2. FOREIGN DIRECT INVESTMENTS AND EMPLOYMENT. STRUCTURAL ANALYSIS

Dorin JULA[1]
Nicolae-Marius JULA[2]

Abstract

We analyze the impact induced by Foreign Direct Investments on changing the sectoral structure of employment. By developing a general methodological framework, we show that, for the dynamics of the structure analysis, the appropriate model is a panel data with time specific fixed effects and with cross-section specific effects, weighted by the growth rate of total employment. To analyze the change in structures, the appropriate model is, likewise, a panel data, without time specific (fixed or random) effects, but with cross-section specific ones, weighted by total employment. We find that for Agriculture, forestry and fishery, Manufacturing and Accommodation and food services*, the growth of FDI was associated with a decrease in industry share in total employment, both at global level, as well as regarding the private and public employment structures. This means that, for the industries concerned, the FDI effect on productivity improvement was superior to the effect induced on employment growth. For* Mining, Electricity, Natural gas and water, Information technology and communications, Financial intermediation and insurance, Professional, scientific, technical and administrative activities and support services *the effect is positive for the private sector and negative for the public one. For the remaining industries (*Construction and real estate transactions, Trade, Transportation*) the effects of FDI was rather positive than otherwise. Consequently, for those industries, the FDI effect on employment growth exceeds that on productivity.*

Keywords: Foreign Direct Investment, industry structure of employment, panel data models

JEL Classification: C33, F21, J21

[1] *Institute for Economic Forecasting, Romanian Academy and Ecological University of Bucharest, Financial Management Faculty, E-mail: dorinjula@yahoo.fr.*
[2] *"Nicolae Titulescu" University of Bucharest, Faculty of Economic Sciences, E-mail: mariusjula@yahoo.com.*

I. Introduction

According to the World Bank (1996), "Foreign direct investment is defined as investment that is made to acquire a lasting management interest (usually 10 percent of voting stock) in an enterprise operating in a country other than that of the investor (defined according to residency) (…). It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments" (World Bank, 1996, p. 182).

The impact of international capital on the host country's economy was widely analyzed in the economic literature. As for the relationship between *Foreign Direct Investments* and *economic growth*, Wan (2010) noted the existence of conflicting results. On the one hand, theories and empirical studies provide evidences of FDI's support to modernize the economy and promote economic development by stimulating technological change and technological spillovers with positive economic effects on employment. On the other hand, there are opinions that "FDI may bring about crowding out effect on domestic investment, external vulnerability and dependence, destructive competition of foreign affiliates with domestic firms and *market-stealing effect*" (Wan, 2010, p. 52). Almfraji and Almsafirc (2014) reviewed 18 researches (developed between 1994 and 2012) that examine the growth effects of FDI. They found 11 papers that report significant positive FDI effects on economic growth, one paper that registers a weak positive effect, 4 papers that show a null effect and 2 papers that describe a negative effect. According to the authors, the reasons for such results include sample selection, the selected estimation techniques, the selected time period and the estimation methodology (Almfraji & Almsafirc, 2014, p. 298). In turn, Ozturk (2007) reviews over 50 studies in the literature and finds 37 of them where there are arguments in favor of positive (or weak positive) effects of FDI on economic growth, 3 studies that show negative causal relationship between FDI and growth, 5 studies where FDI does not have any significant effect on growth and 6 studies where FDI has an ambiguous effect on growth.

In terms of *employment*, Foreign Direct Investment can play a positive role (creating new jobs, especially in the case of Greenfield Foreign Direct Investment, improving the human capital level through spillovers effect, on-the-job training, improving management and so on). However, FDI can also have a negative impact on employment. Investing in high performance technologies leads to increased productivity, which, if not associated with a larger increase in output, leads to loss of jobs. In turn, the layoffs have negative impact on incomes, namely on the overall demand in the economy, which may lead to decline in the demand for labor. A similar effect may occur as a result of removal of the national companies from the market. In Margeirsson's (2015, p. 1) terms: "FDI is a double-edged sword that must be handled with care".

Concerning *the methodologies* used for analyzing the Foreign Direct Investment, Metaxas and Kechagia (2016) carry out a literature review of 100 empirical studies, over the period 1950-2015. They found that prior to 1990, in most of the papers, the multiple regression was applied as an econometric model, usually the OLS was chosen as estimation method, but also some empirical papers used 2SLS and GLS. After 1990, the panel data model with fixed or random effects was used in analysis, eventually with

qualitative explanatory variables (Ciuiu, 2013), and, 3SLS or other modern techniques were used as estimation methods, besides OLS.

