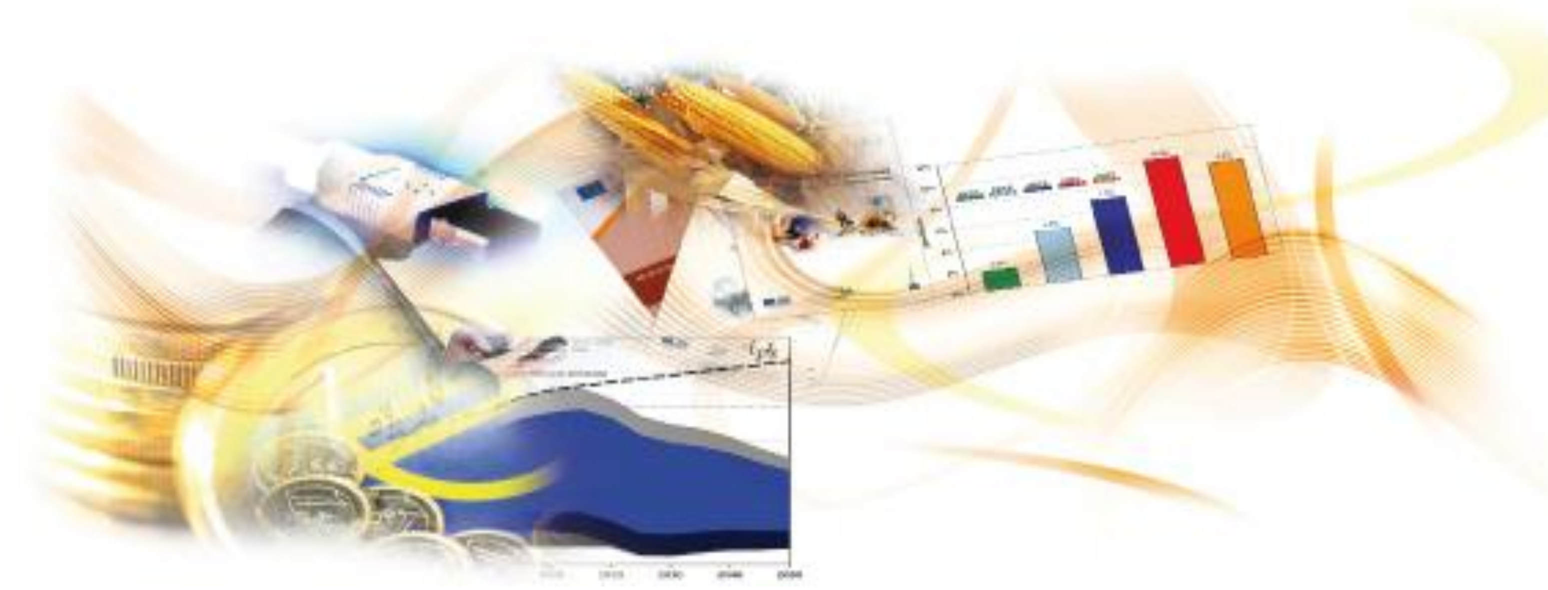

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A framework for assessing innovation collaboration partners and its application to BRICs

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Preface[1]

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:

- 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).
- Internal Technology Transfer between China and the Rest of the World. 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

[1] This article was accepted for publications the International Journal of Technology Management Special Issue on Collaborative Innovation: A New Paradigm in Emerging Countries, 2013.

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1. Introduction

Innovation collaboration is becoming an important model of the innovation process (De Prato and Nepelski 2012b, Narula and Hagedoorn 1999). Whenever there is a research problem that spans the globe, such as global climate change or infectious disease control, different countries are motivated to join forces and work towards a common goal. The development of cross-border innovation collaboration is additionally driven by corporations that seek knowledge sources and opportunities worldwide (Bartlett and Ghoshal 1990, Dunning 1988, Dunning 1994, Archibugi and Iammarino 2002, Doz et al. 2001, Grevesen and Damanpour 2007). Thus, the amount of collaborative research, whether it is motivated by synergy effects, access to specific resources or whether it is thought to be a panacea to skill shortages, is increasing rapidly (Nepelski et al. 2011, UNESCO 2010). One of the important changes is the entry of new countries that are becoming both important players in the field of knowledge and technology development and potential partners for innovation collaboration. In this framework, how to select an innovation collaboration partner is becoming more and more relevant from two perspectives: that of searching for the most appropriate collaboration partner, and that of the appreciation of the possible benefits of collaboration. However, despite the relevance of this issue, there is no methodology that would help either policy makers or business executives to address these questions.

In this paper, we develop a methodological framework to *ex ante* assess innovation collaboration partners and propose patent-based indicators in order to analyze specific cases. The assessment framework helps to profile potential innovation partners in the following steps: measuring their inventive performance, mapping the technology specialization patterns, assessing their openness to innovation collaboration with foreign partners and, finally, assessing the economic potential of technology developed by a country's inventors. The application of this framework is meant to provide help to policy makers who design science and technology collaboration programmes and also companies that are looking for suitable partners for technological joint ventures. By making an *ex ante* evaluation of collaboration benefits, they benefit from improved definition of collaboration needs and selection of suitable partners with relevant capabilities. To test this methodology, we have applied it to a study of the BRIC countries: i.e. Brazil, Russia, India and China.

So far, not much attention has been devoted to the issue of *ex ante* comprehensive assessment of countries' innovation collaboration potential. It is mostly business literature that tackles the question of how to select an innovation collaboration partner and what is the benefit of such a collaboration. For example, examinations of the impacts of technological life-cycle and competencies in a successful joint-venture confirm that these are crucial factors that determine the final outcome of a joint undertaking (Chen et al. 2011, Santamaria and Surroca 2011). A country-level perspective of how to find a perfect match for joint collaboration seems to be missing in the discussion. At best, studies of individual emerging countries exist, e.g. India or China (Abraham and Moitra 2001, Liu and White 2001), which usually focus only on the innovation performance measured by, for example, the number of patents, publications or R&D expenditures. A notable exception is a study that proposes a framework for exploring pathways to innovation in Asia (Ernst 2005). However, by focusing on a single industry and the diversity of specific country trajectories, its application is rather limited.

All in all, the lack of a comprehensive analysis of how to assess an innovation partner is quite surprising, as the number of potential innovation partners is increasing with the growing importance of Asia and other developing countries. Moreover, the right match between innovation collaboration partners has a strong impact on the innovation performance. Hence, our contribution is to provide a framework that can be applied to assessing an innovation collaboration partner, independently of industry or origin. Furthermore, due to the fact that the set of provided indicators is also independent of a particular context and is publicly available, the framework is very flexible in its application.

Regarding the choice of countries, it was motivated by the fact that BRICs belong to the group of the most expanding economies at present and, what is more interesting, also destination of R&D-related investments by foreign companies and countries (Nepelski et al. 2011). However, the economics of these countries are very heterogeneous and so is their R&D landscape. Moreover, despite the large amount of attention BRICs receive (Abraham and Moitra 2001, Simon 2011), to our best knowledge, there has been no attempt to assess their prowess as innovation collaboration partners.

The remaining of the paper proceeds as follows: Section 2 describes the innovation collaboration assessment framework and proposes patent-based indicators. Section 3 introduces the data and measures used in the study. Section 4 applies the assessment framework to BRICs. Section 5 concludes.

