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APPROACHES TO INTERNATIONAL TECHNOLOGY TRANSFER MEASUREMENT – AN OVERVIEW

Summary

The article addresses the issue of the international technology transfer (ITT) process. For most of the countries the ITT remains the main mechanism supporting the technological progress of the economy. Along with the growing importance of knowledge in every economy, technology diffusion taking place due to the ITT takes on a great and potentially even greater economic significance. However, there is no unified complex index of the process, which would indicate its scope and dimension in particular economies. In order to investigate the size of the process, a row of the following single measures are usually applied: the value of the FDI inflow into particular economy, the volume of imports, the value of the acquired intellectual property, the number of the patent application forms submitted by the foreign entities. Of the great importance is to analyse all aforementioned channels and estimate their value in different economies. To compare the process on the global scale, it is reasonable to evaluate the particular variables in relation to the GDP value in different countries individually. It would also allow to demonstrate the degree, to which the economy depends on the foreign technology.

Key words: international transfer of technology, international trade, foreign direct investment

1. Introduction

With the dynamic development of technology in the fields of telecommunications, information and transport, which allows fast and constant knowledge spread, international technology transfer is to be considered an important economic process. It plays a key role in technological progress of the developing countries as well as in the economic growth of the developed countries. The significance of ITT is extremely substantial in case of technologically advanced economic sectors [Xiaolan, Pietrobelli, Soete, 2011, p. 1206]. It is related to much higher costs of developing technical advanced knowledge rather than its transfer. Foreign technologies are estimated to generate 90% growth of productivity in most economies [Keller, 2004, p. 752]. The influence of ITT on domestic productivity is therefore greater than the effect of domestic technology on this variable. The ITT impact on the economy is also visible through its effect on domestic investment processes. It occurs due to actions

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undertaken according to economic policy pertaining development of the domestic innovation system [Xiaolan, Pietrobelli, Soete, 2011, pp.1204-1212] e.g.: through increasing expenditure on the R&D and investing in human capital development. Actions as such are indispensable in order to achieve proper ability of foreign technology absorption along with its functioning well in growing competition.

Available domestic and international literature analyses the ITT process considering it mainly only through single technology transfer channels, especially direct foreign investments and trade values. There is little attention paid to creating complex index which could be used in international comparisons. The following approach prevents from evaluating the ITT process as a whole and to define its real scale in economy. Due to lack of universal and complex ITT rate, its comparison on international scale and research concentrating on its determinants proves to be impossible. Taking it all into consideration, indication the most important and possible to measure, the ITT channels, are to be considered as study cases demanding thorough analysis.

This paper has a theoretical character and pretends to be the initiation to further, empirical research on the ITT measurement[2]. The first goals of this article is to select the ITT channels, which should be recognised as inevitable elements of the ITT process and at the same time are measurable using commonly available statistical data. The second goal is to propose a way to measure the scope of the process in a particular economy. In order to complete the aforementioned goal it is inevitable to clarify some issues related to defining the ITT process and technology diffusion. Furthermore, extensive knowledge being the core issue of the analysed proposes is to be discussed. As to achieve the set goal a hypothetic deductive method together with a descriptive and comparative analysis are to be applied.

2. Knowledge as an object of the transfer process

Knowledge should be considered a far broader term than technology. It does not only encompass a set of techniques available at a company, but also information related to organisation and management as well as combining technical processes [Gomułka 1998 p. 13]. Technology consists of all information required to implement the production. This information, however, may take various forms of knowledge. An effective technology transfer should include a vast scope of knowledge, especially technic-related, defined as technology. Stores of knowledge may be classified into: codified and unconfined as well as embodied and disembodied [Maskus 2004, p.9]. Furthermore, it can be distinguished between explicit knowledge and tacit knowledge. Explicit knowledge can be recorded and codified – taking a form of studies, analysis and products. Hidden knowledge pertains to a scope of skills of certain people gained through experience. Tacit knowledge does not only relate to information, but also to personal beliefs, judgements and intuition. This kind of knowledge is strictly connected with human

