and for nearly 40% of technology flow from China to the rest of the world. The US occupies the second position. Unlike Taiwan, we can see that the US is rather an acquirer of Chinese technology rather than a source of technology procurement for China. The rest of the ranking shows that none of the remaining countries has a particularly strong position as neither a source nor destination in the technology transfer with China. What is worth noting is that Western countries are relatively active as Chinese technology transfer partners, as compared to Asian countries. In particular, the average position of Japan shows that the geographic distance between countries is not necessarily the main impediment of technological collaboration and technology transfer.

Table 1: China's top partners in technology transfer

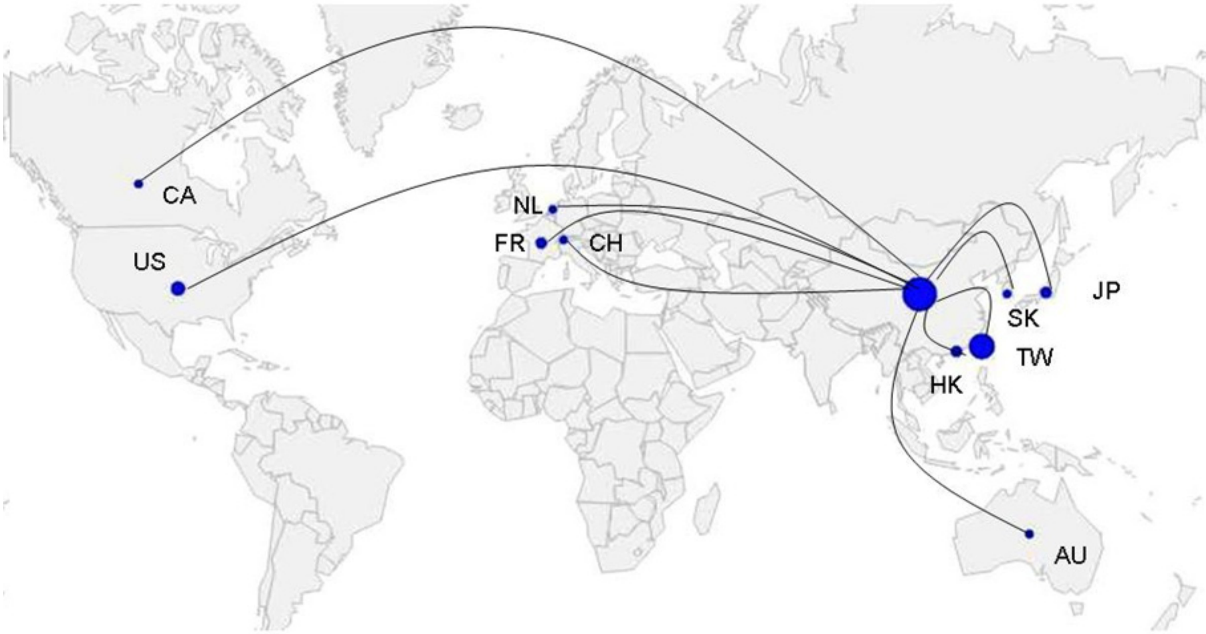
	International technology transfer			
	to China		from China	
Rank	from	Nr of patents	to	Nr of patents
1	Taiwan	1099	Taiwan	2252
2	US	285	US	1674
3	Honk Kong	149	South Korea	441
4	Japan	97	Japan	291
5	France	69	Honk Kong	285
6	South Korea	52	France	173
7	The Netherlands	31	Germany	155
8	Canada	30	The Netherlands	136
9	Australia	27	Finland	68
10	Switzerland	20	Singapore	58
Sum for all countries		1994		5950

Fractional counting according to the applicant criterion. Sum for 1990-2007.
Source: Own calculations based on PATSTAT Database, 2010.