2. A framework for assessing innovation collaboration partners

The main objective of this paper is to develop a methodology of innovation collaboration partner assessment and to apply it to BRICs. To this aim, we introduce some concepts that are relevant for innovation collaboration and a set of indicators that describe and assess a country's capacity and attractiveness as a partner for innovation collaboration. In doing so, we first review the list of drivers behind international innovation collaboration, which serves as a baseline for formulating the key criteria of collaboration assessment.

Although there are many aspects behind internationalisation of R&D in general and behind engaging into international innovation collaboration in particular, there are three main criteria that determine the choice of location and partner (Dunning 1988, Dunning 1994, Boutellier et al. 2008). The first criterion is the access to the resources that, in most cases, are non-transferable and location-specific. Examples of such resources include inputs to R&D activity, e.g. scientists and universities, or the knowledge about customers and markets. The second criterion is related to the macroeconomic environment of the host country and includes, for example, a reliable legal framework for R&D and macroeconomic and political stability. Cost of doing R&D abroad seems to be the third criterion for choosing a location for a collaborative R&D agreement. This issue is particularly important in the context of developing countries. In such cases, mainly business enterprises but also public research institutes expect to benefit from lower cost of labour and/or government incentives when engaging into collaborative research project. It seems that the cost consideration gains on importance as knowledge spreads around the world and as technological tasks become easier to separate, modularise, and divide into distinct phases (Brusoni et al. 2001). These changes allow for allocating different parts of R&D projects in various R&D locations, depending on the expertise and cost advantage.

One way of looking at the international inventive collaboration is by focusing on the exploitation of home-base-generated knowledge versus the exploitation of external sources of knowledge (Kuemmerle 1997, Niosi and Bellon 1994). The former is called asset-exploitation and the latter asset-seeking strategy. Regarding the asset-exploitation strategy, it is argued that the process of building knowledge abroad is a natural step a firm makes after having established its presence through either export or production activities in a new market (Boutellier et al. 2008). By creating learning capacities and collaboration projects in these regions or countries, knowledge about these markets is acquired. This allows to, for example, customize products to better serve customer needs. The asset-seeking strategy reflects another reason to look for collaboration with international partners with the aim of gathering new knowledge and expertise. Setting up a joint collaboration project to tap into the resources of a particular location serves to augment the home base knowledge.

Thus, taking this into account the above discussion, we arrive to four aspects that can be relevant to the selection of innovation collaboration partner: First, the *inventive performance* is taken into account to allow for quantification of the inventive mass and dynamics of a country's inventive performance. Second, in order to reveal a country's innovation capacities and profile, we consider its *technological specialization* patterns. Third, we consider a country's *openness to international innovation collaboration*. Lastly, we include in our framework an aspect that focuses on the *economic potential of technology* produced by a country. Each step makes use of indicators derived from the information included in patent applications. Below, we describe each step of assessing a country's attractiveness as a partner for innovation collaboration in detail. Table 1 summarises the assessment framework together with relevant indicators.

Inventive performance

What is the inventive mass and dynamics of a country's inventive performance? In other words, does a potential innovation partner possess knowledge and technology recourses that can used to complement or augment own assets? In the context of the current study to understand better the inventive capacity of a country as a producer of knowledge and technology allows us to assess its potential attractiveness as an innovation collaboration partner. The inclusion of the inventive performance measure in our methodological framework is motivated by the importance of the existence of knowledge assets that, as explained above, can either complement or augment the available knowledge pool of a collaboration partner. Indeed, it has been found an important factor stimulating and attracting innovation collaboration (De Prato and Nepelski 2012b). Expecting that not only distance hiders and economic factors facilitate international innovation collaborations (Picci

2010), a country's inventive performance indicates the inventive capacity which might attract innovation collaboration partners.

Measuring innovation performance is, however, far from being straightforward. Thus, despite their limitations, we use patent-based measures of innovation performance (OECD 2008). Patent data provide increasingly detailed and wide information on the expected results of research and development efforts and of inventive activity in general. Moreover, the type of information they provide is seen as 'objective', and it offers quantitative results that can be effectively combined with other indicators for cross-validation.

In practical terms, we capture innovation performance of a country by the total number of patent applications of a country. This measure is computed through fractional counting of inventors residing in that country independently of the patent office to which application was submitted.

Technological specialization patterns

One of the drivers behind the emergence of international innovation collaboration is the access to complementary resources and assets (Dunning 1994, Sachwald 2008, Archibugi and Iammarino 2002, Dunning 1988). These resources are, in most cases, non-transferable and location-specific. Hence, before engaging into collaboration one of the most important points is to get to know the strengths and weaknesses of a potential partner. In other words, it is indispensible to know the structure and output of their R&D activity, i.e. technological specialization. One answer to this problem is to map a partner's technological competencies and specialization patterns. The information on what technology a potential partner produces allows determining whether the resources one finds in a foreign country complement or augmenting the domestic knowledge recourses. In the framework introduced by Kuemmerle (1997), it helps to define whether a collaboration with a partner supports the asset augmenting or asset exploiting strategy.

The focus on the technological specialization patterns is additionally motivated by the fact that, as it was shown by a study at company level, technological competency and life cycle of potential partner play a role in the formation of alliances (Chen et al. 2011). This reflects the motivation to establish a technological joint-venture with the intention to find complementary resources and to explore new ideas (Santamaria and Surroca 2011). Hence, the second aspect of our assessment framework is technological profiling. To this aim, we introduce measures that identify a set of technology fields and provide information on how strong a country is in each of the field. In the current framework, to this aim, we measure technological specialization by computing the shares of individual technology fields in the total number of patent applications.

Openness to international innovation collaboration

Considering the phenomenon of international innovation collaboration, the openness of inventors from one country to collaborate with their counterparts from other countries, is at least as important as the inventive performance and innovation profile of a country (De Prato and Nepelski 2012a). This element aims at capturing the macroeconomic environment of the host country, one of the main reasons behind international R&D ventures. The openness to collaboration with foreign actors is not only a function of a reliable legal framework, macroeconomic and political stability, but also of cultural proximity, which are also found relevant to international collaboration (Picci 2010). Hence, in our methodological framework, we include a measure of openness to international collaboration.

In order to capture the role of foreign partners in working with domestic inventors, being aware of the limitations of its limitations (Bergek and Bruzelius 2010), we use the share of international co-inventions in the total number of a country's inventions, i.e. patents.

Economic potential of technology

Potential economic benefits of innovation collaboration might be of high importance when evaluating a collaboration partner. Hence, we are interested in potential economic value of a country's innovations and technology. An informative way of assessing the value of innovations would be to look at their potential market. Clearly, innovations for which there is a global demand would have a clear advantage over innovations that target only local, i.e. national, markets. Thus, we introduce a measure of economic potential of technology which is based on inventors' expectations concerning its value. Here again we make use of the information included in patent applications and distinguish between patent applications that have been filed to national or a foreign patent office. Our approach to the economic potential of technology follows the concept of patent family size, as defined by Grefermann and Röthlingshöfer (1996).