Time series of employment recorded as structure by industries can be regarded as compositional data, in Aitchison (1986) geometry terms. Aitchison (1986) "developed an axiomatic approach to compositional data analysis with a variety of methods, operations, and tools, based on a set of fundamental principles, like sub-compositional coherence" (Boogaart (van den) & Tolosana-Delgado, 2013, p. 5). In his seminal work on compositional data, Aitchison (1986) proposed the fundamental concepts in the field of compositional data analysis, such as sub-compositional coherence, perturbation operation, power transformation, additive and centered log-ratio transformation and so on. Metaxas and Kechagia (2016) do not report any work that analyses the structure of occupation through the concepts described in Aitchison geometry.

Alfaro (2003) carried out a *sectoral analysis* through a panel data model and concludes that foreign direct investments have a negative effect on growth in the primary sector, a positive one in manufacturing, while for the service sector the effect is ambiguous. In a similar manner, by analyzing the regional and sectoral data for Egypt (1992-2007), Hanafy (2015) found that FDI had a positive impact on manufacturing, a negative effect on agriculture and no significant effect on services. In the same line of argument, Wang (2009) finds that, for 12 Asian economies over the period from 1987 to 1997, FDI had a positive effect in the manufacturing sector and it was not a significant factor in the non-manufacturing sectors. Cipollina *et al*. (2012) analyzed a disaggregated data on 14 manufacturing sectors over the period 1992–2004, for developed and developing countries, and concluded that the growth effect of FDI was stronger in capital-intensive and technologically-advanced sectors.

For *Romania*, Simionescu (2016) analyzed the relationship between FDI and regional economic growth and found that FDI generated economic growth only in the Bucureşti-Ilfov region, while in the rest of the country FDI did not induce a growth effect. Pelinescu and Rădulescu (2009) establish that the influence of FDI on Romanian GDP and export growth is still at a low level, but the growth effect on productivity and competitiveness is more significant. Enache and Merino (2017) examined, likewise, the dynamic relationship between FDI and economic growth for Romania. Their results show that FDI had a small influence on economic growth over the 2007-2014 period. Other studies on structure dynamics and economic growth were carried out by Dobrescu (2011), Albu (2008), Jula and Jula (2013). As methodological issue, Bâlgăr (2016) demonstrates that the magnitude of change in industry's share to total employment negatively depends on the initial size of the analyzed sector (scale effect) and is inversely proportional to the size of the economy as measured by the total employment.

II. Methodology

Let s_i be the share of industry "*i*" in total employment, i.e., $s_i = e_i/E$, where e_i is employment in industry *i* and *E* is total employment. Since $0 < e_i < E$, it is obvious that $0 < s_i < 1$. The left side inequality ensures the presence of mentioned industry in the national economy (e_i is not zero), and the right side inequality eliminates the situation when the economy is composed of a single branch.

Suppose that employment in industry "*i*" changes from $e_{i,t-1}$ to $e_{i,t} = e_{i,t-1} + de_{i,t}$, no matter which is the sign of $de_{i,t}$. At the same time, the total employment changes from E_{t-1} to $E_t = E_{t-1} + dE_t$. The share of industry in total employment adapts from $s_{i,t-1}$ to $s_{i,t}$, where $s_{i,t}$ signifies the new share of industry "*i*" in new total employment:

$$s_{i,t} = s_{i,t-1} + ds_{i,t} = \frac{e_{i,t-1} + de_{i,t}}{E + dE},$$

Given that $e_{i,t-1} = s_{i,t-1}E_{t-1}$, we write:

$$ds_{i,t} = \frac{e_{i,t-1} + de_{i,t}}{E_{t-1} + dE_t} - s_{i,t-1} = \frac{de_{i,t} - s_{i,t-1}dE_t}{E_{t-1} + dE_t}$$

Further, let $r_{i,t}$ be the growth rate of employment in the industry, $r_{i,t} = \frac{de_{i,t}}{e_{i,t-1}}$ and $r_{L,t}$ be the growth rate of total employment, $r_{L,t} = \frac{dE_t}{E_{t-1}}$. Given these, we obtain the following transformation of the previous equation:

$$ds_{i,t} = \frac{e_{i,t-1}r_{i,t} - e_{i,t-1}r_{L,t}}{E_{t-1}(1+r_{L,t})} = s_{i,t-1}\frac{r_{i,t} - r_{L,t}}{1+r_{L,t}}.$$