[2] In the future author will continue undertaken research and apply proposed measure ideas to estimate ITT in selected economies

capital, which remains its only carrier at the same time [Grudzewski, Hejduk 2004, p. 78]. Therefore, technology may refer to several aspects – material and embodied like machines and equipment, codified such as technical documentation and uncodified, which pertains mostly to human capital. A common denominator to all kinds of knowledge is the cost of its production or purchase [*Podręcznik*…, 2006, p. 218]. However, access to technology is also available via free of charge research publications or patent application forms. Nonetheless, stores of knowledge accessible in such forms are usually not sufficient to implement on a market scale.

Resulting from its level of codification, a diversified character of knowledge inclines to draw some conclusions. The level of knowledge codification determines the way it is spread on a global scale. Knowledge appearing to be less prone to be codified is based to greater extent on transfer through human capital migration. Higher level of codification allows to use sales channels, or licenses. Furthermore, effective transfer of technology solutions between business entities, especially coming from different countries, requires transferring of knowledge of various kinds and levels of codification simultaneously. Apart from the embodied knowledge transfer such as investment goods or the codified in form of intellectual property goods, a transfer of uncodified knowledge should occur concurrently – by providing technical support like training courses or temporary migration of the qualified staff [Misala, 2001, p. 198]. However, it should be noted that a chance to codify technology only partially equals the fact that its diffusion will never be complete and particular countries will always remain separated by technology gap.

3. Definition of ITT

Domestic literature treating about the analysis of technology transfer focuses mainly on transfer between national entities with indigenous knowledge remaining its main subject. The existing systematics distinguish between i.e.: vertical and horizontal transfer, active and passive transfer, commercial and non-commercial transfer [Matusiak, 2011, p. 301]. The division criterion used less often is the technology's source of origin, which pinpoints internal and external transfer. From the macroeconomic point of view, the internal transfer takes place inside the country between domestic entities [Poznańska, 2001, pp.72-73]. External transfer, however, where the subject of the process remains technology originating from a country different from the receiving one or a particular manufacturing company may be referred to as international transfer of technology. The ITT stands for a mechanism of information transfer beyond the country's borders and its effective diffusion in the receiving economy [Maskus, 2004, p. 7]. International transfer of technology takes place every time technical knowledge becomes available in a country by means different than domestic research or gathered experience [Misala, 2001, p. 198]. According to that, every way of obtaining access to foreign technology by indigenous entities, including commercial or not, should be considered a channel of its transfer. Equated with every single manner of its diffusion,

the ITT defined as above should be, due to its uncountable ways of knowledge transfer, regarded as a phenomenon impossible to measure.

A slightly differentiating view on the ITT process hold the international organisations creating instruments of legal protection and perceiving the transferred knowledge as an object of market transaction. In accordance with that approach, commercialisation becomes transfer's inextricably connected element. Enabling the technology recipient to put it into practice should be characteristic of the transfer [*Intellectual*…, 1996, p. 12.]. United Nations Conference on Trade and Development (UNCTAD) or World Trade Organisation both represent such approach. Within the authority of the WTO the international agreements are made, which further regulate the issues of investments abroad and protection of the intellectual property (The Agreement on Trade Related Investment Measures, The Agreement on Trade Related Aspects of Intellectual Property Rights). UNCTAD defines the process of technology transfer as a mechanism, which effects in spreading technology based on a proper agreement of the parties [*International*…, 2005, pp. 30-31]. Thus, transfer of technology indicates a process, which would make the results of research and development studies available by transferring intellectual property rights in different forms.