This approach assumes that patent applications submitted to a foreign office rather than to a national one have a relatively higher expected value. In other words, the interpretation of the patent family size as a proxy of patent value is that the owners of a patent believe that the invention has the potential to be exploited in a bigger market than the national one. A straightforward justification of this assumption is that protection will be sought beyond the local market only for inventions with sufficient expected value to their owners. This expectation has been confirmed by empirical studies of the relationship between patent size family and firm value, which found a positive relationship between the two variables (Harhoff et al. 2003, Reitzig 2004). To proxy for the value of a country's innovation output, we use the share of patent applications filed to international patent offices in the total number of patent applications.

Table 1: Assessment framework for innovation collaboration partners

Assessment criteria	**Description**	**Indicators**
Inventive performance	• What is the inventive capacity of a country’s inventive performance with which collaboration is sought? Hence, what is its capacity in the production of new knowledge and technology? • Does the inventive output increase or decrease? How does the country progress in the production of knowledge and technology?	• Number of priority patent applications; • Growth of the patent applications.
Technological specialization patterns	• What technology does a country specialize in? • In what technological areas collaboration is feasible? What can be a potential result of collaboration with a country? • Does collaboration with a partner supports the asset-augmenting or the asset-seeking strategy? • Does a country have scientific resources that are deployed to produce similar or different types of knowledge and technology? Are its technological capacities and resources complementary or can they be used as a substitute? • What does the technological landscape look like in terms of diversification? Is it diversified or concentrated in few technological classes?	• Shares of each technology field in the total number of patent applications; • Growth of patent applications by technological classes.
Openness to international innovation collaboration	• Do a country's researches have a record of collaboration with their foreign counterparts? Hence, how open a country is to foreign collaboration? • How important is the share of international inventive collaborations in a country's overall production of knowledge and technology?	Share of international co-inventions in the total number of patent applications.
Economic potential of technology	• Are a country's inventions protected primarily in domestically or internationally? Whereas the first one might indicate a focus on the development of technology demanded domestically, the latter one exhibits an orientation towards developing technology that can be applied in other countries as well. • What is the potential market for inventions developed in a country?	• Share of patent applications filed to international patent offices in the total number of patent applications. • Share of patent applications with subsequent patent filings.

3. Elaboration of patent-based indicators and data source

In order to provide a set of indicators that capture the concepts used in the assessment framework, we use patent data. Even though a number of shortcomings of patent data as a proxy of innovation or technological progress have been pointed out in the literature (De Rassenfosse et al. 2011, Turlea et al. 2011), this source of data is still considered to be one of the best measures of inventing capability and an important method of assessing various aspects of technological change (Griliches 1990). Consequently, a large body of literature uses patent statistics as tool for studying issue of the research and innovation process (De Prato and Nepelski 2012b, Bosworth 1984, Smith 2005). Moreover, this type of information is also used by firms to assess the level of technology development in a particular sector or a firm (Archibugi and Planta 1996, Patel and Pavitt 1997). Patent statistics are also used to analyse the strengths and weaknesses of competitors (Narin et al. 1987), which resembles the use of this source of information for the purpose of the current study.

The 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: 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’) (OECD 2008). 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. In this study, the adoption of the inventor criterion has been chosen, as it allow to provide a more accurate picture of activity of a country's inventors (De Rassenfosse et al. 2011, Turlea et al. 2011).

With regard to the identification of technology fields, patent applications are grouped into eight groups by using 35 International Patent Classification (IPC) technological fields based on the WIPO classification table (Schmoch 2008). The fractional counts approach has also been applied in case of applications referring to more than one technology field.

In order to derive a measure of openness to international collaboration, we make use of a patent-based measure of internationalisation. This measure is based on the concept of co-invention, i.e. an invention developed by more than one person. The measure of international innovation collaboration is defined as the share of a country's inventions with inventors residing in the country and inventors residing outside of the country, in the country's total number of inventions (according to the inventor criterion). Here, we follow Guellec and Van Pottelsberghe de la Potterie (2001),[2] and define algebraically the measure of co-inventions of country *i* as:

$$CoInv_i = \frac{P_i^{II}}{PI_i} \quad (1)$$

where P_{ij}^{II} is the number of patents co-invented be residents of country *i* and country *j* and PI_i total number of patents invented by residents of country *i*.

Finally, when speaking of the economic potential of technology, we proceed in two steps. First we count all the patents applications which include at least one national inventor, i.e. residing in a relevant BRIC country. Second, we distinguish between priority and subsequent applications and between patents filed to the national patent office and those filed to an international patent office. This way, we distinguish between the following patent applications:

i) Priority patent applications submitted to the national patent office, which can be divided into:

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[2] For an extensive description of the methodology and its application to study various types of R&D internationalization using patent-based indicators please refer to the 2011 Report on R&D in ICT in the European Union Turlea, G., Nepelski, D., De Prato, G., Simon, J.-P., Sabadash, A., Stancik, J., Szewczyk, W., Desruelle, P. & Bogdanowicz, M. 2011. 'The 2011 report on R&D in ICT in the European Union.' *JRC Scientific and Technical Report*. Seville: Institute for Prospective Technological Studies, Joint Research Centre, European Commission. and to the Report on Internationalisation of ICT R&D Nepelski, D., De Prato, G. & Stancik, J. 2011. 'Internationalisation of ICT R&D.' *JRC Scientific and Technical Report*. Institute for Prospective Technological Studies, Joint Research Centre, European Commission..

a) Priority patent applications without subsequent patent applications and

b) Priority patent applications with subsequent patent applications to foreign patent offices.

ii) Priority patent applications submitted to any international patent office, which again can be divided into:

a) Priority patent applications without subsequent patent applications and

b) Priority patent applications with subsequent patent applications to foreign patent offices.

iii) Subsequent patent applications to any foreign patent office.

As described in the previous section, for the purpose of the current study, we are interested in knowing what was the potential of inventions expressed in the share of patent applications submitted to any foreign patent office, i.e. the sum of (ii) and (iii), in the total number of inventions co- or developed by domestic inventors.

Regarding the source of data, we use patent data coming from the European Patent Office (EPO) Worldwide Patent Statistical Database 2012, known as PATSTAT. This database provides a worldwide coverage of patent applications submitted to around 90 Patent Offices in the world. The time period taken into account covers from January 1st, 2000 to December 31st, 2008.

4. Assessing BRICs as a innovation collaboration partners

In order to demonstrate the value of the framework for assessing innovation collaboration partners described above, we apply it to study BRIC countries. This way we intend to show what kind of insights can be obtained by using our framework and, at the same time, to cast some light on BRIC countries as innovation partners and on the potential benefits that can result from collaborating with inventors residing in a BRIC country.