II.1. The Growth Rate of Industry Share in Total Employment

The previous relationship is equivalent with

$$\frac{ds_{i,t}}{s_{i.t-1}} = \frac{r_{i,t} - r_{L,t}}{1 + r_{L,t}},$$

the same as

$$r^s_{i,t} = -\frac{r_{L,t}}{1+r_{L,t}} + \frac{1}{1+r_{L,t}}r_{i,t},$$

where: $r^s_{i,t} = \frac{ds_{i,t}}{s_{i,t-1}}$ is the growth rate of the *i* industry share in total employment, in the time-period (year) *t*.

Let X be a variable which influences the dynamics of employment (an influence variable). For example, *X* may be a factor tied to production (foreign direct investments, technological changes, etc.) or to market demand. We denote by $r^x_{i,t}$ – the growth rate of variable *X* tied to industry *i*, $r^x_{i,t} = \frac{dX_{i,t}}{X_{i,t-1}}$ (*e.g.*, the growth rate of foreign direct investments in the industry *i*, or generally, a circumstance, a fact, or an influence factor that contributes to a change in employment in the industry *i*). Further, we denote by η_i –

the industry employment elasticity with respect to *X*. Then, by definition, $r_{i,t} = \eta_i \cdot r_{i,t}^x$. Given this, we can write

$$r_{i,t}^s = -\frac{r_{L,t}}{1+r_{L,t}} + \frac{1}{1+r_{L,t}} \eta_i \cdot r_{i,t}^x ,$$

In the previous equation, $\frac{1}{1+r_{L,t}}$ is the inverse of total employment growth index, so that, $\frac{1}{1+r_{L,t}} > 0$. Then, *the impact of X_i on the change in employment share of industry "i" in total employment is positive if sign(η_i)·sign($r_{i,t}^x$) > 0*. Furthermore, the previous equation asserts that: *the impact of variable X on dynamics of industry share in total employment is proportional to the industry employment elasticity with respect to X, corrected by the inverse of total employment growth index.*

If $r_{L,t}$, (annual rate of change of total employment) is not very large, then $\frac{1}{1+r_{L,t}} \approx 1 - r_{L,t}$ and $\frac{r_{L,t}}{1+r_{L,t}} \approx r_{L,t}$, so that, $r_{i,t}^s \approx - r_{L,t} + (1 - r_{L,t}) r_{i,t}$.

We consider a linear relationship between the influence factor *X* and the dynamics of industry employment. As panel data model, we write:

$$r_{i,t} = \alpha + \beta_i r_{i,t}^x + \gamma_i + \delta_t + \varepsilon_{i,t},$$

where: α is the intercept, independent of *i* and *t* (homogeneity coefficient), β_i are the slopes, γ_i are the cross-section specific effects (time-invariant), δ_t are time specific effects (cross-section invariant) and $\varepsilon_{i,t}$ is the variable of idiosyncratic errors.

Given this, we can write

$$r_{i,t}^s = - r_{L,t} + (1 - r_{L,t})(\alpha + \beta_i r_{i,t}^x + \gamma_i + \delta_t + \varepsilon_{i,t})$$

or

$$r_{i,t}^s = \alpha - (1 + \alpha) r_{L,t} + \beta_i (1 - r_{L,t}) r_{i,t}^x + \mu_i + \tau_t + v_{i,t}$$

where: μ_i and τ_t are the cross section, and the time specific effects, respectively, and $v_{i,t}$ is the variable of idiosyncratic errors.

Based on those theoretical relationships, for empirical testing, we build the following panel data model

$$r_{i,t}^s = a_0 + a_1 r_{L,t} + (a_2)_i \cdot (1 - r_{L,t}) r_{i,t}^x + \mu_i + \tau_t + v_{it},$$

$$\sum_i s_{i,t} \le 1, \quad t = 1, 2, \ldots, T.$$

Since we considered only industries that have been related to FDI, the sum of the weights is less than unit (*sub-composition*, in Aitchison terms). This latter relationship is

required for out-of-sample estimates (*i.e.* forecast). For in-sample estimations, the sum of values of the endogenous variable equals the sum of values estimated through the model (the errors have zero mean).