Having considered the above, ways of transfer onto the market need to be taken into consideration among many of the ITT channels. It would simultaneously enable to measure the process and distinguish it from a broader economic process, that is the technology diffusion. Analysing the possible ways of the ITT process, regarded as an element of the diffusion process, inclines to acknowledge the following notions as the main ITT characteristics: market-related character of the process connected with its contractual nature and a possibility to introduce the transferred knowledge to the market. Therefore, the ITT can be defined as a process consisting in transmitting technology, which is essential to be implemented, by means of market channels of transfer. The assumed definition allows to substantially narrow the channels of international transfer of technology and to set the borders between technology transfer, access to widely available sources and the external effects of the process. It also underlines the significance of the institution, especially of the legal system, in the dynamics of the ITT process. Such approach remains coherent with the contemporary research conducted on the transfer of technology, which classifies agreements as legal instruments of technology transfer and underlines the significance of protection of intellectual property rights during the process [Szewc, Ziołło, Grzeszczak 2006; *Negocjacje*…, 2004].

Technology transfer's vast and positive influence on the economy remains impossible without its diffusion, proceeding until all subjects interested in purchasing technology come into its possession. Due to non-market and informal character, diffusion appears to be of greater economic significance than the transfer itself, which is to be understood as a process involving only the parties of the transfer agreement. Following this way of deduction, actions taken on a global scale such as: trade in goods or trade in intellectual property, FDI or production cooperation – all seem substantial as they intensify the cooperation with rich in high-tech knowledge foreign entities and therefore become factors stimulating technology diffusion [Keller, 2004, pp. 756-759].

Apart from purchase of technology and cooperation in the field of innovation, open sources of information are regarded as main types of knowledge and technology transfer, which, however are not bound to market transaction. The aforementioned means of obtaining access to knowledge simultaneously reflect the elements of spreading technology globally [*Podręcznik Oslo*…, 2008, p. 82], which affects the economic growth in host countries. Thus, ITT constitutes only one of the elements of the process influencing the host economies. On account of the fact that it is possible to measure it and its high level of correlation with the diffusion process, the ITT measurement is of great economic importance.

4. International technology transfer and technology diffusion on a global scale

It is important to note that the terms: ITT and technology diffusion are often used interchangeably in literature and the ITT process is identified with the dissemination of innovation [Cichowski, 1998, pp. 10-11]. However, the process of transfer needs to be clearly distinguished from the diffusion process, which is to be understood as a supplementary benefit resulting from the transfer of technology [*International*…, 2005, p. 30-31]. The process of technology transfer itself should not be equated with its diffusion, which is a broader term.

Diffusion refers to transmitting innovation through market and non-market channels, starting from its primary application to its implementation in other countries and regions as well as other markets and companies. The process of diffusion often denotes something more than assimilating knowledge and technology, since business enterprises acquire new knowledge and technology and use it for further research studies and development. Owing to the process of diffusion, innovation may undergo changes and deliver feedback information to the primary innovators [*Podręcznik wskaźników*…, 2006, p. 82].

Since technology cannot be fully codified and information asymmetry prevails on the market, diffusion of technology on a global scale does not mainly perform via market transactions, but via so called external effects (*spillovers*.) [Keller, 2004, p. 758]. These effects consist in knowledge's leaking and penetrating into domestic companies, largely by cooperating with enterprises possessing advanced technologies. Investments performed by foreign entities are generally based on direct foreign investment. Technology's diffusion beyond subsidiary companies encompasses co-operators and national subcontractors particularly. It is believed that developing cooperation with local companies and establishing a network of subcontractors and suppliers result in the most effective diffusion [Umiński, 2000, p. 50]. Owing to that, local suppliers acquire a chance for training, counselling and sharing license. Knowledge spillovers occurring between subsidiaries and national companies due to technology multipliers result in reducing arrears in technology in the whole business, in which the FDI had taken place. The influence of foreign entities on the level of technological advancement of domestic companies arise mainly owing to two phenomena: the effect of competition and the effect of spillover, which occurs due to demonstration effect [Umiński, 2000, pp. 44-49].

