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Productivity Gap: A Chance or an Obstacle in Absorbing Benefits from FDI in a Host Country

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ABSTRACT

Objective: The objective of this study was to determine the relationship between labour productivity in Poland, the presence of foreign direct investment and productivity gap between Poland and the EU-15.

Research Design & Methods: Panel data techniques including pooled, fixed and random effects models, as well as diagnostic tests were used in this study. The idea was to find the relation between labour productivity measured by gross value added per employee (or hours worked) and the degree of the penetration of foreign capital.

Findings: While investment decisions regarding the choice of a country are determined by the size of the target market, the distance is still a negative factor in the creation of FDI volume. Additionally, the backwardness of business or its relative proximity in terms of labour productivity in relation to the EU-15 is an unfavourable factor when it comes to the improvement of productivity.

Implications & Recommendations: The results that we have obtained confirm the hypothesis that there exists an optimal level of productivity gap implying high absorption benefits of FDI presence. Moreover, an increasing involvement of foreign investors in different sectors implies both higher productivity of these sectors and the gap reduction. This may prove that too small or too huge productivity gap is an obstacle to the absorption of benefits from the presence of foreign capital to boost productivity by local firms.

Contribution & Value Added: The study contributes to the observation in the existing literature that an increasing accumulation of FDI is accompanied by the progressive convergence of productivity between the UE-15 and Poland almost across all sectors. The heterogeneity of the phenomenon is noticeable on the sectoral level, which seems to be unsaid in the majority of empirical studies basing on national-aggregated data.

Article type: research paper
Keywords: internationalisation; productivity gap; FDI; panel analysis; sectoral study
JEL codes: C33, F21

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INTRODUCTION

The main objective of this study is to determine the relationship between the presence of foreign direct investment (FDI) and labour productivity in the host country and the size of productivity gap between Poland and economically developed countries of the EU-15, which are the main providers of FDI into Poland. The investigation was carried out on the basis of the concept of absorption capacity of the economy. It was decided to regress the labour productivity, measured by gross value added per employee and the degree of penetration of foreign capital, expressed as the ratio of the stock FDI in section to gross value added on the NACE level. We considered gross value added per worker (hour worked) in the EU-15 and Poland as a variable expressing the level of technological gap in the individual sections. Panel data techniques (including models with fixed and random effects (Baltagi, 2005) for comparable annual data from Eurostat and National Polish Bank for the period 1997-2014.

We tested the hypothesis espousing non-linear, inverted U-shaped relationship between the productivity gap and obtained benefits from the presence of FDI in terms of increasing productivity. It was a priori assumed that there is an optimal level of development gap implying maximal absorption benefits from the presence of FDI (Kolasa, 2007), which may be confirmed by a negative impact of the level of the technological gap of sectors. This may prove that too small or too large technological gap is a barrier to absorb the benefits of the presence of foreign capital to productivity growth of enterprises in the host country investments (Damijan, Knell, Boris, & Rojec 2003; Damijan, Rojec, Majcen, & Knell 2013; Cieślik, 2005; Wach & Wojciechowski, 2014, 2016a, 2016b).

The inflow of FDI is one of the factors which may influence the development of catching-up economies. Foreign investment contributes not only to an increase in the value of the total capital in economy, but also causes improvement of technology and efficiency of resource utilising in terms of technological progress.

The results of the study also show that FDI had an impact on the progressive convergence of productivity and wealth of the European Union countries. The paper is structured as follows: in Section 1 we present the existing literature body giving assumptions for the theoretical concept. Then in Section 2 we prepare a preliminary analysis of the collected data and we move with empirical observations to econometric modelling in Section 3. Section 4 concludes and suggests some policy recommendations, as well as further in-depth research intentions.

LITERATURE REVIEW

Technology diffusion from foreign companies to local ones may be carried out through different channels (Ciołek & Golejewska, 2005; 2006). Technology can be embodied not only in tangible assets, but also in patents, know-how and managerial skills (Blomström, Kokko, & Zejan, 1994). While in the short term companies with foreign capital do not need to invest much in human capital but just rely on experience gained by workers in the host country, the situation is quite different in the long term. In this situation, many employees who have gained experience can migrate back to domestic companies that offer them a chance to gain the experience and qualifications acquired by entities with the participation of foreign capi-

tal. The results of an empirical analysis for the after-transformation period suggest that companies with foreign capital have not contributed to the restructuring of local companies but have even led to the deterioration of the situation on the market. Djankov and Hoeckman (2000, pp. 49-50) obtained for the Czech Republic similar results as Ciołek and Golejewska (2006) and Golejewska (2009) did for Poland. It could indicate the weakness of domestic companies and their weak absorption capacity in terms of increasing competition.

In literature on this subject, the prevailing view is that foreign ownership has positive impact on the economy of the host country (Damijan *et al.*, 2003, pp. 2-4). Researchers suggest that the effects of this presence may be in the net result of several factors related to the characteristics of the host country (a developed/ developing one), and as shown by recent studies – also in the motives and the type of investment undertaken. While in most transition economies FDI inflow initially could lead to negative spillover effects (e.g. the phenomenon of market stealing) (Żukowska-Gagelman, 2000, p. 223), it is expected that at the moment positive effects can outweigh the negative ones.