In the empirical model:

t	denotes the time-period;
i	symbolizes industry (cross-sections variables);
$s_{i,t}$	is the share of industry "*i*" in total employment, in the time-period (year) *t*;
$r_{L,t}$	is the annual rate of change of total employment;
$r^{s}_{i,t} = \frac{ds_{i,t}}{s_{i,t-1}}$	denotes the growth rate of share of industry "*i*" in total employment, in the time-period (year) *t*;
$r^{x}_{i,t}$	is the growth rate of variable *X* tied to industry "i", in the time-period (year) *t*;
μ_i	are cross-section specific effects (they are time-invariant);
τ_t	are time specific effects (they are cross-section invariant);
v_{it}	denote idiosyncratic errors variable, independent of each other and among themselves;
a_0	is the intercept, independent of *i* and *t* (homogeneity coefficient);
a_1, a_2	are the slopes.

According to the panel-data model, we notice that:

- If $a_{2,i} > 0$, this means that growth in influence factor *X* leads to increased employment in the industry "i";
- If $a_{2,i} < 0$, this means that growth in influence factor *X* leads to increased productivity in the industry "i";
- If $a_{2,i} = 0$, this means that growth in influence factor *X* is not associated with the change in employment in the industry "i".

II.2. The Change in Industry Share in Total Employment

We start from the equation

$$ds_{i,t} = s_{i,t-1} \frac{r_{i,t} - r_{L.t}}{1 + r_{L,t}}$$

where, the same as before, $s_{i,t-1}$ is the initial share of employment of the industry *i* in total employment, $s_{i,t-1} = e_{i,t-1}/E_{t-1}$ ($e_{i,t-1}$ is employment in the industry *i* in the time-period (year) *t-1* and E_{t-1} is the total employment at the same moment), $ds_{i,t} = s_{i,t} - s_{i,t-1}$ is change in the industry share in total employment, $r_{i,t} = de_{i,t}/e_{i,t-1}$ is the growth rate of employment in the industry *i*, and $r_{L,t} = dE_t/E_{t-1}$ is the growth rate of total employment.

We use the approximations $1/(1 + r_{L,t}) \approx 1 - r_{L,t}$, so that $ds_{i,t} \approx s_{i,t-1}(r_{i,t} - r_{L,t})(1 - r_{L,t})$. In addition, if neither $r_{L,t}$ nor $r_{i,t}$ is not very large, then $ds_{i,t} \approx s_{i,t-1}(r_{i,t} - r_{L,t})$. We find

$$ds_{i,t} \approx - s_{i,t-1} r_{L,t} + \left(\frac{1}{E_{t-1}}\right) de_{i,t}$$

Let X be, like in the previous model, a variable which influences employment dynamics (an influence factor that contributes to a change in employment in the industry *i*, from $e_{i,t-1}$ to $e_{i,t}$), namely, $de_{i,t} = f(X_{i,t}, v_{i,t})$, where v_i means the other factors.

We take into account a linear relationship between the change in the size of $X_{i,t}$, *i.e.* $dX_{i,t}$, and the dynamics of industry employment, $de_{i,t}$. As panel data model, we write:

$$de_{i,t} = \lambda + \mu_i dX_{i,t} + \zeta_i + \theta_t + \upsilon_{i,t},$$

where: λ is the intercept, independent of *i* and *t* (homogeneity coefficient), μ_i are the slopes, ζ_i are the cross-section specific effects (time-invariant), θ_t are time specific effects (cross-section invariant) and $u_{i,t}$ is the variable of idiosyncratic errors.

Given this, we can write

$$ds_{i,t} \approx - s_{i,t-1} r_{L,t} + \left(\frac{1}{E_{t-1}}\right)(\lambda + \mu_i dX_{i,t} + \zeta_i + \theta_t + \upsilon_{i,t})$$

Based on these theoretical relationships, for empirical testing we build the following linear panel data model

$$ds_{i,t} = a_0 + a_1 \cdot s_{i,t-1} \cdot r_{L,t} + a_{2,i} \cdot \left(\frac{1}{E_{t-1}}\right) \cdot dX_{i,t} + \mu_i + \tau_t + v_{it},$$

$$\sum_i s_{i,t} \leq 1, \quad t = 1, 2, \ldots, T.$$

In the empirical model:

t denotes the time-period;

i symbolizes industry (cross-sections variables);

$s_{i,t-1}$ is the share of industry "*i*" in total employment, in the time-period (year) *t-1*;

$dX_{i,t}$ is the dynamics of variable *X* tied of industry "i", in the time-period (year) *t*;

$r_{L,t}$ is the annual rate of change of total employment;

μ_i are cross-section specific effects (fixed or random); they are time-invariant;

τ_t are time specific effects (fixed or random); they are cross-section invariant;

v_{it} denotes idiosyncratic errors variable, independent of each other and among themselves;

a_0 is the intercept, independent of *i* and *t* (homogeneity coefficient);

a_1, a_2 are the slopes.