The demonstration effect occurs every time an economic entity introduces a new product, which is based on innovative technological solutions and simultaneously makes certain significant information about it widely available. Possessing even some vague general information about the newest technological solutions stimulates competitors to obtain supplementary data inevitable to create an imitation. As a result, owing to learning by watching and reverse engineering domestic entities gain new knowledge. Additionally, the process remains stimulated by the effect of competition. National entities aiming at fighting the competition from the foreign companies are somewhat forced to enhance their level of innovation. Resulting from the so called external effects, among the channels of technology diffusion, different than the effect of demonstration or vertical linkages, one may appoint the labour turnover [Saggi, 2002, pp. 209-214; Hoekman, Maskus, Saggi, 2005]. Hence, the employees, who had acquired knowledge and experience by working for companies abroad, become vehicles of knowledge for domestic companies by changing their jobs or setting up their own businesses. Only a certain part of the technology transfer takes place as a result of market transactions occurring between the interested parties. Some knowledge remains commonly accessible, and its agreement does not involve any cost, or if so, the cost is rather minor. It transpires by obtaining knowledge from widely available sources. In accordance with some classification, these easily available, also called informal, ways of receiving access to knowledge to some extend coincide with the external effects and encompass such channels as: exchange of scientific and technological staff, research and technological conferences, show and trade fairs, education and training of foreigners, trade missions and industrial history [Nasierowicz, Nowakowski, 1994, p. 70]. The above may be classified as non-market channels of transfer among which one can additionally distinguish: copying, reverse engineering, staff turnover, widely available knowledge in form of scientific magazines or patent applications. The division into market and non-market ways of transferring technology, which has been adopted as the main criteria of distinguishing the process of transfer and diffusion, however, causes some problems. International movement of people is often enumerated among market-related channels of ITT [Maskus, 2004; Fosuri, Motta, Ronde, 2001]. Whenever the following movements come as the result of agreements between particular employers and oblige to introduce certain knowledge into the company, they may be characterised as market-related transfer. Migrations of scientists, students or interns, however, do not share this quality. Moreover, widely available statistic data allows precise and comparable measurement of the process on the global scale. Since human capital is not only the generator, but also the transmitter of knowledge, it can be considered, in a broader sense of the process, a channel of technology diffusion.

It remains impossible to directly measure the effects of the external market-related channels of the transfer. Occasionally, regression analysis is used in order compare the level of correlation of expenditure on the R&D of one of the examined companies with the growth of TFP of the other company cooperating with the first one. High level of correlation should stand for the occurrence of the technology diffusion [Keller, 2002, pp. 120-142]. Therefore, the changes in productivity of the companies as a result of their cooperation with innovative entities or their presence alone may be considered a measure of diffusion. However, the measure is far from

being perfect as it omits the endogenous efforts of the company, research studies among them, to increase the level of productivity. Owing to the fact that it is for the market channels of technology transfer that constitute a premise whether the external effects have taken place or not, their size and scale can be reflected in the intensity of the diffusion process. A strong dependence between market-related manners of technology diffusion and the external effects results in measuring the scope of ITT – the only key and possible to measure element of the technology transfer process – which simultaneously allows to partially evaluate the diffusion process as a whole.

5. Channels of International Transfer of Technology

Most available scholars literature does not define the process of technology transfer explicitly, but rather indicates the manners of its occurrence [Watson, Johnstone, Hascic, 2009]. These manners are referred to as the channels of technology transfer. Apart from the channels, the literature also mentions the phases of the technology transfer process. The following phases correspond with particular mechanisms of knowledge transfer, which take place according to its level of codification. The first phase encompasses export of innovative materials or products between the countries. The second following phase is referred to as design transfer, which covers various types of intellectual property rights. Finally, capacity transfer takes place, which is strictly related to the capacity to adapt new solutions to local conditions. The last phase consist in learning how to learn and is connected with production cooperation with more technologically advanced partners.

Traditionally, channels of technology transfer were interpreted in a very narrow manner, which would distinguish: turnover of patents, design patterns, licence agreements and know-how [Stoneman 1987; Malecki 1991]. The following division, however, does not reflect the business practice, in which transfer of technology and knowledge takes place through other transfer channels.