Inventive performance

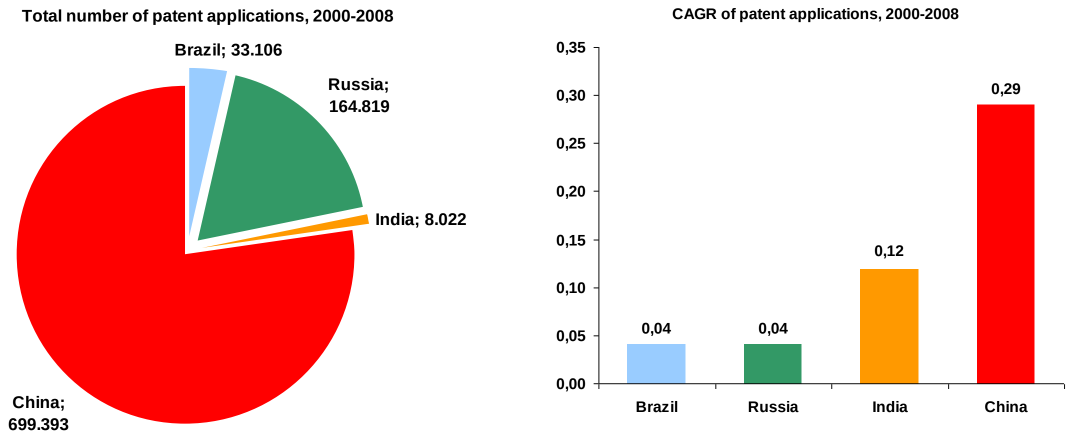
Following our framework, BRICs' innovation performance is captured by the total number of patent applications with inventors residing in each of the country. This number is computed through fractional counting of inventors residing in a BRIC country independently of the patent office to which application was submitted.

According to Figure 1, the output of the BRICs inventors for the time period between 2000 and 2008 was slightly nearly 1 million of patent applications in all technology fields. However, we can see that there are extreme differences in the inventive performance between the BRICs. Whereas there were altogether 8.022 patent applications with Indian inventors, the amount of Chinese patent applications was nearly 100-fold higher. The remaining BRIC countries were equally far behind the output of China. For example, there were nearly 165 and 33 thousand of patent applications including Russian and Brazilian inventors respectively.

In absolute terms, the inventive performance of BRIC is very heterogeneous and, with exception of China, the inventive performance of the most of the BRIC countries is at a very modest level, owning to the history of the development of these countries (Simon 2011). Thus, it is rather the growth rate of the inventive performance than absolute number that calls for our attention. According Figure 1, the compound average growth rate (CAGR) in the number of patent applications ranged between 4% for Russia and Brazil and 29% for China between 2000 and 2008. For the same period of time, the remaining India recorded CAGR of 12% in priority patent applications. Thus, the most dynamic BRIC countries whereas include China and India. However, there again we can observe strong differences between these two countries and a very impressive performance of China. In the last decade, the output of Chinese inventors increased 15-fold whereas the number of patent applications produced by Indian inventors more than doubled.

In other words, Chinese innovation capabilities are increasing as China is turning into one of the most prolific countries in terms of applications for and grants of patents. In comparison, in 2007, there were around 60.000 and 100.000 patents developed by US and European Union (EU) inventors respectively. Regarding India, the reasons behind the developments in India's patenting are manifold (Malik 2013). First of all, as until the 1990s, the economy was under state control and there was no incentive for private companies to invest in R&D. Moreover, the state-run science and technology organizations did not aspire to compete at international levels as well. A change came with the liberalisation of the economy in the 1990s. Domestic firms faced global competition, on the one hand, and state research institutes were forced to generate revenues through technology commercialisation and to showcase their capabilities through patents. As a result, over the last years we can observe very dynamic growth in India's patenting.

Figure 1: Total number and growth of priority patent applications with BRICs' inventors, 2000-08



Note: Based on fractional counting of priority patent applications including inventors residing in BRIC countries.

Source: Own calculations using the inventor criterion based on PATSTAT Database, version 2012.

Technological specialization patterns

In order to cast some more light on the technological specialization patterns of the BRICs, we analyse the priority patent applications with inventors of each of the BRIC country by technological fields. Figure 2 presents the patent applications submitted to any patent office including an inventory from a BRIC country between 2000 and 2008 broken down by the top ten IPC technological classes. A detailed picture of the size of each technological field can be found in Table 4 (see Annex). In addition, to obtain some information on the recent dynamics in the technological progress, Figure 2 reports ten fastest growing technological fields and Table 5 includes CAGRs for each of the 35 technology class defined by the WIPO (see Annex).

According to Figure 2, Brazilian patents seem to be technologically dispersed. The top ten technological classes account for 60% of all the priority patents with Brazilian inventors. The most relevant fields are civil engineering, special machinery, transport and furniture. Each of this class does not constitute more than 10% of all the patents. Considering the growth rates of patenting in some technological classes (see Table 4, Annex), we can see that the most dynamic ones include nanotechnology, semiconductors, IT methods and organic and basic materials chemistry. Whereas the CAGR of patenting in nanotechnology reached 200% between 2000 and 2008, the growth in the remaining fields was at the level between nearly 30% and 22% for semiconductors and IT methods and organic chemistry respectively. Except for the national and companies' innovation strategies that address these technological areas, an important stimulus of patent growth in such areas as biotechnology, business methods and computer-implemented inventions is due to the changes in the Brazilian patent law (Rizzotto 2009, Simon 2011), which introduced changes facilitating patenting in the field of information and communication technologies (ICT).

Considering the case of Russia, Figure 2 shows that its patenting activity is much more concentrated, as compared to Brazil. The three largest technological fields, i.e. food chemistry, medical technology and civil engineering, have a share in the total number of patents between 8 and 12%. Moreover, the top ten technological classes account for altogether 63% of all patent applications with Russian inventors. With respect to the growth in particular technological classes, we can observe that nanotechnology, digital communication and food chemistry are the most dynamically growing ones. In particular, as in the case of Brazil, nanotechnology is the fastest growing technological field.

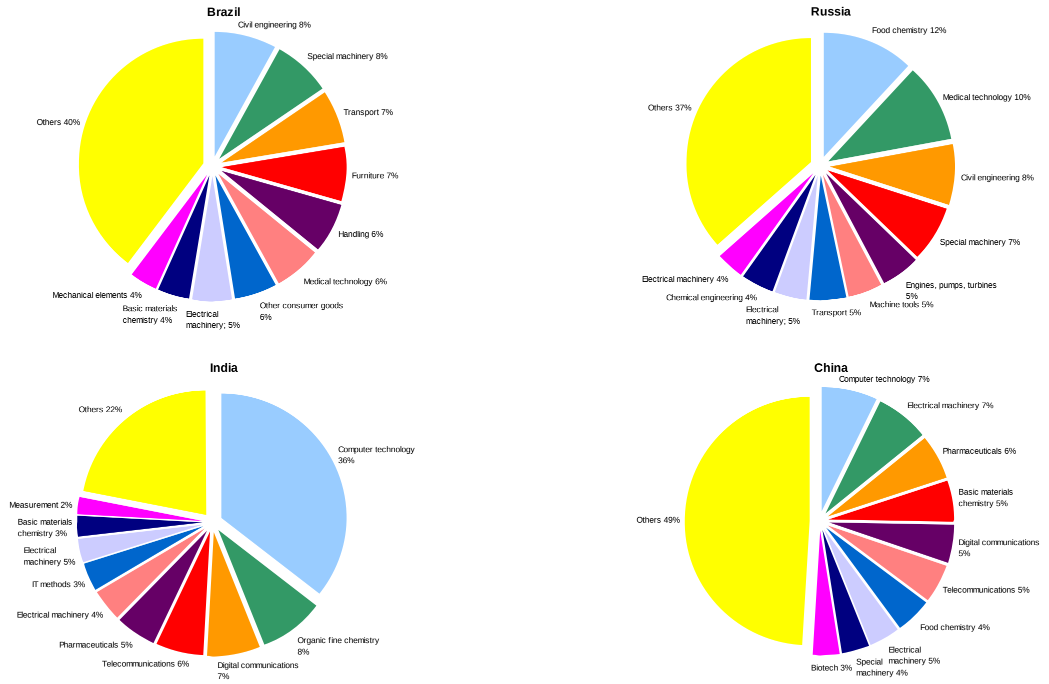
Regarding India, the most important technological fields include computer technology, organic fine chemistry, digital communication, telecommunications and pharmaceuticals. These five technological fields account for more than 60% of technological diversity of Indian inventions. Moreover, three fields belong to the broad category of ICT. This list clearly confirms the image of India's innovation activity focused on only two sectors, i.e. IT and pharmaceuticals. There are two major factors behind this concentration of inventive activity and relatively large innovation productivity in these two industries. First, these are mainly multinational enterprises (MNEs) that are the prime drivers of the increasing number of patenting. Hence, as a large share of the multinational firms with R&D activities in India belong either to the IT or pharmaceutical sector, it partially explains the dominant role of the two technological fields. However, also domestic companies operating in these fields are slowly but successfully entering the global high-tech industries (Mazumdar 2010, Simon 2011). One part of their strategy is to increase R&D expenditures to meet international competition. This additionally strengthens the focus on IT and pharmaceuticals R&D activity. A closer look at the growth rate in patenting in all technology fields reveals that the dominant technologies are not necessarily the fastest growing ones. The fastest growing technological fields include other consumer goods, micro nanotechnology, transport, optics and thermal processes. At the same time, we can observe a relative decline in importance of such technological fields as basic materials and chemistry, pharmaceuticals and biotechnologies (see Table 4, Annex). Here it comes as a surprise a sharp decline in the pharmaceuticals or organic and fine chemistry.

