ECONOMIC DETERMINANTS OF INTERNATIONAL TECHNOLOGY TRANSFER

Najla Shafighi

Department of Industrial Engineering, bbw University of Applied Sciences, Berlin, Germany

Abstract

The main aim of this paper is to identify the main determinants of the international technology transfer between developed and developing nations. In this paper Germany is considered as the transferor and India and South Africa are considered as the transferees. In terms of methodology, a quantitative research method with the use of regression analysis by SPSS is implemented. The empirical findings reveal that the previous work of Cho and Shenkayo (2019) can be extended to other contexts. The findings support the "classic country-modern firm international trade theory" developed by Cho and Shenkayo for the case of South Africa but not India. The results will have major policy coordination for the developed countries to design their public and international policies toward the developing countries.

Keywords: *International Technology Transfer, regression, balance of payments, FDI, international trade theory*

1. INTRODUCTION

The rise of globalisation and formation of various trade blocks, custom unions, and economic unions around the world resulted in the integration of the world economy (Gharleghi & Shafighi, 2020; Gharleghi & Popov, 2018). This integration requires movement of people, capital, and especially technology (Shafighi, et al, 2016). These movements will help economic development of the partner countries. In particular, the movement of technology (technology transfer) will stimulate technology innovation in the recipient economy and that helps extending commercialization of the products. Therefore, international Technology Transfer (TT) is seen as a mechanism for economic stabilization of the recipient country as well as the transferor country (Dunska, 2017).

This article follows the work of Cho and Shenkoya (2019) about the application of the "classic country-modern firm international trade theory" develop by them. This theory is a hybrid theory that combines the features of the "classic theory of international trade" and "modern theory of international trade". The reason the hybrid model is introduced is because the factors considered in this theory cuts across the individual countries and that of the firm within the countries to be considered. Based on the classic theory, the emphasis is on the country's capabilities to produce a good/service according to its superior technology (Morgan and Katsikeas, 1997). Instead, the modern theory emphasis on the way countries develops their international abilities while strengthening their own interest (Choudhary, 2018). The hybrid model also helps to mitigate the limitations of previous theories. For example, in the classic theory, the assumption is that the production cost is determined by cost of labour, or in the modern theory it is assumed that the factors of production are immobile (Dutta, 2018). Both assumptions are distracting, therefore, by combining both theories, the hybrid model presents a better formulation of both theories and mitigate the flaws of both. To the best of the researcher's knowledge, this article is in fact the second paper in which examines the above theory in the context of Germany as the transferor, and South Africa and India as the transferees.

The recent results from the empirical study of Oettmeier and Hofmann (2016) on a firm level research stated that the compatibility and the demand-side benefits (product customization to meet customer demands) are the main determinants of Automotive Manufacturing technology transfer. In another study by Good (2019), the case of Technology Transfer in academia (university technology transfer) was examined. They have reviewed numerous literatures to provide an understanding of the organisational design for the general form of TT. Their findings show that academic entrepreneurship has a revolutionary impact on the design of the holistic format of TT.

The literature has shown that Foreign Direct Investment (FDI) has an explicit impact on technology transfer. It is widely accepted that technology transfer is derived from FDI. In a recent study by Saini & Singhania (2018), various determinants of FDI have been identified in the context of developing and developed economies. To analyse the problem, they used the data of 9 developing and 11 developed countries for the period of 2004 – 2013 with the help of a dynamic model of generalized moments of methods (GMM). The empirical findings of their research indicate that the policy-oriented variables in the host economies play a significant role in attracting FDI that eventually paves the way for TT. In the case of developing countries, capital formation, and trade openness and in the case of developed countries freedom index, and trade openness were the most crucial variables. Therefore, it is imperative for the policy makers to design the economic policies so that FDI flows into the country (Klong Klaew, et. al, 2016; Senkuku & Gharleghi, 2015). Based on the above, the main question of this study would be to examine the main determinants of international technology transfer from Germany to India and South Africa.

The rest of this paper is organized as follow: section 2 provides the most recent literature in the are of TT, section 3 depicts a brief on the data and methodology, section 4 presents the empirical results, and section 5 concludes with policy implications.

2. LITERATURE REVIEW

Ituarte et. al (2019) have explained that technology transfer would be successful when it is integrated into the settings of the recipient economy. Simultaneously, they argued that the outcome of successful technology transfer would be different in different contexts. Therefore, in the current paper, different countries are considered for both transferor and transferee to see if the outcome would be different.