According to the panel data model, we notice that:

- If $a_{2,i} > 0$, this means that growth in influence factor *X* leads to increased employment in the industry *i*;
- If $a_{2,i} < 0$, this means that growth in influence factor *X* leads to increased productivity in the industry *i*;
- If $a_{2,i} = 0$, this means that growth in influence factor *X* is not associated with the change in employment in the industry *i*.

III. Data

We used data on *Foreign Direct Investment* (FDI) provided by the National Bank of Romania, (http://www.bnro.ro/PublicationDocuments.aspx?icid=14364, accessed on January 23, 2017). The data cover the 2003-2015 period and the structure by 12 industries is the following: Agriculture, forestry and fishery; Industry (Mining; Manufacturing; Electricity, natural gas and water); Construction and real estate transactions; Trade; Accommodation and food service activities; Transportation; Information technology and communications; Financial intermediation and insurance; Professional, scientific, technical and administrative activities and support services; Other activities.

Foreign Direct Investments in the Manufacturing industry was registered for the following industries: food, beverages and tobacco; cement, glassware, ceramics; wood products, including furniture; computers, other electronic, optical and electrical equipment; machinery and equipment; metallurgy; transport means; oil processing, chemicals, rubber and plastic products; textiles, wearing apparel and leather goods; other manufacturing sub-sectors. In the econometric models, we did not use this detailed structure, because we have not a similar structure in the employment data.

As regards employment, we used the data from National Institute of Statistics (NIS), concerning *Employment by ownership type of working place and by activities of the national economy*. The data cover the 1996-2015 period (NIS, TEMPO-Online Time series, AMG110M).

As *ownership type of working place,* we selected *total employment, public, private, mixed employment and other ownership* (co-operative or community ownership, other).

Since the sectoral structure of employment data (National Institute of Statistics for data source) differs from the sectoral structure of FDI (National Bank of Romania for data source) and, moreover, there is a break in the data series on employment (changing from NACE Rev.1 to NACE Rev.2, starting in 2008), we had to convert the two structures to ensure a better equivalence. The approximations are detailed in the Annex.

IV. Econometric Models

We test the panel data model on total employment; on public and private employment ownership type of working place (mixed ownership type of working place represents approximately 1% of total employment). To consider the possibility of joint sectoral effects in time (the correlation of the errors among equations), we estimated the models by the *Seemingly Unrelated Regressions* (SUR) method. In the panel data model, this method corrects for both period heteroskedasticity and general correlation of

observations within a given cross-section (Baltagi, 2005, pp. 105-110). To compute Robust Coefficient Covariances, we used the *White period method*. This method allows to construct a robust estimator of general variance-covariance error matrix (Baltagi, 2005, p. 14), *i.e.* the estimator "is robust to cross-sectional dependence, heteroskedasticity, and serial correlation of arbitrary form" (Arellano, 2003, pp. 18, 41).

IV.1. The Growth Rate of Industry Share in Total Employment

If we consider Foreign Direct Investment as influence factor and that the specific effects were induced by sectoral Foreign Direct Investments, then the panel data model is the following:

$$r^{s}_{i,t} = a_0 + a_1 r_{L,t} + (a_2)_i \cdot (1 - r_{L,t}) r^{FDI}_{i,t} + \tau_t + v_{it},$$

$$\sum_{i=1}^{11} s_{i,t} = 1 - s_{other,t}, \quad t = 2003, \ldots, 2015.$$

where: $s_{other,t}$ is the share of *other activities* in total employment. The coefficients have the following significances:

- a_0 is homogeneity coefficient, independent of *i* and *t*;
- the time specific effects are evaluated by the parameters τ_t, which are cross-section invariant coefficients;
- the cross-section specific effects are estimated by $a_{2,i}$, time-invariant coefficients (without the fixed effects measured by μ_i).