Lastly, considering China, we can observe that the dominant technologies include computer technology, electrical machinery and pharmaceuticals. However, none of the top ten technological classes exceeds the 10% benchmark and, altogether they account for only 51% of all the patent applications. Thus, out of all the BRIC countries, the Chinese technological landscape is the most diversified. Moreover, when we consider also the growth rates by technology class, we can observe that there are very dynamic changes. In general, patenting in 33 out off all 35 technological classes recorded a CAGR of at least 20% and the three fastest growing technological classes, i.e. nanotechnology, IT methods and digital communication, maintained a CAGR of over 50% (see Table 4, Annex). All this confirms a relatively strong development of Chinese R&D landscape and a sound diversification of the technological portfolio.

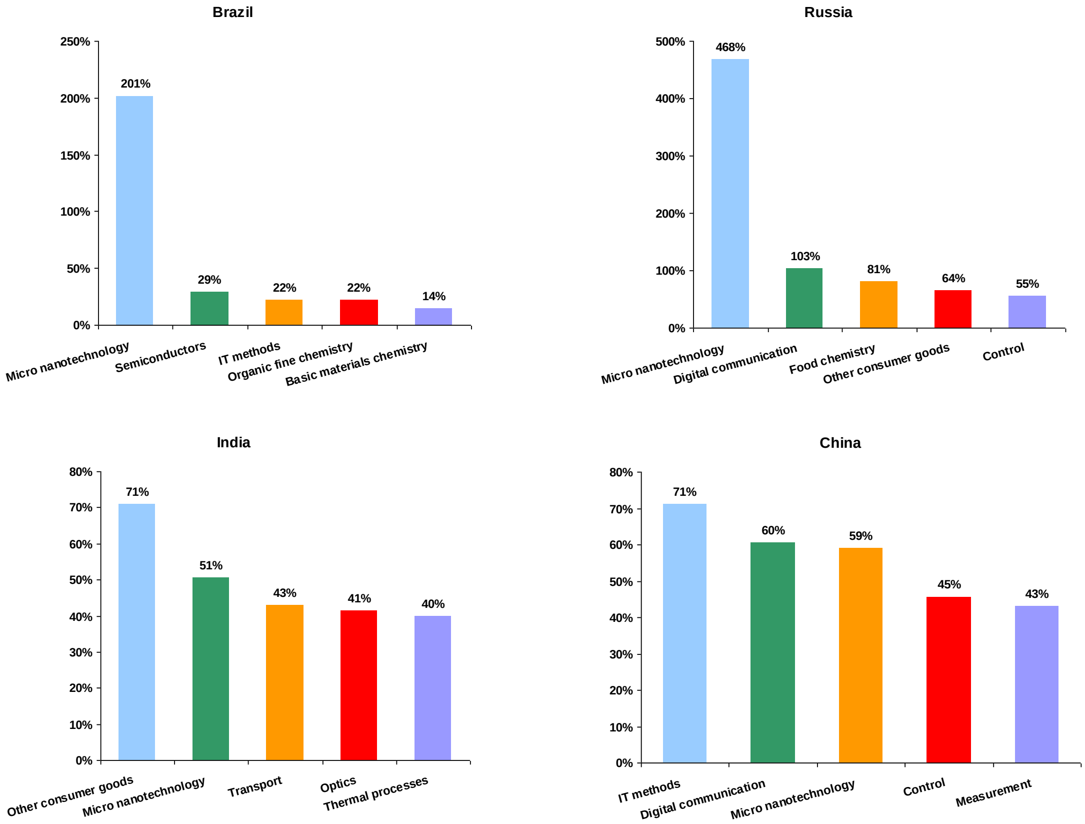
Summing up, the analysis of technological specialisation patterns of the BRICs reveals that there are considerable differences between the countries. For example, Indian and Russian patents are dominated by only few technological classes, Brazilian and particularly Chinese patents exhibit a large diversity of technologies. Moreover, the high growth rates in some technological classes in most of the countries clearly show that the entire innovation landscape of each country is going through some important structural transformations. Except for China, where we can see high growth rates in all areas, the remaining countries clearly focus on few technologies, such as nanotechnology. In the case of India, for example, this is also happening at the cost of technological fields that have been so far considered as strength of the Indian R&D and innovation system, i.e. chemistry and pharmaceuticals.

Figure 2: Distribution and dynamics of patent applications by IPC technology class, 2000-08

Ten largest technological classes: total number of patent applications between 2000 and 2008



Five fastest growing technological classes: CAGR between 2000 and 2008



Note: Based on fractional counting of priority patent applications including inventors residing in BRIC countries.

Source: Own calculations using the inventor criterion based on PATSTAT Database, version 2012.

Openness to international innovation collaboration

Turning to the question of how open BRICs' inventors are towards collaboration with their foreign counterparts, Figure 3 shows for each of the analysed countries the share of international co-inventions between domestic and foreign inventors and their growth over the period between 2000 and 2008.

Regarding the level of international collaboration, in general, it has remained low over the analysed time. For the majority of the countries, the number of inventions developed with foreign inventors oscillated around the level of 1%-4% of their inventive output. In our comparison, India and to some extent Russia have the highest level of international co-inventions, whereas, China and Brazil report the lowest level of inventive collaboration with international partners. Moreover, with the exception of India, we can not see a clear trend. For the majority of the countries the end value was not far from the beginning of the period. Thus, the absolute growth of international co-inventions can be attributed to the overall growth of patenting activities. In other words, although the process of R&D internationalisation in the developing continues is progressing (Nepelski and De Prato 2012), the overall importance of join collaboration between inventors from different countries does not get more attention as the strengthening of R&D capacities and output of individual countries.