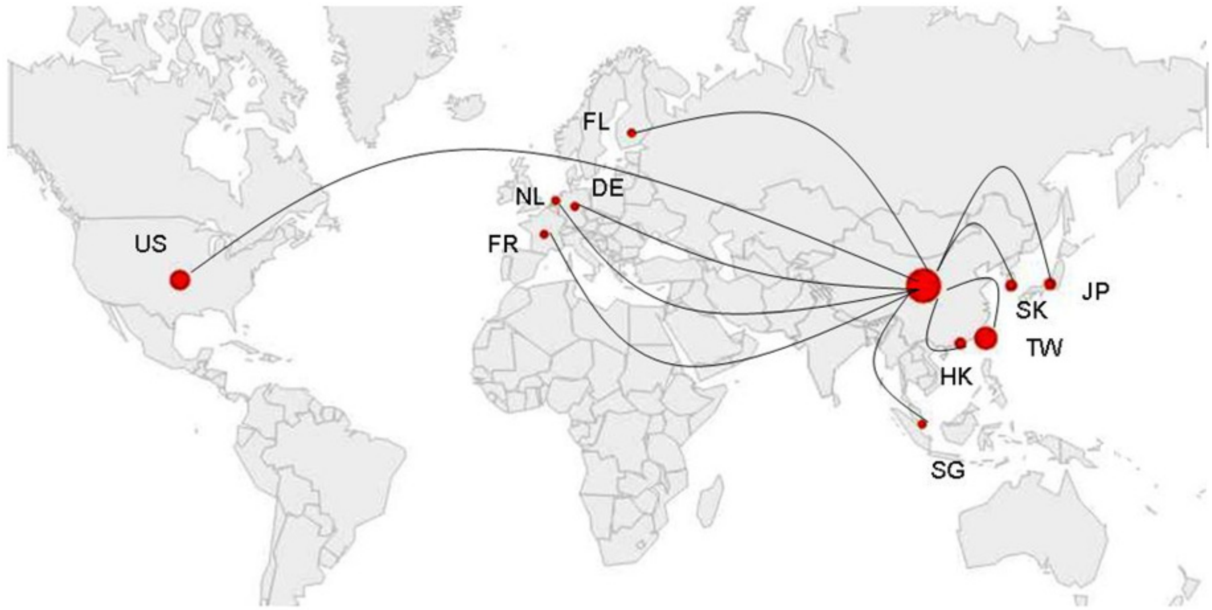
[3] Unfortunately, due to the problem of data availability for Taiwan, we exclude this country from the proceeding part of analysis.

Figure 1: Technology transfer between China and the rest of the world

Technology transfer to China



Technology transfer from China



Source: Own calculations based on PATSTAT Database, 2010.

Regression results

To estimate the functions specified in (3) and (2), we run regression with time fixed effects. Table 2 reports the results where the dependent variables are: the first one is the total number of inventions developed by foreign inventors and owned by Chinese applicants at time *t*. This relates to the issue of the technology transfer to China from abroad. The second one is the total number of inventions developed by Chinese inventors and owned by foreign applicants at time *t*. This concerns the transfer of Chinese technology to other countries. For gravity model, we report first estimations with variables controlling for geographic proximity and GDP of China and its partners at time *t*. The extended specification includes controls of net FDI in-flows, inventive performance of China and its technology transfer partner *j* and the region of origin of country *j*.

Regarding the technology flow to China, the coefficients of the standard gravity model, i.e. distance and the economy size of a partner country, have the expected signs, and are significant. The coefficients of the FDI in-flows are not relevant. Interestingly, the economic development of China does not play a role in Chinese technology acquisition from abroad. Regarding the second estimation, we can see that only the coefficient related to the inventive performance of China, measured by the number of patents, show significant impact on the technology transfer to this country. This indicates that the flow of technology from abroad to China intensifies as the absorptive capacity of the latter one grows. Concerning the sources of technology acquired by Chinese entities, we can observe an interesting pattern of a clear orientation towards the US. Despite their geographical proximity, the role of other Asian countries as a source of technology transferred to China is negligible. Similar conclusions can be made with respect to Japan and European countries.

With respect to the technology transfer from China to other countries, we can see that there is a negative impact of distance and a positive one of the GDP of a country sourcing technology from China. Like in the previous case, FDI flows to both countries are irrelevant and the absorptive capacity of the sourcing country increases the likelihood of technology acquisition from China. However, in the case of technology transfer from China we can observe much higher levels of polarization when we consider the region of destination. Whereas the dummies controlling for Asian countries and Japan have a very strong negative impact on the technology sourcing from China, the positive and significant sign of the US-dummy shows a very strong interest of US entities in the technology developed in China.