In order to group the ITT three manners of transfer are usually demonstrated [Haug, 1992, p. 5]. imports of machines and equipment as a vehicle of embodied technology, acquiring intellectual property rights such as technical know-how, patent and licence agreements, and classified in this article to diffusion channels, migrations of human capital as vehicles of uncodified knowledge. Analysing mechanisms of ITT the Polish literature refers to a vaster array of transfer channels [Firszt, 2007, pp.106-107]: licence operations, sales of patents, provision of know-how and other commercial agreements, which pertain to intellectual property rights; international trade, import of investment goods influencing production processes, import of consumption goods being objects of imitation, direct foreign investment, by which movement of capital is strictly related to spreading new technical and management solutions to subsidiaries located in the receiving country; joint-venture consisting in common business ventures of foreign and domestic entities, international industry cooperation in the field of research and development studies. It is often the

case that literature narrows the channels of the ITT to strictly two groups [Keller 2004 pp.752-783] the first one being investment channels and the second – trade channels (see Table no. 1).

TABLE 1.

The channels for transferring technology to enterprises

Trade Channel	Investment Channel
Direct exporting	Co-production
One-off transaction	Sub-contracting
Licensing	Contract joint venture
	Equity joint venture
	Wholly owned subsidiary

Source: own, based on: [Bennett, Vaidya, 2002].

Investment channels remain of great significance as they posses a strong ability to generate external effects. It is worth noticing that the transfer taking place within international joint-ventures also encompasses the transfer of disembodied knowledge [Sazali, Haslinda, Jeżak, Raduan, 2010]. The significance of international M&A is also underlined in the process of technology transfer. The mergers are referred to as fast ways of acquiring technology by companies backwarded in terms of technology and using it further to enhance the level of endogenous innovation and competitiveness [Xiuling, Li, Huiping 2012 pp.7-12]. Nonetheless, there is some research available, which points at low correlation of FDI with an increase in domestic companies' productivity. It has been proved that trade, similarly to FDI, remains an important channel of international diffusion of knowledge with its influence on the productivity increase remaining relatively low. Information technology has been therefore acknowledged as diffusion channel, which played an important role in productivity growth in the recent years [Lei, Bang Nam, 2007].

Analysing the literature in the field of transfer channels allows to formulate a conclusion that major number of various forms of technology transfer may be divided into two main groups, so called market channels of transfer. According to that, it can be assumed that the ITT is a process occurring through market channels including the purchase of technology by importing high-tech goods and acquiring rights to intellectual property as well as through investment channels encompassing the inflow of DFI and production cooperation.

6. Measuring ITT

The assumed definition of ITT defining it as one of the components of technology diffusion on a global scale allows to eliminate the external effects as well as non-market technology spillovers, also called informal channels of transfer, from the measuring process. Both, Polish and world literature does not dedicate a lot of attention to issues related to synthetic measurement of the ITT. As three main man-

ners of indirect technology measurement one may appoint: expenditures connected with its production (R&D), the results of its codification (patents) and the effect of its implementation in the production process (higher productivity.) International payments concerning patents and the level of their correlation with trade in goods between particular countries may be assumed as one of the ITT measurements examples in a certain trade [Watson, Johnstone, Hascic 2009 pp.1-4]. A different example of the ITT measurement attempt in a certain trade was measuring the amount of purchased investment goods, that is production equipment and the level of staff recruitment among foreign specialists. Necessary data was obtained from the surveys conducted among various companies. Annual payments and incomes from the licence and copyright fees are also regarded as measures of technology transfer in the United States.