To avoid the possibility of joint sectoral effects in time (case in which the error terms could be correlated across the equations), we estimated the models by the Seemingly Unrelated Regressions (SUR) method (Pooled EGLS – period SUR).

The coefficients a_1 (that evaluate the influence of total employment growth, $r_{L,t}$, at growth rate of the industry share in total employment) are not significant, either for total employment, or for all ownership type of working place (public and private). Under these circumstances, we dropped them from the econometric models. Therefore, the models, estimated for total, public and private ownership type of working place are the following:

$$r^{s}_{i,t} = a_0 + a_{2,i} \cdot (1 - r_{L,t}) r^{FDI}_{i,t} + \tau_t + v_{it}.$$

The coefficients $a_{2,I}$ evaluate the impact of FDI, tied to specific industry, on the growth rate of industry share in total employment, effect weighted by the growth rate of total employment.

In summary, the results are the following:

Table 1

The Growth Rate of Industry Share in Total Employment

Sample (adjusted): 2006 2015 Cross-sections included: 11 Total pool (balanced) observations: 110 (Standard errors in parentheses)	Growth rate of share of industry "*i*" in total employment ($r^{s}_{i,t}$)		
	Total	*Ownership type of working place*	
		Public	Private
Constant	0.020715 (0.00123)	-0.021079 (0.00168)	0.038560 (0.00285)
Cross-section specific effects of FDI ($a_{2,i}$ coefficients)			
Agriculture, forestry and fishery	-0.052448 (0.00256)	-0.050973 (0.01172)	-0.110108 (0.00217)
Mining	-0.108188 (0.00852)	-0.208490 (0.05047)	0.412304 (0.00501)
Manufacturing	-0.149658 (0.01200)	-0.069279 (0.01482)	-0.335452 (0.01329)
Electricity, natural gas and water	0.001774**) (0.00601)	-0.097419 (0.01538)	0.156175 (0.0099)
Construction and real estate transactions	0.00509 (0.00050)	-0.012095 (0.00060)	0.000611 (0.00106)
Trade	0.128522 (0.01269)	0.594767 (0.01850)	-0.106819 (0.01127)
Accommodation and food service activities	-0.01721 (0.00078)	-0.004310 (0.00093)	-0.027424 (0.00113)
Transportation	0.034651 (0.00855)	0.115721 (0.00886)	-0.031255 (0.01193)
Information technology and communications	0.073595 (0.00705)	-0.666171 (0.01447)	0.134208 (0.00668)
Financial intermediation and insurance	0.020309 (0.00290)	-0.057306 (0.00494)	0.017604 (0.00585)
Professional, scientific, technical and administrative activities and support services	0.111431 (0.00829)	-0.107223 (0.01036)	0.158787 (0.01074)
R^2	0.88242	0.89092	0.92002
	Fixed Effects (Period)		

***) Not significant at standard level.*

Except for the coefficients that measures the cross-section effects for *Electricity, natural gas and water*, all the other coefficients are significantly different from zero (at the 0.0001 level).

Given that $(1 - r_{L,t}) > 0$, the sign of $\hat{a}_{2,i}$ shows the direction of cross-section FDI influence on the growth rate of industry "i" share in total employment.

For *Agriculture, forestry and fishery*, *Manufacturing*, *Accommodation and food service activities*, all the influences are negative (for total, public and private ownership type of

working place). This means that, for the industries concerned, the FDI effect on productivity improvement was superior to the effect induced on employment growth.

At overall level (total employment), the FDI effect on employment growth exceeds that on productivity for Construction and real estate transactions, Trade, Transportation, Information technology and communications, Financial intermediation and insurance, Professional, scientific, technical and administrative activities and support services. The FDI effect is not significant for Electricity, natural gas and water.

In public employment, except for *Trade* and *Transportation*, in all the other industries the FDI effect on growth rate of industry share in total employment is negative. This means that almost entirely the effect of FDI on employment in the public sector led to loss of jobs or to significant productivity gains (or to both).

Except for the sectors where all the FDI effects are negative, in the private sector every time the FDI effect is contrary to that registered in the public sector. If in the public sector the effects of FDI on productivity exceed those on employment, the effects on employment in the private sector are more relevant, and vice versa.