Literature concerning productivity gap in catching-up countries via productivity increasement is extent but still inconclusive. Findlay (1978) reveals that the rate of technological progress in the host country is an increasing function of the technology gap between that country and the investor's country and also the increasing function of acquired FDI. Haddadl and Harison (2001) assumed that foreign companies are more productive and have lower growth rates than domestic ones. That implies convergence which is observed especially in low-tech sectors characterised by the lack of the ability of local companies to assimilate high technology. Karpaty and Lundberg (2004) found that indirect benefits of FDI depend on the absorption capacity of local entities in terms of their own R&D activity. Dimelis (2005) found positive relationship between the technological position of domestic enterprises and indirect effects accompanying FDI in the host country. Negative effects of FDI are observed rather among domestic companies in economies which liberalise trade and introduce market mechanisms in economies characterised by technological backwardness (Sczepkowska-Flis, 2008). However, Glass and Saggi (1998) stated that the technological gap between the host country and the origin of FDI can be treated as an indicator of the absorption capacity of enterprises, i.e. the greater distance the lower quality of technology transferred and lower potential benefits accompanying FDI. Kokko, Tansinis and Zeman (1996) demonstrated that local companies can benefit from the activities of foreign companies in the single market if the gap is not too high, which potentially allows to absorb more efficient technical or organisational solutions. When analysing FDI productivity spillovers concerning technology gap in electrical and electronic industries in Malesia Khalifah, Salleh and Adam (2015) pointed that there is negative (or insignificant) impact of FDI spillover effects on TFP. They also noticed that there exists mixed evidence on the effects of interactions between FDI spillovers and the technology gap and suggested that fine-tuning of fiscal incentive schemes for FDI to arrive at positive net benefits may prove to be a daunting task in the Malaysian E&E industries. In his recent study, Herzer (2017) found a positive long-run effect of FDI on TFP basing on the cointegration analysis of Bolivian time series over the period 1980-2011. The direct motivation of the authors to conduct this study was a paper by Meyer and Sinani (2009) where the authors suggest a curvilinear relationship between spillovers and the host country's level of development in terms of income, institutional framework and human capita. We decided to verify the hypothesis of

a nonlinear, reversed, U-shaped relationship between productivity gaps, and the benefits of the presence of foreign capital in terms of productivity growth.

The current knowledge does not give a clear answer to the question of the impact of FDI on productivity. The results of empirical studies are still inconclusive. Although there is empirical evidence pointing to the varied scale and direction of the impact of FDI on various economic aspects of the host country, there is still no comprehensive theory explaining the complex mechanism of the impact of FDI on the efficiency of resources utilisation. It should also take into account the possibility that FDI and productivity are linked and that there is a bidirectional relationship between them. This issue is particularly important because on the one hand FDI can contribute to changes in productivity in the host country, but on the other hand its level and dynamics may imply that FDI should be undertaken in a given country. Therefore, in both theoretical and technical terms it does not authorise us to consider these categories separately. This fact remains ignored by the majority of the researchers of this phenomenon, despite the dynamic development of the quantitative approach and its application in economics. Thus, it should be assumed that the presence of indirect effects of FDI in the host country varies (both in time and the strength and direction of impact), depending on the host country specifics, the technological gap and finally, on institutional factors. As already mentioned, a two-way relationship between the presence of FDI and productivity in the host country should be assumed, taking into consideration the endogenous nature of FDI.

These two assumptions are reflected in the copyright framework of the created concept, which will be subject to empirical verification (Figure 1). According to the proposed model, the amount and quality (type) of foreign direct investment located in a host country is determined by pull and push factors, which is inseparably connected with motives for making those investments. The (technological) gap between the investor and host countries, in turn, may impact the economy of the host country (both directly and indirectly).

In this study we modify the well-known technological gap concept, assuming that the level of the productivity gap between foreign and national companies is positively correlated with diffusion of productivity. Findlay (1978) showed a positive correlation between the technology gap and the possibilities of catching up with the leader (that is, the country of origin of FDI), which implies the reduction of the technological gap. Opponents of this conclusion state that the gap may limit the absorption of the benefits of the presence of FDI. Backward economies which use outdated technologies may not be able to absorb the potentially positive effects posed by the presence of foreign capital (Teece, 1997, p. 243; Aitken, 1999, pp. 606-607). Contrary to the majority of the literature, we assume that both large and small differences between technology used by different countries may be associated with relatively low benefits from the presence of foreign capital. However, we can find somehow similar approach in the work by Meyer and Sinani (2009). We assume that there should also be a minimum level of technological advancement of economies (branches, enterprises) for them to be able to take advantage of the diffusion of productivity implied by the presence of FDI. Literature suggests there are significant differences between impact of FDI on productivity when controlling investors' origins and motives (Javrocik, 2004; Javrocik-Smarzyńska, Saggi, & Spatarenau 2004). Both cooperation and competition between local and foreign firms

occurs (Kokko, 1996). The theoretical framework presented in Figure 1 is based on Dunning (1973, 1992) and the theory of economy development stages of Ozawa (1992).

Most recent studies of Hussain and Haque (2016) found that FDI is positively correlated with the economic growth in a developing country. Baltabaev (2014), when analysing 49 countries found that the incensement in FDI stocks leads to higher productivity growth. In the view of the authors of this study, the question of the importance of the origin of FDI in the case of potential benefits for the host country is also examined in the work by Azeroual (2016). He concludes that the source country of investment, in particular those which originate from France and Spain, TFP is differently impacted. Indeed, the impact of French investments on TFP is negative and statistical significant, especially in medium and high level technology industries of Marocco. Demeti and Rebi (2014) conclude that between productivity and FDI a strong positive correlation and one side causation exist since productivity can cause FDI, but not the contrary.