Most research, both practical and theoretical, focuses on either one or two main channels of the transfer with FDI and trade attracting the most attention [Saggi, 2002, p. 193]. In research dedicated to measuring the transfer, Maskus analysed the following values: the value of incoming FDI, the value of technologically advanced imported goods, payments concerning intellectual property rights (technological balance of payments.) Among capital goods, which remain substantial technology vehicles, the following goods according to SITC methodology are appointed: capital intensive, skill-intensive, high-technology, which all originate from the OECD of high income. Statistic data used to measure the aforementioned values come from the UN Comtrade database, IMF balance of payments and UNCTAD World Investment Reports [Maskus, 2004]. The manners of foreign knowledge acquisition were analysed by Dahlman using two channels [Dahlman 2008, 2010]: the value of FDI and technology licensing. In the conducted analysis the mentioned values were compared with the value of GDP of chosen countries, which allowed to compare in a relatively objective way the scope and value of the knowledge acquired from abroad with the size of the whole economy. Research dedicated to acquisition of foreign technology by emerging economies such as: Brazil, China, India in terms of acquiring global knowledge the following values were analysed: imported goods as a percent of GDP, manufacturing imports as a percent of the whole import trade, average FDI value to GDP from certain years; remuneration for copyright, licence copyright fees compared to GDP; number of high school graduates taking education abroad compared to the number of students in the home country.

Technology balance of payment is regarded to be an indicative measure in terms of transfer measurement, which is considered as a partial measure of technology diffusion on a global scale. In the field of engineering the balance of payment is used in order do asses the position each country takes in the international arena concerning trade in intangible technology. It mainly refers to commercial transactions between the residents of different countries pertaining mainly to transfer of technology by means of: patents (purchase, sales, licence agreements), non-patented innovation; disclosures know-how, design and industry patterns, trademarks (sales, licensing, franchising), technical services, R&D works and services [Matusiak, 2001]. International technology payments are regarded as important, but not the only components of

ITT [Madeuf, 1984, pp. 125-140]. According to OECD Handbook on Economic Globalization Indicators [*Podręcznik wskaźników*…, 2006], the reference indicators of international technology diffusion are the following: trade in disembodied technology in form of patents, licences, know-how, technical support, research in the field of the R&D (all of the above comprise the elements of technology balance of payments) as well as trade in high tech products. In accordance with the recommendation of the TBP Manual [*TBM Manual*…, 1990] the technology balance of payments does not comprise the operations such as: business, financial, management or legal assistance, advertisement, insurance, transport, films and other copyright recordings, software etc. However, one of the disadvantages of the technology balance of payments as a measure of diffusion is the fact that over 66,6% of such transactions take place in the framework of KNT.

The literature indicates some attempts, which have been made to establish a special measure, or indicator, the so called Technology Transfer Index. Its aim would be to rate the percentage of imported technological components in the overall production costs of certain goods, each year in a given country. A proper adjustment of the set of goods in the suitable sectors of industry, which according to some scholars should not be more complex than the one applied by creating the consumer price index, would result in measuring the level of the ITT share in the economy of each country and thereby its independence on foreign technology. A quantitative measure constructed as such would, according to the authors, be a valuable source of information in the process of determining economic development strategy.

7. Conclusion

Based on the conducted analysis of literature and the assumed definition of the ITT, a way to measure the scope of the process in a particular economy may be achieved by adding the following values: the value of the imported investment goods, the value of the technologically advanced goods (all qualified according to SICT, CN), the value of the technology balance of payments (OECD, Technology balance of payments, IMF balance of payment), FDI inflow (World Bank Statistics Database, or UNCTAD). Considering the enterprise's sector responsible for the FDI and its significance for the indigenous economy, the most technologically advanced channels are to highlighted. According to that, an industrial structure of the undertaken FDI requires further analysis. However, the available date is not sufficient and there is are no standards concerning the FDI classification according to particular industries, which would lead to unreliable comparisons among different countries. The choice of the aforementioned variables is mostly based on the widely available access to the standardized databases. Moreover, the proposed measures reflect the key re-occurring channels of transfer. At the same time, it is worth noticing that the value of transfer, which is a total of the three assumed values, does not fully exhaust the whole size of the process. It omits the value of subcontracts concerning the production cooperation, consulting agreements and service. Moreover, the isolated value of the chosen channels without its reference to the whole

economy does not allow to evaluate the influence it has on the domestic economy. Comparing the size of particular channels of transfer with some of its counter indicators in the domestic economy enables to indicate the degree of the economy's dependence on the foreign technology. Thereby, it will be possible to determine the degree of the domestic technology development's dependence on foreign sources. In order to conduct such analysis, the following dependencies in a given periods of time may be applied:

1. the value of FDI / the value of domestic investment,
2. high-tech imports / domestic high-tech production,
3. number of domestic patent applications or/and granted / number of foreign patent applications or/and granted.