In the context of the above observations, the case of India calls for particular attention. In the year 2000, 18% of all Indian innovations were a result of international collaboration. Moreover, this number experienced an intensive growth over the last years and reached the level of over 50% by 2008. Considering that at the same time the overall global share of international co-inventions was much smaller, i.e. below 2% of all inventions patented around the world (Nepelski et al. 2011), this puts India among the world leaders in international innovation collaboration.

The explanation behind India's exceptional collaborative performance is related to the same drivers that lead to the rapid growth of patenting and the technological specialization patterns of Indian innovation activity. It is the increasing presence of multinational firms conducting R&D in India that shape the country's R&D landscape and explains the high co-patenting level of Indian inventors. Considering the important role of MNEs in the inventive activity in India, this findings show their twofold role. On the one hand, MNEs have very strong interest in the inventive potential of India and, on the one hand, they actively shape the country's inventive landscape. Moreover, policy measures directed towards foreign companies operating in India have created incentives for multinational companies to integrate R&D activities in their operations in India (Mazumdar 2010), which increased the number of both patents and international co-inventions. Thus, it can be concluded that these companies seem to animate and activate the resources available in India and, by combining them with their assets, generate new types of knowledge and technology. This type of conditions cannot be found in the remaining BRIC countries, which mainly rely on the development of the existing R&D structures, e.g. Russia and particularly China.

Figure 3: Share of international co-inventions, 2000-2008

	International co-inventions			
	Brazil	**Russia**	**India**	**China**
2000	1%	3%	18%	1%
2001	2%	3%	24%	1%
2002	2%	2%	32%	1%
2003	2%	2%	35%	1%
2004	2%	2%	46%	1%
2005	1%	3%	53%	1%
2006	2%	4%	54%	2%
2007	2%	3%	59%	2%
2008	2%	3%	56%	2%

Note: Bilateral measures of international co-inventions for each of the BRIC country are based on fractional counting of priority patent applications including inventors residing in a BRIC country and at least one inventor residing outside of a BRIC country.

Source: Own calculations using the inventor criterion based on PATSTAT Database, version 2012.

Economic potential of technology

The last point of the assessment framework is to evaluate the economic potential of technology developed in BRIC countries. As outlined above, to this aim we track the destination of patent applications which include BRIC inventors. Table 2 reports the results of analysis of patent applications by the type, i.e. priority and subsequent patent applications, and the patent office to which they were filed, i.e. national or foreign one. Moreover, in order to see what share of priority patent applications have follow-ups, we distinguish between those that have subsequent patent applications and those that are filed to only one patent office and do not result in subsequent filings.

According to Table 2, the majority of patent applications including inventors from BRIC countries are priority patent applications filed to a national patent office. This number varies however strongly. Whereas nearly 90% of priority patent applications with Russian and Chinese inventors are filed to a national patent office, 76% of Brazilian and only 3% of Indian patent applications are first filed to a domestic patent office. Here we can see that, again, the case of India is quite exceptional in our analysis, as the majority of patent applications covering Indian inventions, i.e. developed by Indian residents, are filed outside of India. Moreover, according to other sources, around 50% of these applications are filed to the US Patent and Trademark Office (De Prato and Nepelski 2011).

Looking at the priority filings through the perspective of subsequent application, we can see that nearly 90% of all Russian and Chinese priority patent applications do not have a subsequent patent application. At the same time, 73% of Brazilian priority patent applications and only 43% of Indian ones cover inventions that are protected in only one country. The remaining priority applications with inventors, i.e. 27% of Brazilian and 57% of Indian priority applications, result in subsequent applications to other patent offices in the world.

The composition of the subsequent patent applications by the destination of the priority patent applications shows that the priority patent applications filed to a national patent office result in between 3% (Indian inventions) to 16% (Brazilian inventions) subsequent patent applications. In comparison, between 1% (Chinese inventions) and 40% (Indian inventions) priority patent applications filed to a foreign patent office have further follow-ups. Thus, while on the one hand Brazilian and Chinese priority patent applications filed to a national patent office have the highest share of follow-up applications, i.e. 16% and 7%, a high number of priority patent applications with Indian inventors filed to a foreign patent office result in a subsequent application, i.e. 40%.

It must be noted that the picture presented here is strongly influenced by the national innovation and industrial policies and the IPR regimes. For example, up to 2009, the Chinese Patent Law required that a Chinese patent applicant for an invention completed in China must first file a patent application in China before any foreign filing (JD 2009). The recent Amendment introduced in 2009 provides that patent applications for inventions completed in China may be filed directly outside of China without the need of first filing in China.

Although this clarify the relatively low level of patent applications filed to a foreign patent office, it can not explain it completely, considering the discrepancies between the BRIC countries in the share of patent applications that are filed to foreign patent offices.

Summing up, the above analysis leads us to conclude that there are significant discrepancies between BRICs with respect to the potential value of inventions, as measured by the size of a patent family. First of all, except for India, the patenting activities in the remaining countries follow a well known pattern of home bias, i.e. where protection for domestically developed inventions is first sought under the national jurisdiction (OECD 2008). Thus, due to a large share of patent filings submitted abroad, on average Indian inventions are likely to exhibit supranational commercial potential. At the same time, however, we need to mention that it is very likely that it is not only the value of Indian innovations that drives the inventors to file patent applications outside of India first. There are a number of other reasons why such a large share of Indian inventions is patented outside of the country of origin. For example, the role of MNEs and the weak domestic R&D infrastructure, as already discussed above, play a key role. The strength of intellectual property protection in the country might also be an issue. However, we can also observe that a relatively large share of Brazilian and Indian priority patent applications results in a subsequent patent application, while their Russian and Chinese equivalents are relatively less productive. Among BRICS, China and Russia report the highest shares of inventions that are protected only in one country, i.e. mainly home country. This can be interpreted in two ways. On the one hand, the high share of mainly Indian and to lesser extent Brazilian inventions protected internationally might be considered as a sign of a global orientation of their domestic R&D activity, which produces inventions attractive for global markets. On the other hand, the size of the Chinese and Russian economies might justify the local orientation of inventions owners who do not seek for patent protection abroad. In any case, however, the more international orientation of Brazilian and Indian intellectual property owners might be a sign that inventions developed by inventors from these two countries have economic potential that goes beyond the national borders.

Table 2: Patent applications by application type and patent office, total for 2000-2008

			Brazil	Russia	India	China
Priority patent applications	To national patent office		76%	89%	3%	89%
		Without subsequent applications	71%	88%	2%	86%
		With subsequent applications	5%	2%	0%	4%
	To foreign patent offices		3%	3%	54%	2%
		Without subsequent applications	2%	2%	41%	2%
		With subsequent applications	1%	1%	13%	1%
	Total		**79%**	**92%**	**57%**	**92%**
Subsequent patent applications	With priority applications filed to the national patent office		16%	5%	3%	7%
	With priority applications filed to a foreign patent office		5%	3%	40%	1%
	Total		**21%**	**8%**	**43%**	**8%**
Total number of patent applications			**100%**	**100%**	**100%**	**100%**

Note: Includes all patent applications with at least one inventor residing in a BRIC country. Own calculations using the inventor criterion based on PATSTAT Database, version 2012.