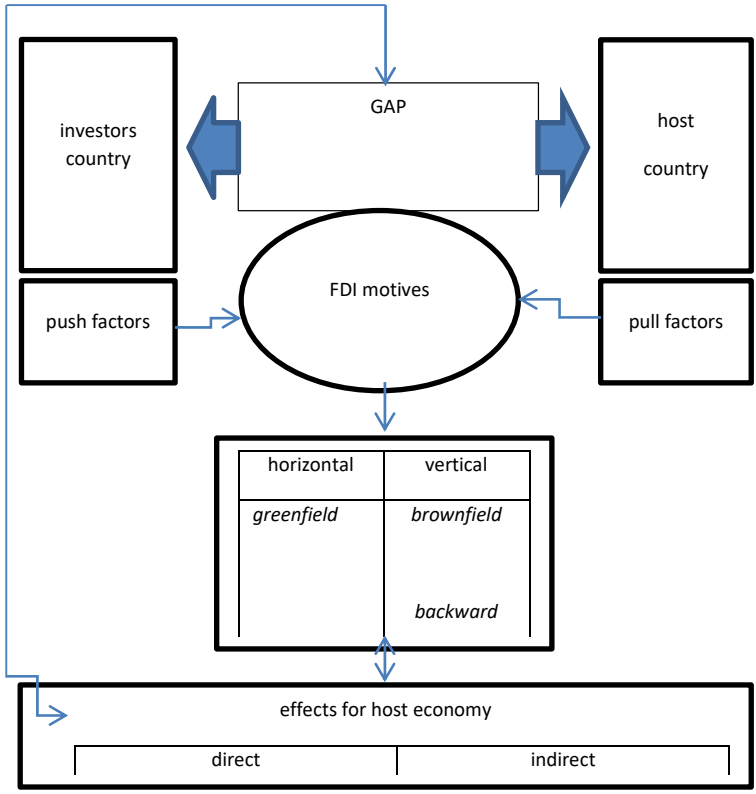

Figure 1. Author's concept for theoretical model
Source: own elaboration.

MATERIAL AND METHODS

The main objective of this study is to check the existence of potential dependence between labour productivity and FDI accumulation across sections of the Polish economy. We also

concern about differences in absorbing capacity in terms of productivity gap. The hypotheses we are checking are as follows: (i): The technological gap between Poland and the EU in the sectoral dimension is constantly decreasing, which is a sign of the catching-up effect; (ii): The greater the share of foreign capital in a given sector, the higher the productivity of the sector; (iii): There is a non-linear parabolic relationship between productivity and productivity gap. In this study we use yearly data covering the 1997-2014 period. Data on FDI divided into 11 NACE sectors[1] were obtained from the balance of payments statistics of the National Bank of Poland, while the data for productivity comes from Eurostat (Table 1).

Table 1. List of variables used in models

No	name	description	formula	abbreviation	unit
1	FDI_pos_mEUR_i,t	Stock FDI in i-sector in t-period	-	FDI	millions of EUR
2	GVA__mEUR_PL_i,t	GVA in i-sector in t-period in Poland	-	GVA_PL	millions of EUR
3	GVA__mEUR_EUR_i,t	GVA in i-sector in t-period in EU-15	-	GVA_UE	millions of EUR
4	EMP_t_hours_PL_i,t	Number of hours worked in i-sector in t-period in Poland	-	EMP_h_PL	thousand
5	EMP_t_hours_UE-15_i,t	Number of hours worked in i-sector in t-period in EU-15	-	EMP_h_UE	thousand
6	EMP_t_employees_PL_i,t	Number of employees in i-sector in t-period in Poland	-	EMP_e_PL	thousand
7	EMP_t_ employees_UE_i,t	Number of employees in i-sector in t-period in Poland	-	EMP_e_UE	thousand
8	GVA_employees_UE-15_i,t	Productivity in i-sector in t-period in EU-15 (type a)	(3)/(7)	GVA_e_UE	–
9	GVA_employees_PL_i,t	Productivity in i-sector in t-period in Poland (type a)	(2)/(6)	GVA_e_PL	–
10	GVA_hours_UE-15_i,t	Productivity in i-sector in t-period in EU-15 (type b)	(3)/(5)	GVA_h_UE	–
11	GVA_hours_PL_i,t	Productivity in i-sector in t-period in Poland (type b)	(2)/(4)	GVA_h_PL	–
12	GAP_1	Productivity GAP (type a)	(8)/(9)	GAP_1	–
13	GAP_2	Productivity GAP (type b)	(10)/(11)	GAP_2	–
14	FDI_GVA_PL_i,t	The share of stock FDI in GVA in i-sector in t-period in Poland	(1)/(2)	FDI_BIZ	%

Source: own study.