Comparing the above values allows to draw some conclusions concerning the influence of the process on the domestic technology advancement, however, it does not allow to compare it on a global scale. Thereby, it is impossible to determine the reference between the dimension of the ITT and the economic growth rate or defining the factors influencing the size and the efficiency of the process. Therefore, the comparative studies concerning the process are of great significance. In order to compare the ITT in particular domestic economies the chosen variables indicating the technology transfer should be juxtaposed with the corresponding values of a given economy. The following equations may be applied:

1. the value of FDI/GDP,
2. high-tech imports/GDP,
3. TBP/GDP,
4. foreign patents granted in selected country/overall number of patents granted in selected country in a given year.

Changes in the size of these measures in a given period of time would allow to determine their economic significance in particular economies as well as to identify the changes occurring in the structure of the conducted process. The comparative analysis would allow further research concerning the factors influencing the occurring changes and thereby indicating the efficient determinants of the ITT process.

Finally, it is worth highlighting once again, that the above described methods of measuring the size of the ITT in a given economy include a significant margin of error. First of all, they do not take in account other than indicated market transactions concerning the technology overturn. Moreover, in accordance with the assumed definition of transfer the role of the non-market ways of technology diffusion have been omitted. The diffusion, however, has even a greater economic significance than the technology transfer itself. Owing to the fact that diffusion largely takes place due to the market transactions, the conclusions concerning the scale of the process may be drawn only in reference to the ITT size. Therefore, the attempts to measure the process gain even more importance as it has been shown and attempted in this paper.

Bibliography

Bennett D., Vaidya K., 2002, *Meeting Technology Needs of Enterprises for National Competitiveness*, [in:] *Management of Technology*, Selected Discussion Papers presented at the Vienna Global Forum, Vienna International Centre, Austria, 29-30 May 2001, UNIDO, Vienna.

Cichowski L., 1998, *Przepływ kapitału i technologii*, Wydawnictwo Politechniki Poznańskiej, Poznań.

Dahlman C. J., 2008, *Innovation Strategies of the BRICKS: Brazil, Russia, India, China, Korea. Different Strategies, Different Results*, Paris, November 18, www.oecd.org/dataoecd/60/45/41709204.pdf , [access: 25.06.2011].

Dahlman C. J., 2010, *Innovation Strategies in Brazil, China and India: From Imitation to Deepening Technological Capability in the South*, [in:] *The Rise of Technological Power in the South*, X. Fu, L. Soete (eds.), Palgrave MacMillan, London–New York.

Firszt D., 2007, *Międzynarodowy transfer technologii jako narzędzie budowania gospodarki opartej na wiedzy*, „Zeszyty Naukowe Akademii Ekonomicznej w Krakowie" nr 741.

Fosfuri A., Motta M., Ronde T., 2001, *Foreign Direct Investment and Spillovers through Workers' Mobility*, "Journal of International Economics", vol. 53(1).

Gomułka S., 1998, *Teoria innowacji i wzrostu gospodarczego*, CASE, Warszawa.

Grudzewski W. M., Hejduk I. K., 2004, *Zarządzanie wiedzą w przedsiębiorstwie*, Difin, Warszawa.

Hoekman B. M., Maskus K. E., Saggi K., 2005, *Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options*, "World Development", vol. 33, no. 10.

Haug D. M., 1992, *The International Transfer of Technology: Lessons that East Europe Can Learn form the Failed Third World Experience*, "Harvard Journal of Law and Technology. Recent Development", vol. 5 (209), Spring.