A synthesis of the assessment

In order to provide an overview of the results that were obtained after applying the framework to BRICs, in this section we present a synthesis of the most important results concerning BRICs' innovation performance, technological specialization patterns, openness to international innovation collaboration and the economic potential of technology. Table 3 provides the list of assessment criteria together with some stylised facts.

Table 3: A synthesis of the BRICs' assessment as an innovation collaboration partners

Assessment criterion	Brazil	Russia	India	China
Inventive performance	• Modest inventive performance; • Low growth in inventive activity.	• Relatively large inventive performance; • Low growth in inventive activity.	• Relatively low inventive performance; • Very high growth in inventive activity.	• Extremely high inventive performance, which places China among the world leaders in the number of inventions; • Very high growth in inventive activity, which maintains its pace over time.
Technological specialization patterns	• Top 10 technologies account for 60% of inventive output; • Technologically diversified R&D landscape; • Main technologies include civil engineering, special machinery and transport equipment; • Growth mainly in nanotechnology, semiconductors and IT methods.	• Top 10 technologies account for 63% of inventive output; • Technologically diversified R&D landscape; • Main technologies include food chemistry, medical technology and civil engineering; • Growth mainly in nanotechnology, digital communication and food chemistry.	• Top 10 technologies account for 78% of inventions • Strong concentration in two technological fields, i.e. IT and pharmaceuticals; and hence little technological diversification • Dynamic structural changes in the innovation activity; • Sharp increase of activity in such technological fields as consumer goods and nanotechnology; • Decline of activity in pharmaceuticals and biotechnology, traditionally considered as the strength of India's innovation system.	• Top 10 technologies account for 51% of inventive output; • Very diversified R&D landscape; • Main technologies include computer technology, electrical machinery and pharmaceuticals; • Growth mainly in nanotechnology, IT methods and digital communication.
Openness to international innovation collaboration	• Modest level of openness to international collaboration.	• Modest level of openness to international collaboration.	• Extremely high level of international innovation collaboration.	• Very low level of openness to international collaboration.
Economic potential of technology	• Despite a home bias, a relatively high share of patent filings to foreign patent offices; • In general, a high share of subsequent patent filings; • A relatively high share of subsequent patent filings to foreign patent offices.	• A strong domestic bias in priority applications filings; • Majority of inventions are protected only under domestic jurisdiction; • Very low share of filings to foreign patent offices; • Very small share of subsequent patent filings.	• The overall number of patent applications, including priority and subsequent applications, submitted to foreign patent office is outstanding; • The majority of all priority patent applications are filed to the USPTO; • Only a small fraction of priority patent applications with Indian inventors are filed to the Indian patent office.	• A strong domestic bias in priority applications filings; • Majority of inventions are protected only under domestic jurisdiction; • Very low share of filings to foreign patent offices; • Very small share of subsequent patent filings.

5. Conclusions

To better understand the process of innovation collaboration, we have tackled the question of how to assess potential innovation collaboration partners and the benefits resulting from this collaboration. Drawing from the insights on the determinants of innovation collaboration, we have developed a framework for assessing an innovation collaboration partner and provided a set of indicators which allow us to apply this framework to study the BRIC countries as potential innovation collaboration partners.

Our analysis shows that there are large differences between BRICs, not only in the traditional measures of what makes for fruitful inventive collaboration, e.g. inventive performance, but also in terms of specialized dimensions such as openness to international collaboration or the economic potential of technology developed by these countries. Thus, this analysis shows not only what divergent countries could be like as potential innovation collaboration partners, but also what benefits can be expected from this collaboration.

Our work suffers from a number of drawbacks. First of all, patent data, despite the rich information it provides, suffers from its own obvious drawbacks. Moreover, our approach ignores the value of patents, and it does not take into account a country's IPR environment or its policy as regards the output of international collaboration. Second, due to the fact that there is no clear-cut theoretical foundation which explains the formation and evolution of innovation collaboration, we make use of a number of approaches to this issue in order to design the assessment framework and related indicators.

The above non-exhaustive list of limitations to our work provides some suggestions for future work on the subject concerning an *ex ante* assessment of innovation collaboration partners. It seems that the most critical point that needs to be addressed in this area is the economic value of technology, a subject that has recently attracted the attention of researchers, business executives and policy makers. Moreover, the results of applying this framework to studying a larger group of countries would help us to better understand the determinants of innovation collaboration.

Despite its limitations, the framework presented provides a reflection on and a synthetic view of a methodology for innovation collaboration partner selection and for the assessment of innovation collaboration benefits. Based on the results of an assessment, relevant policy and business consideration can be drawn by profiling potential innovation collaboration partners by assessing inventive performance, openness to collaboration, and market potential of the joint inventive output. Therefore, it may help in designing science and technology policy and R&D strategy by making an *ex ante* evaluation of collaboration benefits, and allowing for improved targeting of technology needs and selection of suitable partners. Due to its flexibility, depending on the needs, the framework can be extended by additional measures that are relevant in the context of particular innovation collaborations and which can additionally help to assess the "suitability" and "openness" of potential partners to joint innovation projects. A detailed list of patent-based indicators, which can enrich the current framework, can be found, for example, in a study of internationalisation of R&D activity (Nepelski and De Prato 2012).

Annex

Table 4: Share of IPC technology classes in total number of patent applications between 2000 and 2008