At the end of 2014, the value of stock FDI in Poland amounted to almost 172 billion EUR. Nearly 30% of this amount was invested in manufacturing (cat. C. NACE rev. 2), mainly in the production of food, beverages and tobacco products, as well as refined petroleum

[1] A (Agriculture, forestry and fishing), B + E (Mining and quarrying + Water supply, sewerage, waste management and remediation activities), C (Manufacturing), F (Construction), G + I (Wholesale and retail trade repair of motor vehicles and motorcycles + activities with accommodation and services catering), J (Information and communication), K (Financial and insurance activities), L (Real estate activities), M + N (Professional, scientific and technical activities + services administration and support service activities), O + Q (Human health and social work activities), R + U (Activities in arts, entertainment and recreation + Other services).

products, chemicals, pharmaceuticals, rubber and plastic (C19T22). Almost 59% of the stock FDI was invested in services, respectively (mainly in wholesale and retail trade, repair of cars and motorcycles, manufacturing and financial, insurance as well as professional and scientific activities. At the turn of the twentieth and twenty-first century (1997-2001), the average annual growth rate of stock FDI exceeded 37%. Since the Polish accession to the EU we have observed substantial, nearly 28% average annual growth in the rate of stock FDI. During the crisis period (2002-2003) and 2008, and also during a decline in investors' confidence in emerging markets in 2011 and 2013, the slowdown in the growth rate without significant divestments was observed. Nevertheless, the pace of divestment did not exceed 5% y/y. In the mesoeconomic scale there was observed the highest growth in FDI between the years 2003 and 2014 in branches of O + Q, R + U and a (in relative terms). During that period, a substantial amount of capital was invested in the processing industry (nearly 36.1 billion), financial activities and insurance (28.8 billion EUR) retail and wholesale trade, and hotel and catering services (18.3 billion EUR).

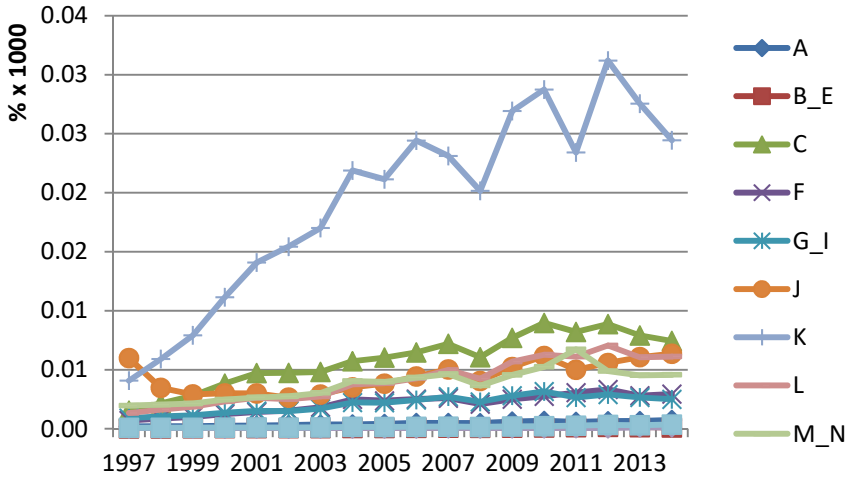

Figure 2. The share of stock FDI in the gross value added employment in i-sector in t-period in Poland
Source: own elaboration.

In the analysed period, we observed a substantial increase in the involvement of FDI in Poland, which was particularly noticeable in financial and insurance (cat. C) activities (Figure 2). The largest absolute increase in productivity per employee and per hours worked has been found in the operational activity of the real estate as well as information and communication markets (cat. J) (Figures 3 and 4). In 1997-2014, a significant decrease in the technological gap between Poland and the old European Union countries was observable. The most spectacular improvement occurred in areas such as agriculture, forestry and fishing, (cat. A), information and communication (cat. J), and real estate services (cat. L). Despite a relatively high growth of the interest of foreign capital in the Polish construction industry, productivity increased slightly, and the output gap remained almost unchanged. An interesting fact is that activities related to real estate output gap increased significantly. Pearson correlation coefficients that were calculated for both Poland and the

EU-15, for each category of the NACE, were characterised by high positive values, which ultimately implied a strong linear and dependency, as shown in Figure 5 and Figure 6.

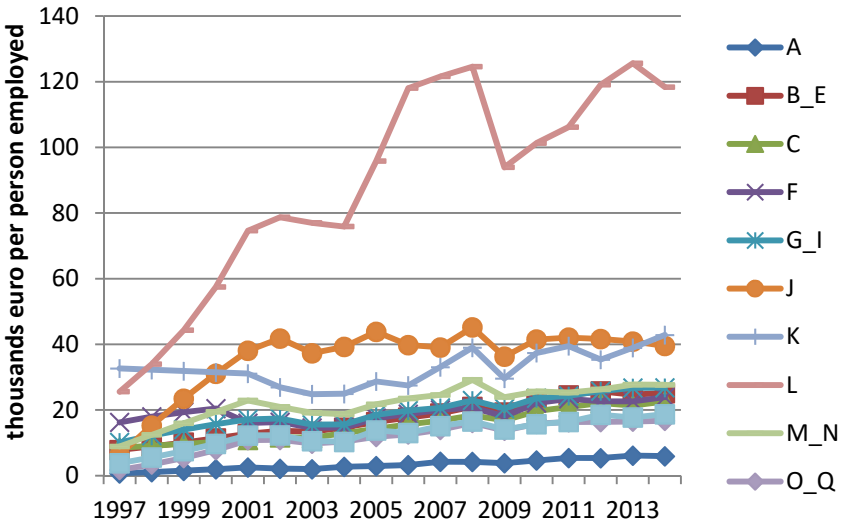

Figure 3. The productivity (per person employed) in the i-sector in t-period t-in Poland
Source: own elaboration.