Singhai et al (2021) investigated the factors affecting technology transfer from publicly funded research institutions to the small and medium enterprises in the case of developing countries. They argued that academic entrepreneurship derives TT and stimulates innovation. A quantitative method with the help of self-administered questionnaire (321 respondents) and the structural equation modelling was applied to obtain the results. The results reveal that innovativeness of the product, knowledge, and quality of the product are the main factors that positively affect technology transfer.

More specifically in the research by Pillai & Rao (2013), the case of FDI inflow to India was investigated. The relevant quarterly data for the dependent (FDI) and independent variables were collected for the period of 2000 to 2010. The elasticity and magnitude of sensitivity analysis show that market size, level of import, and trade balance have a large and direct impact in the inward foreign direct investment in India. This is an indication that trade, balance of payments, and FDI will have an impact on the decision of the transferor on the international technology transfer. In addition to the above paper, Zheng (2009) explored the determinants of FDI for both India and China to see if there are any similarities/differences between the two countries in terms of attracting foreign investment from abroad. Using panel data analysis, the study shows both similarities and differences. Market growth, level of imports, and liberalisation policy are the common determinants for both cases. For china, market size, and export are important while in India, cultural distance is more important.

Fasanya & Olayemi (2018) examined the “Balance-of-Payment (BOP) constraint growth model” for the case of Nigerian economy for the period of 1980-2012 using the autoregressive distributed lag (ARDL) method. The empirical result s of the paper indicates that import is cointegrated with income, and relative price levels, while the equilibrium growth rate is cointegrated with actual growth rate, confirming the Thirwall’s law in the case of Nigeria. The law indicated that the actual growth rate is equal to the forecasted growth rate by the balance of payments (current account) equilibrium. One of the reasons for this law to be hold is in the fact that the Nigerian economy depends on international trade. In addition, these results indicate that higher growth can be achieved by making export to be more competitive through human and physical capital improvement and reducing the barriers of accessing external markets in which both can be facilitated by international technology transfer.

A theoretical framework for the success of technology transfer from the technology provider viewpoint was developed by Chiș & Crișan (2020). The authors conducted a comprehensive literature review as well as an interview with a case study to derive the results. By applying the qualitative analysis, the five-category framework for technology transfer was confirmed. Those five categories are technology, context, organisation, customer absorptive capacity, and collaboration.

3. RESEARCH METHODOLOGY

A quantitative research method is used in this paper to perform the statistical analysis between the dependent and independent variables using the SPSS software. In this paper, a general form of technology transfer as well as a specific form of technology transfer in the Information and Communications Technology (ICT) industry are considered and the relevant variables are estimated.

The data for this study is retrieved from the international sources such as World Bank, UNCTAD, and the United Nations COMTRADE. Table 1 shows the list of variables used in this paper.

Table 1. List of variables for the transferor and the transferee

Transferor (Germany)	**Transferee (India & South Africa)**
Balance of payments (current account) between Germany and India	Balance of payments (current account) between India and Germany
Balance of payments (current account) between Germany and South Africa	Balance of payments (current account) between South Africa and Germany
Germany export to India	Exchange rate between Germany and India
Germany export to south Africa	Exchange rate between Germany and South Africa
Germany ICT export	Difference in inflation between Germany and India
	Difference in inflation between Germany and South Africa
	India Foreign direct investment
	South Africa Foreign direct investment
	India total export
	South Africa total export

Note: all data are in *current US$* and the *natural logarithm* form of the data has been used.

In order to calculate the balance of payments between Germany and the two Transferees, the export / import of Germany to/from those two countries are used. The similar calculation has been done to find the balance of payments between the Transferees and Germany.

4. EMPIRICAL FINDINGS

In this paper, two different models have been estimated. One is for a general technology transfer case, and another one for the ICT technology transfer. It is noteworthy that the technology transfer is examined from the transferor perspective only, therefore it leaves some room for the future research to examine the transferee perspective too.

As I indicated above, this paper follows the work of Cho and Shenkoya (2019) in relation to the economic determinants of technology transfer between the transferor and transferee countries. In fact, this phenomenon has been examined in the literature in different contexts using classic or modern theories of international trade. The "classic country-modern firm international trade theory" developed by Cho and Shenkayo is tested in this paper with the data from Germany as transferor and India and South Africa as transferee.

Table 2 shows the relationship between Germany and India in terms of the general form of technology transfer. The regression results from this model indicate that the independent variables have no significant impact on the dependent variable. However, the direction of impact can be identified from the coefficients. One plausible reason could be that the export and FDI from Germany to India was mostly on the consuming goods rather than durable and technology intensive products.