IV.2. The Change of Industry Share in Total Employment

The panel data model for estimating the change of industry share in total employment ($ds_{i,t} = s_{i,t} - ds_{i,t-1}$) induced by the foreign direct investments (FDI) is as follows:

$$ds_{i,t} = a_0 + a_1 \cdot s_{i,t-1} \cdot r_{L,t} + a_{2,i} \cdot \left(\frac{1}{E_{t-1}}\right) \cdot dFDI_{i,t} + \mu_i + \tau_t + v_{it},$$

$$\sum_{i=1}^{11} s_{i,t} = 1 - s_{other,t}, \qquad t = 2003, \ldots, 2015.$$

where: $dFDI_{i,t}$ is dynamics of FDI tied to industry "i", in the time-period (year) *t*:

$$dFDI_{i,t} = FDI_{i,t} - FDI_{i,t-1},$$

$s_{i,t-1}$ is the share of industry "*i*" in total employment, in the time-period (year) *t-1*; $r_{L,t}$ is annual rate of change in total employment; μ_i and τ_t are the cross section, and time specific effects, respectively; a_0, a_1 and a_2 are the model's coefficients.

For all the three models, there are not time specific effects (coefficients τ_t are not significant at standard 0.05 level). However, the constants a_0 are not significant, either for total employment, or for the public or private ownership type of working place. Besides, the cross-section specific effects (time-invariant) are estimated by $a_{2,i}$ coefficients (without the fixed effects measured by μ_i).

In these circumstances, we estimated the following model:

$$ds_{i,t} = a_1 \cdot s_{i,t-1} \cdot r_{L,t} + a_{2,i} \cdot \left(\frac{1}{E_{t-1}}\right) \cdot dFDI_{i,t} + v_{it},$$

In other words, for each industry, the structural shifts are influenced by $r_{L,t}$ – the dynamics of total employment (mediated by initial share of respective industry) and $dFDI_{i,t}$ – the changes in FDI amounts (weighted by the total employment). The results are shown in the following table.

Table 2

The Change in Industry Share in Total Employment

Sample (adjusted): 2006 2015 Cross-sections included: 11 Total pool (balanced) observations: 110 (Standard errors in parentheses)	Change in share of industry "*i*" in total employment ($ds_{i,t}$)		
	Total economy	*Ownership type of working place*	
		Public	Private
Influence of total employment growth rate ($r_{L,t}$) at change of the industry's share in total employment, mediated by initial share (a_1 coefficients)	0.153600 (0.01383)	0.108184 (0.01086)	-0.084208 (0.01510)
Cross-section specific effects ($a_{2,i}$ coefficients)			
Agriculture, forestry and fishery	-132.8568 (0.23204)	-2.163669 (0.07194)	-46.58689 (0.63191)
Mining	-0.568924 (0.00059)	-1.107195 (0.05531)	0.323310 (0.00196)
Manufacturing	-14.37673 (0.08751)	-2.138511 (0.02351)	-3.446604 (0.12336)
Electricity, natural gas and water	-2.33215 (0.00335)	-1.175048 (0.05182)	1.545183 (0.00580)
Construction and real estate transactions	21.92191 (0.01011)	0.624100 (0.01128)	3.929942 (0.11950)
Trade	41.36727 (0.08907)	2.090947 (0.02088)	9.348015 (0.14393)
Accommodation and food service activities	-5.035906 (0.0095)	-1.575918 (0.03740)	0.943143 (0.07079)
Transportation	27.70141 (0.5306)	-35.25433 (0.16772)	26.95223 (0.33414)
Information technology and communications	-1.511353 (0.00596)	-2.396776 (0.01155)	0.817430 (0.01757)
Financial intermediation and insurance	2.38879 (0.00026)	-0.060987 (0.00979)	0.372038 (0.00516)
Professional, scientific, technical and administrative activities and support services	19.17326 (0.1472)	-7.522023 (0.05746)	5.599089 (0.04750)
R^2	0.93675	0.68556	0.97507

All the coefficients are significant at 0.01 level.

Since all the ($1/E_{t-1}$) values are positive, the sign of $a_{2,i}$ coefficients reveal the direction of FDI influence on the change in the structures of employment by industries.