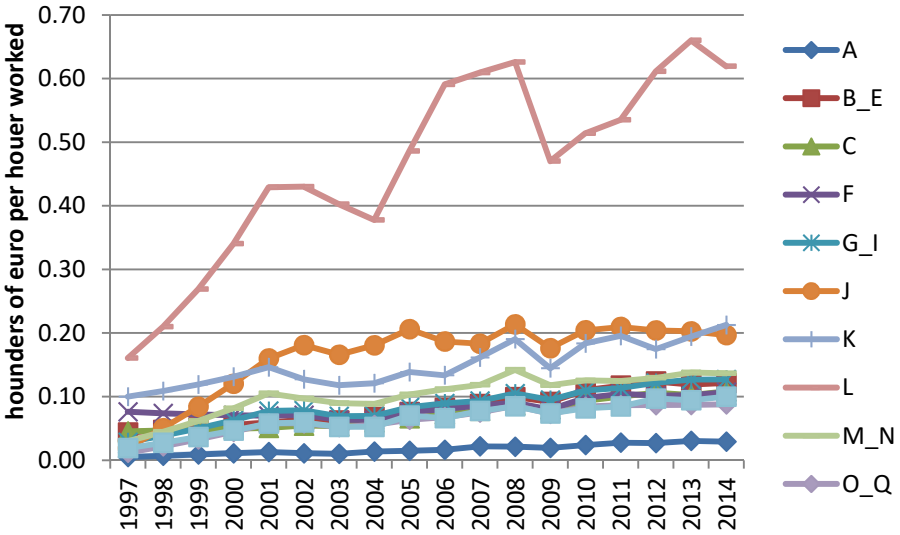

Figure 4. Productivity (per hour worked) in the i-sector in t-period t-in Poland
Source: own elaboration.

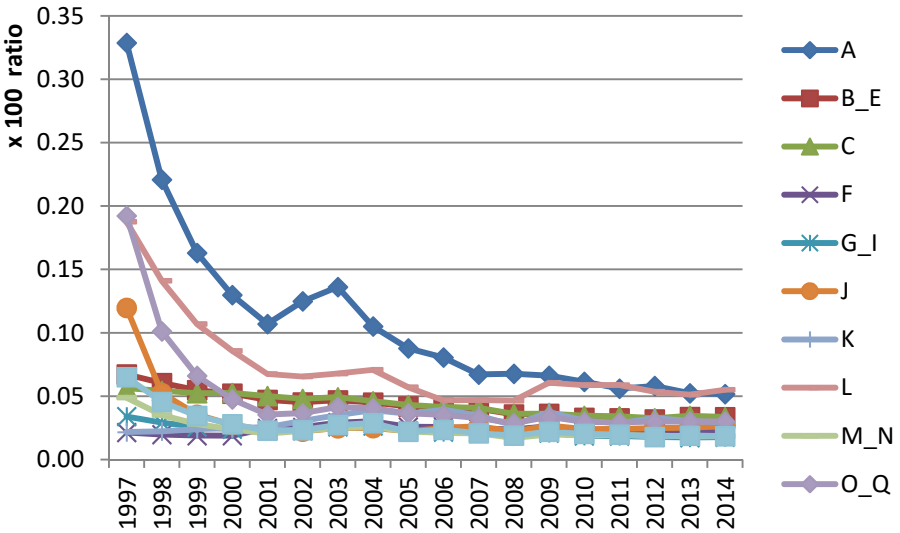

Figure 5. Productivity gap per person employed between the UE-15 and Poland
Source: own elaboration.

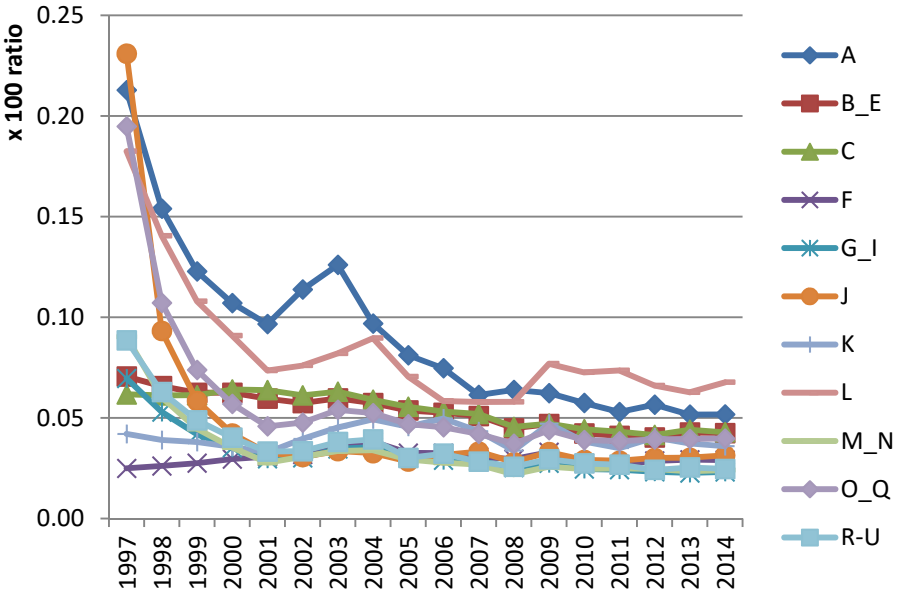

Figure 6. Productivity gap per person hour worked between the UE-15 and Poland
Source: own elaboration.

The methodology used in the paper and the conclusions drawn on this basis are not without weaknesses. The data in nominal terms used in this study may pose questions, but there are no PPP sector deflators available which would provide reliable international or sectoral comparisons. The problem of measuring the productivity was bypassed by considering it in terms of productivity per worker and per hour (as robust analysis). Some data shortages resulted in unbalanced panel. The data analysis suggests significant differences both in the productivity levels and productivity gap. The functional form that we use in the study is only partially embedded in the literature in the Cobb-Douglas production function, however, it includes also the selected elements of the trans-log function with the interactions, which was the subject of the hypotheses verification. The paper nevertheless presents innovative results, partly in line with the results obtained by Meyer and Sinani (2009), indicating the non-linear dependence of the FDI benefits on productivity gaps.