The above analysis shows that, as sometimes believed (Picci 2010) and unlike in the patterns of international trade (De Benedictis and Tajoli 2011), geographical distance does not reveal the whole picture about the globalization of technology. In particular, the technology flow between China and the US shows a very strong bias in technological collaboration between countries. This is even more emphasized by the negligible role of Japan and Asian countries in the process of technology exchange with China.

Table 2: Estimation results

	International technology transfer			
	to China		from China	
	$LogApIn_{CNjt}$	$LogApIn_{CNjt}$	$LogApIn_{jCNt}$	$LogApIn_{jCNt}$
$Log\ Distance_{CN,j}$	-0.63***	-0.71**	-0.59***	-1.78***
$Log\ GDP_{CN,t}$	0.45	(dropped)	0.35	(dropped)
$Log\ GDP_{j,t}$	0.51***	0.45**	0.46***	0.60***
$Log\ FDICN_{,t}$		-0.38		0.22
$Log\ FDI_{j,t}$		0.00		-0.16
$Log\ Inv_{CN,t}$		0.85*		0.42
$Log\ Inv_{j,t}$		0.08		0.13**
EU		-0.40		-0.11
Asia		-0.81*		-1.42***
US		1.01**		2.22***
Japan		-0.68		-16.57**
Constant	-20.58	-11.55	-16.85	-11.39
N	242	177	332	232
R^2	0.39	0.55	0.32	0.65

The table shows the results of panel regressions with time fixed effects for the period between 2000-2007. The first regression concerns the total number of inventions developed by foreign inventors and owned by Chinese applicants, i.e. it captures the technology transfer to China from abroad. The second one reflects the total number of inventions developed by Chinese inventors and owned by foreign applicants, i.e. the transfer of Chinese technology to the rest of the world.
Significance levels: * = .90, ** = .95, *** = .99. Year dummies included.
Rest of the world=base category. Source: Own calculations based on PATSTAT Database, 2010.

6. Conclusions

China's rapidly increasing innovation potential is attracting a lot of attention from both policy makers and business people, as these developments are expected to re-shape the geographic distribution of knowledge and technology development. However, little is known about the patterns of international technology transfer from and to China. To address this gap, we constructed patent-based measures of cross-border ownership of inventions to capture the technology flow from China to the rest of the word, on the one hand, and from the rest of the world to China, on the other hand. Subsequently, to map and quantify these technology flows, we used PATSTAT, a patent database which provides worldwide coverage of patent statistics. In order to explain the drivers of technology flows, we applied a gravity model that incorporates a number of factors that drive the process of innovation globalization.

This paper delivers valuable insights into China's innovation landscape and an analysis of the perspectives for cooperation in science and technology with China. In particular, we explain the drivers behind the formation and intensity of technology exchange between China and other countries. First of all, we show that unlike in the patterns of international trade (De Benedictis and Tajoli 2011), geographic distance does not reveal the whole picture about globalization of technology in general and the international technology transfer between China and the rest of the world in particular. The intensive technology flows between China and the US, on the one hand, and the relatively weak ties between China and the remaining Asian countries, except for Taiwan, on the other hand, show a very strong bias and concentration in technological collaboration towards a few countries.

This paper has some limitations. First of all, patent data, despite the richness of the information it provides, suffers from its own drawbacks. Second, due to the fact that there is no theoretical foundation explaining the formation of linkages between countries, we are forced to adhere to the gravity model, which is not free of flaws either. Moreover, our approach ignores the value of patents, and it does not take into account a country's IPR environment or its policy towards international collaboration in the field of science and technology. Finally, we have not found a proper way of addressing the issue of Taiwan. Here the problem lies in the availability of representative data, rather than with the political situation of the country.

Although we cast new light on the patterns and drivers of technology transfer between China and the rest of the world, it remains obvious that there are still a number of unanswered questions which call for future research. First of all, it would be very interesting to know what kinds of technologies are exchanged between China and other countries. Second, in the same context, it is worth asking whether the technology transfer between China and other countries is a way of substituting what is produced locally, i.e. de-localization of R&D activities, or whether this process is driven by a search for complementary resources. In our view, these questions should be answered.