For *Agriculture, forestry and fishery* and *Manufacturing*, as in the previous model, the growth of Foreign Direct Investments was associated with a decrease in the industry share in total employment, both at overall level, as well as regarding the private and public employment structures. This means that in these industries the Foreign Direct Investments were connected rather with productivity growth than with employment

growth. For *Construction and real estate transactions* and *Trade*, the growth of FDI was related with a rise in the industry share in total employment (FDI has effects on employment, rather than on productivity). In all the other sectors, like in the structure dynamics model, every time when the FDI effect is positive in the private sector, the registered impact in the public sector is negative and vice versa.

V. Conclusion

We developed a methodology for analyzing the impact induced by a specific factor on changing the sectoral structure of employment and we showed that the impact of some exogenous variable on dynamics of industry share in total employment is proportional to the industry employment elasticity with respect to the concerned variable, weighted by the inverse of total employment growth index.

Also, we found that, for the dynamics of structure analysis, the appropriate model is a panel data with time specific fixed effects and with cross-section specific effects, weighted by the growth rate of total employment. To analyze the change in structures, the appropriate model is, likewise, a panel data without time specific (fixed or random) effects, but with cross-section ones. For each industry, the structural shifts are influenced by the dynamics of total employment (mediated by the initial share of concerned industry) and by the changes in the FDI amounts, weighted by total employment.

The conclusions drawn from the two models are consistent (only a small number of coefficients do not have the same sign in both models). For *Agriculture, forestry and fishery* and *Manufacturing*, the growth of FDI was associated with a decrease in the industry share in total employment, both at global level, as well as regarding the private and public employment structures. Also, for *Accommodation and food service activities,* the FDI impact on the employment structure was predominantly negative. This means that for the industries concerned the FDI effect on productivity improvement was superior to the effect induced on employment growth. In other words, the effect of FDI on employment led to loss of jobs, or to significant productivity gains (or to both).

For Mining, Electricity, natural gas and water, Information technology and communications, Financial intermediation and insurance, Professional, scientific, technical and administrative activities and support services the effect is positive for the private sector and negative for the public one. For the remaining industries (Construction and real estate transactions, Trade, Transportation), the effects of FDI were rather positive than otherwise. This means that for such industries the FDI effect on employment growth exceeds that on productivity.

The negative effect of FDI on industry share in total employment is not necessarily associated with a negative effect on the employment in the respective industry. The direction of change of the industry share in total employment (increase/decrease) may be opposite to the real effect of the Foreign Direct Investments on employment in the concerned industry. This happens, for example, when an investment in industry "i" leads to a higher increase in employment in the other sectors of the economy.

Considering these, we propose a refinement of this analysis, in a forthcoming paper, through an exploration based on *Aitchison geometry*. That is an analysis not of the structures dynamics, but a modeling of structures as compositional data.

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Annex

Equivalence of Industries to Ensure Compatibility between the Structure of FDI (NBR) and the Structure of Employment (NIS)

Equivalence of industries to ensure compatibility between the structure of FDI (provided by the National Bank of Romania) and the structure of employment (data from National Institute of Statistics)

Industries by structure of Foreign Direct Investments	*Industries by structure of Employment*
Agriculture, hunting and forestry, 1996-2007	Agriculture, hunting and forestry (NACE Rev.1) Agriculture, hunting (NACE Rev.1) Sylviculture, forestry (NACE Rev.1) Fishery and fish farming (NACE Rev.1)
Electric and thermal energy, gas and water, 2008-2013	Production and distribution of electric and thermal energy, gas and warm water and air conditioning (NACE Rev.2) Water distribution; sewerage, managing of waste, decontamination activities (NACE Rev.2)
Professional, scientific, technical activities and support services	Professional, scientific and technical activities (NACE Rev.2) Activities of administrative and support services (NACE Rev.2) Real estate transaction and other services (NACE Rev.1) *minus* Real estate transaction (estimation), for 2003-2007
Transports and storage, 1996-2007	Transport, storage and communications (NACE Rev.1) *minus* Post and telecommunications (estimation, NACE Rev.1)
Other activities, 2008-2015	Cultural and recreational entertainment activities (NACE Rev.2) Other service activities, staff and social (NACE Rev.2)
Source: ▪ For FDI structure: National Bank of Romania, *Regular publications*, "Foreign Direct Investment", http://www.bnro.ro/PublicationDocuments.aspx? (accessed on 2016, September 6) ▪ For *Employment structure*: National Institute of Statistics, *TEMPO-Online Time series*, AMG110M table, http://statistici.insse.ro/shop/index.jsp?page=tempo3&lang=en& ind=AMG110M (accessed on 2016, September 6))	