In order to estimate the impact of the involvement of foreign capital on labour productivity in Poland, we considered three different forms of the model and, alternatively, two measures of productivity: per person employed and per hour worked. In model (1) we combined labour productivity per person employed with the degree of the penetration of FDI in the sector (expressed as a share of stock FDI to GVA in the same sector) and the product of this factor through the gap in productivity per worker between the EU-15 and Poland, and the same two-component factor squared. In model (2), labour productivity per employee has been regressed on the degree of penetration of foreign capital in the sector, as well as the productivity gap in the first and second power. In model (3), as opposed to model (2), we postulate an interaction between the degree of the penetration of foreign capital and the gap productivity. For models 4-6, there was analogous reasoning, with a variable expressing productivity being gross value added per an hour worked in the *i*-th sector in the *t*-th year.

$$GVA_{employees_{PL\,i,t}} = const + \beta_1 \frac{FDI_{pos_{mEUR\,i,t}}}{GVA_{mEUR_{PL\,i,t}}} + \\ +\beta_2 \left(\frac{FDI\_pos\_mEUR_{i,t}}{GVA\_mEUR\_PL_{i,t}}\right) x \left(\frac{GVA\_employees\_UE15_{i,t}}{GVA\_emplyees\_PL_{i,t}}\right) \\ + \beta_3 \left[\left(\frac{FDI\_pos\_mEUR_{i,t}}{GVA\_mEUR\_PL_{i,t}}\right) x \left(\frac{GVA\_employees\_UE15_{i,t}}{GVA\_emplyees\_PL_{i,t}}\right)\right]^2 \\ + u_{i,t} \tag{1}$$

$$GVA_{employees_{PL\,i,t}} = const + \beta_1 \frac{FDI_{pos_{mEUR\,i,t}}}{GVA_{mEUR_{PL\,i,t}}} + \\ +\beta_2 \left(\frac{GVA\_employees\_UE15_{i,t}}{GVA\_emplyees\_PL_{i,t}}\right) + \beta_3 \left[\left(\frac{GVA\_employees\_UE15_{i,t}}{GVA\_emplyees\_PL_{i,t}}\right)\right]^2 + u_{i,t} \tag{2}$$

$$GVA_{employees_{PL\,i,t}} = const + \beta_1 \frac{FDI_{pos_{mEUR\,i,t}}}{GVA_{mEUR_{PL\,i,t}}} + \\ +\beta_2 \left(\frac{GVA_{employees_{UE15\,i,t}}}{GVA_{employees_{PL\,i,t}}}\right) + \\ +\beta_3 \left(\frac{FDI\_pos\_mEUR_{i,t}}{GVA\_mEUR\_PL_{i,t}}\right) x \left[\left(\frac{GVA\_employees\_UE15_{i,t}}{GVA\_emplyees\_PL_{i,t}}\right)\right]^2 + u_{i,t} \quad (3)$$

$$GVA_{hours_{PL\,i,t}} = const + \beta_1 \frac{FDI_{pos_{mEUR\,i,t}}}{GVA_{mEUR_{PL\,i,t}}} + \\ +\beta_2 \left(\frac{FDI_{pos_{mEUR\,i,t}}}{GVA_{mEUR_{PL\,i,t}}}\right) x \left(\frac{GVA_{hours_{UE15\,i,t}}}{GVA_{hours_{PL\,i,t}}}\right) + \\ +\beta_3 \left[\left(\frac{FDI\_pos\_mEUR_{i,t}}{GVA\_mEUR\_PL_{i,t}}\right) x \left(\frac{GVA\_hours\_UE15_{i,t}}{GVA\_hours\_PL_{i,t}}\right)\right]^2 + u_{i,t} \quad (4)$$

$$GVA\_hours\_PL_{i,t} = const + \beta_1 \frac{FDI\_pos\_mEUR_{i,t}}{GVA\_mEUR\_PL_{i,t}} + \beta_2 \left(\frac{GVA\_hours\_UE15_{i,t}}{GVA\_hours\_PL_{i,t}}\right) \\ + \beta_3 \left[\left(\frac{GVA\_hours\_UE15_{i,t}}{GVA\_hours\_PL_{i,t}}\right)\right]^2 + u_{i,t} \quad (5)$$

$$GVA\_hours\_PL_{i,t} = const + \beta_1 \frac{FDI\_pos\_mEUR_{i,t}}{GVA\_mEUR\_PL_{i,t}} + \beta_2 \left(\frac{GVA\_hours\_UE15_{i,t}}{GVA\_hours\_PL_{i,t}}\right) \\ + \beta_3 \left(\frac{FDI\_pos\_mEUR_{i,t}}{GVA\_mEUR\_PL_{i,t}}\right) x \left[\left(\frac{GVA\_hours\_UE15_{i,t}}{GVA\_hours\_PL_{i,t}}\right)\right]^2 + u_{i,t} \quad (6)$$

The six models presented above were estimated using panel techniques and covers the years 1997-2014 for 11 NACE rev. 2 sections of economy. While using panel econometric models, we postulate that every individual and every period of the research is characterised by individual specificity, which may be included in the model through the introduction of individual and periodic effects. The general form of the model of the panel is expressed as follows:

$$y_{it} = \beta_0 + \sum_{p=1}^{k} \beta_p x_{p\,i,t} + n_i + v_t + u_{i,t} \quad (7)$$

where:

k - is the number of variables in the model;
n_i - is the individual effect for the *i*-th unit;
v_t - is the result of periodical for the *t*-th year
$u_{i,t}$ - is a random term.