In conclusion, we believe that our working paper provides a number of valuable insights into the determinants of international technology transfer from and to China. It opens up a new approach to studying the role of China in the process of global knowledge and technology development. This approach focuses not only on the potential threat posed by its increasing innovation capacity, but also on China's role in international technology exchange.

Annex

Table 3: Descriptive statistics

Technology transfer from the rest of the world to China					
Variable	Obs	Mean	Std.Dev.	Min	Max
$ApIn_{CN,j}$	260	7,669178	25,56209	0,023821	253,8903
GDP_{CN}	260	1,72E+12	8,92E+11	3,57E+11	3,49E+12
GDP_j	242	1,65E+12	2,55E+12	5,02E+09	1,41E+13
FDI_{CN}	260	60777,2	36202,16	3487	149624
FDI_j	201	37725,72	55661,05	-24184,2	321276
INV_{CN}	260	54020,31	42382,16	5299,121	133781,6
INV_j	260	35732,84	83712,05	0	359642,1
Technology transfer from China to the rest of the world					
Variable	Obs	Mean	Std.Dev.	Min	Max
$ApIn_{j,CN}$	378	1,57E+01	4,89E+01	2,38E-02	4,07E+02
GDP_{CN}	378	1,61E+12	9,11E+11	3,57E+11	3,49E+12
GDP_j	332	1,33E+12	2,26E+12	3,51E+08	1,41E+13
FDI_{CN}	378	57782,96	35762,32	3487	149624
FDI_j	272	31851,24	50846,8	-24184,2	321276
INV_{CN}	378	49109,38	42642,21	5299,121	133781,6
INV_j	378	25649,63	71134,4	0	359642,1

Table 4: Pair-wise correlations

Technology transfer from the rest of the world to China							
	$ApIn_{CN,j}$	GDP_{CN}	GDP_j	FDI_{CN}	FDI_j	INV_{CN}	INV_j
$ApIn_{CN,j}$	1						
GDP_{CN}	0.6192*	1					
GDP_j	0.1225*	-0,0982	1				
FDI_{CN}	0.4303*	0.5821*	0.2052*	1			
FDI_j	0,092	-0,0739	0.9385*	0.2163*	1		
INV_{CN}	0,0088	0.4623*	-0.1570*	-0,1008	-0.1309*	1	
INV_j	0.1266*	-0,0844	0.9855*	0.1787*	0.9073*	-0.1422*	1

Technology transfer from China to the rest of the world							
	$ApIn_{CN,j}$	GDP_{CN}	GDP_j	FDI_{CN}	FDI_j	INV_{CN}	INV_j
$ApIn_{CN,j}$	1						
GDP_{CN}	0.1747*	1					
GDP_j	0.7161*	-0,0178	1				
FDI_{CN}	0.1352*	0.9392*	-0,017	1			
FDI_j	0.4654*	0.2814*	0.5807*	0.2867*	1		
INV_{CN}	0.1737*	0.9841*	-0,0109	0.9091*	0.2528*	1	
INV_j	0.1167*	-0,0915	0.4851*	-0,0852	-0,053	-0,0847	1

Significance levels: * = .95

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Abstract
We study the patterns and drivers of international technology transfer to and from China and the rest of the world. Our analysis makes use of patent-based measures of cross-border ownership of inventions. To quantify these technology flows, we a patent database providing a worldwide coverage of patents. We use a gravity model to explain the drivers of the international technology transfer. Although China exhibits a large deficit in international technology transfer, the flow of technology from abroad to China intensifies as its absorptive capacity grows. Excluding Taiwan, the US and China relationship dominates the technology transfer between China and the rest of the world. This is even more emphasised by the relatively weak position of Japan and other Asian countries in the process of technology exchange with China. This is result is not affected by the fact that the US acts mainly as an acquirer of Chinese technology.

Keywords: international technology transfer, cross-border ownership of inventions, patent analysis, China
JEL classification: D8, F23, O14, O30, O57

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