Table 2. General Technology Transfer relationship between Germany and India in which Germany is the transferor and India is the transferee (Transferor /Transferee)

Variables	**Coefficients**	**Std. Error**	**t-stat**	**Sig.**
(Constant)	-38.135	77.643	-.491	.630
India exchange rate	.131	.178	.737	.473
India FDI	-1.399	3.035	-.461	.651
Difference inflation Germany and India	-.151	.400	-.377	.711
India export to world	-6.378	6.902	-.924	.370
Germany to India export	10.899	6.494	1.678	.114

Note: R-square is 0.474. Dependent variable is the balance of payments between Germany and India. The independent variables are difference between the inflation rate in Germany and India, exchange rate between Germany and India, India FDI, India export.

Table 3 depicts the relationship between Germany and South Africa in terms of general technology transfer. I would like to examine South Africa to see the role of Germany in the development of Africa. As it is evident from Table 2, there are evidence of technology transfer from Germany to South Africa as the coefficients of "South Africa Export" and also "Germany Export to South Africa" are significant at 10% and 5% respectively.

Table 3. General Technology Transfer relationship between Germany and South Africa in which Germany is the transferor and South Africa is the transferee (Transferor /Transferee)

Variables	Coefficients	Std. Error	t-stat	Sig.
(Constant)	-102.793	65.038	-1.581	.135
South Africa exchange rate	-.494	.399	-1.239	.234
Difference inflation Germany and South A.	.486	.446	1.089	.293
South Africa Export to world	-12.466	6.732	-1.852	.084
South Africa FDI	.303	1.254	.242	.812
Germany Export to South Africa	18.855	7.480	2.521	.024

Note: R-square is 0.453. Dependent variable is the balance of payments between Germany and South Africa. The independent variables are: difference between inflation rate in Germany and South Africa, South Africa FDI, exchange rate between Germany and South Africa, South Africa export.

To examine if the technology transfer from Germany to the above-mentioned countries is in the form of ICT, this sector (ICT) has been examined. Table 4 represents the relationship between Germany and India for the case of ICT technology transfer. It is evident that there is no significant technology transfer from Germany to India. This is perhaps because India itself is one of the major ICT exporters in the world.

Table 4. ICT Technology Transfer relationship between Germany and India in which Germany is the transferor and India is the transferee (Transferor /Transferee)

Variables	Coefficients	Std. Error	t-stat	Sig.
(Constant)	-41.326	113.755	-.363	.722
India exchange rate	.081	.271	.298	.770
India FDI	1.771	3.412	.519	.612
Difference inflation Germany and India	.055	.473	.117	.908
India export to world	.195	6.828	.029	.978
Germany ICT export	.386	5.555	.069	.946

Note: The R-square is 0.384. Dependent variable is the balance of payments between Germany and India. While independent variables are difference between inflation rate in Germany and India, India FDI, exchange rate between Germany and India, India export, and Germany ICT export.

Table 5 shows the relationship between Germany and South Africa for the case of ICT technology transfer. There is evidence in the model that shows ICT has been transferred from Germany to South Africa. The coefficients of "South Africa Export" and "Germany ICT export" are significant at the level of 1%.

Table 5. ICT Technology Transfer relationship between Germany and South Africa in which Germany is the transferor and India is the transferee (Transferor /Transferee)

Variables	Coefficients	Std. Error	t-stat	Sig.
(Constant)	6.533	4.524	1.444	.171
South Africa exchange rate	.022	.040	.568	.579
Difference inflation Germany and South A.	.005	.033	.141	.890
South Africa export to world	1.546	.354	4.366	.001
South Africa FDI	-.104	.093	-1.117	.283
Germany ICT export	-.877	.306	-2.867	.012

Note: R-square is 0.616. Dependent variable is the balance of payments between Germany and South Africa. The independent variables are difference between inflation rate in Germany and South Africa, South Africa FDI, exchange rate between Germany and South Africa, South Africa export.

5. CONCLUSION

This paper examined the major determinants of international technology transfer between Germany and India as well as between Germany and South Africa. The "classic country-modern firm international trade theory" developed by Cho and Shenkayo was used to obtain the results. This paper is in fact the second paper that applies the above theory into a different context to see if it can be validated. The empirical results revealed that the general form of technology transfer and the specific ICT technology transfer has taken place between Germany and South Africa only. Therefore the "classic country-modern firm international trade theory" can be validated for the case of South Africa. This leaves rooms for future research to examine this theory in other contexts to see the interaction between the variables.

Policy implications

This paper has some policy implications based on the obtained results. (i) South Africa exchange rate policy should be oriented towards stabilizing the currency so that the foreign firms are able to rely on a more stable exchange rate in the host country. (ii) A special attention should also be given to the investment policies to facilitate inward FDI into South Africa. (iii) Germany should continue the support for ICT technology transfer and export policies to South Africa.

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