Provided that individual and periodic effects exist, the model can be defined as bidirectional. These effects can be either fixed (fixed effects FE) or random (random effects RE). The presence of the effects of fixed amounts simply comes to the attribution of another intercept

parameter to each of the audited entities. In this case, it is reasonable to estimate the model using GLS, which takes into account correlation between components of the same unit or period. When individual and periodical effects are included in the disturbing factor, assumptions about the lack of correlation of these effects with the explanatory variables of the model should be true. When they are not, the methods of estimation based on OLS give burden results. In the assessment of the effects which need to be taken into account, we use the Hausman specification test. Under the conditions of the truth of the null hypothesis that both GLS estimator and OLS are consistent and unbiased, but GLS is more efficient, which indicates the selection of the model RE. The alternative hypothesis, indicating that GLS estimator is biased, the preferred model is the one with fixed FE effects. We also took into account the results of the Breusch-Pagan test when estimating the model.

RESULTS AND DISCUSSION

Statistical analysis of data concerning FDI and both Poland's and the EU-15's productivity was the first stage preceding estimation. Thanks to the use of panel techniques we estimated models with specifications presented in paragraph 3. The procedure for the selection of models was as follows:

- pooled estimation model;
- diagnostic tests of:
  1. the residual variance (The culture model of pooled, Ha- FE);
  2. Breusch-Pagan Test (The culture model of pooled, Ha- model RE);
  3. Hausman Test (The culture model RE, Ha- FE):
     - estimation of the proper model;
     - assessment of the model when it comes to its:
       1. statistical properties;
       2. interpretational properties.

Table 2. Estimated panel models for productivity

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Const	7.845***	11.286***	9.714***	18645***	22531***	22380***
β_1	14.079***	6.515***	8.565***	43900***	10149***	20537***
β_2	0.273			-6243.4**		
β_3	-0.149**	-0.426***	-0.0776***	-321.1*	-37.11***	-854.5***
Hausman test	FE	RE	FE	FE	FE	FE
LSDV-R^2 (%)	87.55	-	86.92	85.90	83.56	87.60
Within-R^2 (%)	26.91	-	23.18	27.17	15.09	35.94
LSDV F p-value	7.13e-76	-	6.49e-75	6.13e-71	7.79e-66	4.75e-77
Joint test on named regressors p-value	1.70e-012	-	2.56e-011	1.23e-012	2.27e-018	1.29e-018
Test for constant p-value	7.63e-062	-	2.26e-073	1.37e-057	1.30e-058	6.62e-074
AIC	1179.45	1565.40	1187.32	4200.43	4228.79	4173.01
BIC	1225.48	1575.26	1230.07	4246.46	4271.53	4215.76
HIQ	1198.08	1569.39	1204.62	4219.06	4246.09	4190.32

p-value <0,01 ***; p-value<0,05 ** p-value<0,1*

Source: own study.

According to all the models analysed, an increase in the share of foreign capital in a given sector corresponded with an increase in labour productivity (per person employed and per hour worked). The analysed models partly suffer from autocorrelation. In model (1) the element of the interaction of the involvement of foreign capital in the sector with a gap of production per employee was not relevant. However, before this factor is squared, the assessment of the statistical parameter is negative and it is statistically significant when the risk is lower than the acceptable 0.05 level of significance. It means that, due to the shape of an inverted parabolic function, sectors characterised with the highest increase in productivity are those where values of the gap are rather average. Negative and statistically significant evaluations of β3 parameter were also obtained in model (2) (no interaction) and (3) (excluded from the interaction of the factor subject to exponentiation). Similar results were obtained for models 4-6, while taking into account productivity per hour worked instead of the employee. In order to determine the course of the function describing the addictive effect of the involvement of foreign capital on the productivity of the sector in the host country, (β1), the size of the (changes in) the output gap, the results summarised in Table 3 were examined. After the outliers for selected sections had been excluded (A, C, F, G + I, J, K, M + N), it was found out that there is a postulated relationship between coefficient (β1) and the change in the output gap. The more the gap between sectors of Poland and the EU changed, the smaller benefits from the presence of FDI were. Thus, the ones which "benefited" most were those which were characterised by a moderate change in the output gap, which is in some way about the ability of initial absorption. By limiting the analysis to sections A, C, J, K, M + N, we realised that the greater the initialised gap in productivity was, the greater the expressed "benefits" were reaped by sectors. The assumption here was that the gap in productivity expressed as the quotient of productivity in the *i*-th sector in period *t*-including the EU-15 and Poland in 1997 was higher than 16 times (which was not uncommon, Figure 5 and 6).