	Brazil		Russia		India		China	
Nr	IPC technology class	Share in total	IPC technology class	Share in total	IPC technology class	Share in total	IPC technology class	Share in total
1	Civil engineering	8%	Food chemistry	12%	Computer technology	37%	Computer technology	7%
2	Other special machinery	8%	Medical technology	10%	Organic fine chemistry	8%	Electrical machinery	7%
3	Transport	7%	Civil engineering	8%	Digital communication	7%	Pharmaceuticals	6%
4	Furniture & games	7%	Other special machinery	7%	Telecommunications	6%	Basic materials chemistry	5%
5	Handling	6%	Engines, pumps & turbines	5%	Pharmaceuticals	5%	Digital communication	5%
6	Medical technology	6%	Transport	5%	Electrical machinery	4%	Telecommunications	5%
7	Other consumer goods	6%	Machine tools	5%	IT methods	4%	Food chemistry	4%
8	Electrical machinery	5%	Measurement	4%	Biotech	3%	Civil engineering	4%
9	Basic materials chemistry	4%	Electrical machinery	4%	Basic materials chemistry	2%	Other special machinery	4%
10	Mechanical elements	4%	Chemical engineering	4%	Measurement	2%	Biotech	3%
11	Engines, pumps & turbines	4%	Mechanical elements	4%	Engines, pumps, turbines	2%	Measurement	3%
12	Food chemistry	3%	Basic materials chemistry	3%	Macromolecular chemistry	2%	Machine tools	3%
13	Chemical engineering	3%	Pharmaceuticals	3%	Food chemistry	2%	Organic fine chemistry	3%
14	Machine tools	3%	Biotech	2%	Chemical engineering	2%	Chemical engineering	3%
15	Control	3%	Environmental technology	2%	Semiconductors	2%	Optics	3%
16	Environmental technology	2%	Thermal processes	2%	Medical technology	2%	Audio visual technology	3%
17	Textile & paper machinery	2%	Analysis biological materials	2%	Control	1%	Semiconductors	3%
18	Thermal processes	2%	Surface technology	2%	Audio visual technology	1%	Environmental technology	3%
19	Measurement	2%	Organic fine chemistry	2%	Surface technology	1%	Thermal processes	2%
20	Pharmaceuticals	2%	Handling	2%	Transport	1%	Medical technology	2%
21	Audiovisual technology	2%	Telecommunications	2%	Environmental technology	1%	Macromolecular chemistry	2%
22	Telecommunications	2%	Other consumer goods	1%	Optics	1%	Transport	2%
23	Computer technology	2%	Computer technology	1%	Other special machinery	1%	Textile, paper machinery	2%
24	Surface technology	1%	Control	1%	Other consumer goods	1%	Mechanical elements	2%
25	Biotech	1%	Optics	1%	Mechanical elements	1%	Other consumer goods	2%
26	Organic fine chemistry	1%	Macro molecular chemistry	1%	Machine tools	1%	Engines, pumps, turbines	2%
27	Macro molecular chemistry	1%	Furniture & games	1%	Analysis biological materials	0%	Surface technology	2%
28	IT methods	1%	Semiconductors	1%	Civil engineering	0%	Furniture	2%
29	Optics	1%	Textile & paper machinery	1%	Furniture	0%	Control	2%
30	Analysis biological materials	0%	Audiovisual technology	1%	Thermal processes	0%	Handling	2%
31	Digital communication	0%	Materials metallurgy	1%	Handling	0%	IT methods	1%
32	Semiconductors	0%	Digital communication	0%	Textile, paper machinery	0%	Analysis biological materials	1%
33	Materials metallurgy	0%	Micro nanotechnology	0%	Micro nanotechnology	0%	Materials, metallurgy	0%
34	Micro nanotechnology	0%	IT methods	0%	Materials, metallurgy	0%	Micro nanotechnology	0%
35	Basic communication processes	0%	Basic communication processes	0%	Basic communication processes	0%	Basic communication processes	0%
Total		100%		100%		100%		100%

Note: Based on fractional counting of priority patent applications including inventors residing in BRIC countries. Source: Own calculations using the inventor criterion based on PATSTAT Database, version 2012.

Table 5: Growth of the number of patent applications by IPC technology classes between 2000 and 2008

	Brazil		Russia		India		China	
Nr	IPC technology class	CAGR	IPC technology class	CAGR	IPC technology class	CAGR	IPC technology class	CAGR
1	Micro nanotechnology	201%	Micro nanotechnology	468%	Other consumer goods	71%	IT methods	71%
2	Semiconductors	29%	Digital communication	103%	Micro nanotechnology	51%	Digital communication	60%
3	IT methods	22%	Food chemistry	81%	Transport	43%	Micro nanotechnology	59%
4	Organic fine chemistry	22%	Other consumer goods	64%	Optics	41%	Control	45%
5	Basic materials chemistry	14%	Control	55%	Thermal processes	40%	Measurement	43%
6	Analysis biological materials	14%	Analysis biological materials	52%	Telecommunications	34%	Semiconductors	41%
7	Pharmaceuticals	11%	Organic fine chemistry	52%	IT methods	34%	Optics	40%
8	Biotech	11%	Measurement	52%	Computer technology	33%	Machine tools	39%
9	Computer technology	10%	Medical technology	50%	Engines, pumps & turbines	32%	Analysis biological materials	39%
10	Machine tools	8%	Other special machinery	49%	Control	31%	Mechanical elements	39%
11	Macro molecular chemistry	7%	Civil engineering	48%	Textile & paper machinery	30%	Telecommunications	38%
12	Other special machinery	5%	Pharmaceuticals	47%	Electrical machinery	30%	Electrical machinery	38%
13	Medical technology	5%	Textile & paper machinery	47%	Civil engineering	28%	Audiovisual technology	36%
14	Thermal processes	5%	Machine tools	46%	Measurement	26%	Surface technology	35%
15	Digital communication	5%	Macro molecular chemistry	45%	Surface technology	24%	Materials metallurgy	34%
16	Chemical engineering	5%	Transport	44%	Semiconductors	22%	Handling	33%
17	Environmental technology	4%	Basic materials chemistry	43%	Machine tools	22%	Engines, pumps & turbines	32%
18	Surface technology	4%	Electrical machinery	42%	Mechanical elements	20%	Thermal processes	31%
19	Measurement	3%	Thermal processes	41%	Audiovisual technology	19%	Furniture & games	31%
20	Other consumer goods	3%	Chemical engineering	41%	Environmental technology	14%	Civil engineering	31%
21	Engines, pumps & turbines	3%	Handling	41%	Medical technology	13%	Textile & paper machinery	30%
22	Handling	3%	Biotech	40%	Digital communication	13%	Computer technology	29%
23	Civil engineering	3%	Mechanical elements	39%	Handling	12%	Pharmaceuticals	29%
24	Food chemistry	2%	Furniture & games	39%	Analysis biological materials	10%	Transport	29%
25	Electrical machinery	2%	Environmental technology	39%	Furniture & games	9%	Chemical engineering	28%
26	Mechanical elements	2%	Audiovisual technology	38%	Chemical engineering	0%	Environmental technology	28%
27	Transport	1%	Engines, pumps & turbines	38%	Other special machinery	-4%	Other special machinery	28%
28	Furniture & games	1%	Semiconductors	38%	Macro molecular chemistry	-5%	Medical technology	26%
29	Telecommunications	0%	Surface technology	37%	Biotech	-12%	Macro molecular chemistry	25%
30	Textile & paper machinery	-1%	Optics	37%	Organic fine chemistry	-14%	Organic fine chemistry	25%
31	Optics	-1%	Telecommunications	33%	Pharmaceuticals	-17%	Other consumer goods	24%
32	Audiovisual technology	-1%	Materials metallurgy	32%	Basic materials chemistry	-19%	Food chemistry	21%
33	Control	-3%	Computer technology	30%	Food chemistry	-22%	Basic materials chemistry	19%
34	Materials metallurgy	-8%	IT methods	24%	Basic communication processes	0%	Biotech	5%
35	Basic communication processes	-100%	Basic communication processes	0%	Materials metallurgy	0%	Basic communication processes	0%

Note: Based on fractional counting of priority patent applications including inventors residing in BRIC countries. Source: Own calculations using the inventor criterion based on PATSTAT Database, version 2012.

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Abstract
In this paper, we develop a framework for assessing innovation collaboration partners. Based on the studies explaining the internationalisation of inventive activity, we identify four elements that are drivers of innovation collaboration: inventive capacity, technological specialization patterns, openness to international innovation collaboration and the economic potential of technology. In order to make the framework operational, we propose a set of patent-based indicators that capture the relevant elements. This way the proposed framework serves as a tool to both assess the potential of inventive collaboration and to anticipate benefits of such a collaboration. In a second step, we apply the framework to the analysis of the attractiveness of BRIC countries as potential partners for innovation collaboration. Our analysis shows that BRICs differ not only in terms of inventive performance, but also in terms of their openness to international collaboration, or the economic potential of technology developed by these countries.
Keywords: collaborative innovation, science and technology collaboration, globalisation of technology, patent analysis, BRICs
JEL classification: D8, F23, O14, O30, O57

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