Intellectual Property, Technology Transfer and Genetic Resources. An OECD Survey of Current Practices and Policies, 1996, Paris, OECD.

International Investment Agreements: Key Issues, Chapter 23. Transfer of Technology, 2005, Volume III, New York and Geneva, UNCTAD.

Keller W., 2004, *International Technology Diffusion*, "Journal of Economic Literature", vol. XLII, September.

Keller W., 2002, *Geographic Localization of International Technology Diffusion*, "American Economic Review", no. 92.

Lei Z., Bang Nam J., 2007, *International R&D Spillovers: Trade, FDI, and Information Technology as Spillover Channels*, "Review of International Economics", vol. 15(5).

Maskus K. E., 2004, *Encouraging International Technology Transfer*, UNCTAD-ICTSD Project on IPRs and Sustainable Development, "Intellectual Property Rights and Sustainable Development", no. 7, May.

Malecki J., 1991, *Technology and Economic Development: the Dynamics of Local, Regional and National Change*, Longman Group UK Ltd, London.

Misala J., 2001, *Współczesne teorie wymiany międzynarodowej i zagranicznej polityki ekonomicznej*, Oficyna Wydawnicza SGH, Warszawa.

Madeuf B., 1984, *International Technology Transfers and International Technology Payments: Definitions, Measurement and Firms' Behaviour*, "Research Policy", vol. 13 (3), June.

Matusiak K.B. (red.), 2011, Innowacje i transfer techniki. Słownik pojęć, Wyd. III, PARP Warszawa, http://www.parp.gov.pl/files/74/81/469/12812.pdf [access: 20.04.2013].

Nasierowicz W., Nowakowski M., 1994, *Biznes międzynarodowy*, CIM, Warszawa.

Negocjacje w transferze technologii. Podręcznik szkoleniowy, ONZ ds. Rozwoju Przemysłowego, 2004, Warszawa.

Podręcznik Olso. Zasady gromadzenia i interpretacji danych dotyczących innowacji, 2008, OECD/ Eurostat, Wyd. 3, Warszawa.

Podręcznik wskaźników globalizacji ekonomicznej OECD, 2006, GUS, Warszawa.

Strefa badawczo-rozwojowa i przedsiębiorstwa w działalności innowacyjnej, 2001, K. Poznańska (red.), Instytut Funkcjonowania Gospodarki Narodowej, Oficyna Wydawnicza SGH, Warszawa.

Saggi K., 2002, *Trade, Foreign Direct Investment, and International Technology Transfer: A Survey*, "The World Bank Research Observer", vol. 17 (2), Fall.

Sazali A. W., Haslinda A., Jeżak U., Raduan C. R., 2010, *MNCs' Size, Technnology Recipient Characteristics and Technology Transfer in International Joint Ventures*, "Research Journal of International Studies", Issue 13, March.

Stoneman P., 1987, *The Economic Analysis of Technology Policy*, Clarendon Press, Oxford.

Szewc A, Zioło K., Grzeszczak M., 2006, *Umowy jako prawne narzędzie transferu innowacji*, PARP, Warszawa.

TBP Manual. Proposed Standard Method of Compiling and Interpreting Technology Balance of Payments, 1990, OECD, Paris, 1990.

Umiński S., 2000, *Znaczenie bezpośrednich inwestycji dla transferu technologii do Polski*, „Organizacja i Kierowanie", nr 4 (102).

Watson F., Johnstone N., Hascic I., 2009, *Using Patent Data As An Indicator of International Technology Transfer, Empirical Policy Analysis Unit*, OECD Environment Directorate, October.

Xiuling L., Li C., Huiping T., 2012, *International Technology Mergers & Acquisitions and Raising the Competitiveness of China Equipment Manufacturing Industry*, "Technology and Investment", vol. 3.

Xiaolan Fu, Pietrobelli C, Soete L, 2011, *The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-up*, "World Development", vol. 39 (8).