Table 3. Dependencies between the benefits from the presence of FDI for individual sector and the size of the productivity gap

NACE	*GVA_hours_PL_i.t*		*GVA_employees_UE-15_i.t*		*GAP1 1997*	*GAP1 2014*	change_ *GAP1_ 2014/1997*
	β_1	β_3	β_1	β_3			
A	46.498 ***	7.2493	88658.7 ***	26995.1 ***	21.3	5.2	4.1
B_E	1831.78***	-3933 ***	3.58e+06***	-1.35e+07***	7.1	4.2	1.7
C	20.39 ***	-0.48 **	40808.8***	-1941.64 ***	6.2	4.3	1.4
F	51.85 ***	1.74063	116744 ***	2578.17	2.5	2.9	0.9
G_I	53.93 ***	-27.83**	113357 ***	-94061.7***	7.0	2.3	3.0
J	32.79 ***	0.46***	84096.4 ***	3460.57***	23.1	3.1	7.4
K	10.93 ***	-0.016458	22510.7 ***	166.10***	4.2	3.6	1.2
L	155.43 ***	-1.52023 *	277812 ***	-6943.00**	18.2	6.8	2.7
M_N	25.38 **	2.49192	63107.3 ***	-11005.4*	9.0	2.4	3.7
O_Q	1081.85***	-3143.06	1.8e+06 ***	8.42E+06	19.5	4.0	4.9
R-U	426.95 ***	-774.01	814973 ***	-2.50E+06	8.9	2.5	3.6

p-value <0,01 ***; p-value<0,05 ** p-value<0,1*

Source: own study.

The obtained results suggest a positive influence of the presence of foreign capital on labour productivity in Poland, in particular the NACE sections. Available data do not indicate whether the productivity of domestic firms is improving, so only the net effect of FDI is examined. From the point of view of the research plan, the statistical parameters obtained are in line with the expectations, in particular negative for GAP^2, which implies the assumed non-linearity. Due to the observed non-stationarity of the analysed time series, an error correction model appears to be more appropriate, however, a long-run relationship between FDI and GVA in all sectors was not found (see Havranek & Irsova, 2010). Only the GAP level was neglected in the study, such as the technical arming of labour due to the lack of data on sectoral capital was neglected. Significant differences in GAP and productivity may suggest the need for an individual analysis for individual sectors because of heterogeneity problem. In one of recent studies, Hussain and Haque (2016) found that FDI contribute positively to the economic growth of a developing country which is Bangladesh. Baltabaev (2014), using panel data for 49 countries over the period 1974-2008 and the existence of Investment Promotion Agencies in the host countries showed that incensement in FDI stock leads to higher productivity growth. He finds a significant positive effect on the interaction between FDI stock and the distance to the technological frontier, suggesting that the ability of technologically backward countries to absorb technologies developed at the frontiers increases as more FDI stock is accumulated. The results obtained by Roy (2016) who investigated effects of FDI on TFP, taking into consideration the role of the initial distance of the country from the technology frontier determining the net effect of FDI on TFP also suggest convergence in terms of productivity. He found that the net effect of FDI on the TFP growth decreases with an increase in the distance, which is opposite to Findlay's model. His analysis also suggests that if the initial distance of a country exceeds a threshold level, then the leader will have a locomotive effect and can pull the followers along, while in the other situation there is a significant negative impact of FDI which increases with distance, as a result of which the net benefit from FDI can be miniscule. To a large extent, the obtained results are quality-comparable to those mentioned in literature.

CONCLUSIONS

This article aimed at verifying the hypothesis that espouses a non-linear, inverted, U-shaped relationship between the technology gap and the benefits from the presence of foreign capital in the form of increased productivity. Statistical analysis of the time series indicates that while in 1997-2014 there was an increase in the involvement of foreign investors in the context of FDI in Poland in all sectors, with different dynamics and volume, there was also an increase in the productivity of sectors. The comparison of 1997 with 2014 shows a significant reduction in the productivity gap between Poland and the EU-15 in almost all major categories of the NACE. At the same time, the fact that productivity grew more dynamically in Poland may be indicative of processes characterised by convergence, which is a legitimate subject of a separate, in-depth analysis. The estimated models, which take into account the degree of the penetration of foreign capital, productivity gap and interactions, bring the expected results, proving at the same time that the accumulation of FDI in Poland occurred simultaneously with the increase in productivity. What is more, the backwardness of business or its relative proximity in terms of labour productivity in relation to the EU-15 was an unfavourable factor when it comes to the improvement of productivity.

The obtained results confirm the stated hypothesis. An increased involvement of foreign capital in different sectors of the economy imply higher productivity of these sectors. Although with an increasing technological gap, GVA in a sector typically grow to a certain point, and after exceeding it, they decrease (see Girma, Gong, Gorg, & Lancheros, 2014; Görg & Greenway, 2004). The analysis confirmed hypothesis (i) (the technological gap between Poland and the EU in the sectoral dimension was constantly decreasing through the analysed period, which is a sign of the catching-up effect. We observed that the greater the share of foreign capital in a given sector was, the higher the labour productivity of the sector was. The assumed and confirmed formula of the model concerning non-linearity suggests that the dependence between productivity and technological gap is not simply linear. The obtained results do not allow to reject hypothesis (iii) that there exists an optimal level of productivity gap implying high absorption benefits of the FDI presence because of a negative and statistical significant parameter with GAP^2. We observe the highest benefits from the presence of FDI especially for mid-gap sectors. The results point to the importance of supporting relatively backward sectors to allow them *ti* absorb benefits from FDI.

In further studies, we intend to use more disaggregated and comparable NACE data in terms of 64 industries. Factors which may constitute a restriction in these studies are statistical data which are not readily available or comparable and developed with the use of different methodologies. In subsequent studies, there will be more emphasis on the structure and changes of dynamics and its distribution within individual sectors, including changes resulting from restrictions of employment and growth in value-added tax or other alternative measures, just as sold production, postulated in the literature on this subject. An important limitation of the research, which will be discussed thoroughly in further studies, is the inclusion of entities with the majority of domestic capital as potential beneficiaries of the presence of FDI in the economy (in industries).

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