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Abstract

In a recent model Markusen and Venables (1999) describe the conditions under which foreign direct investments (FDI) can act as a catalyst for local industrial development. We apply this framework to the case of Poland, allowing for the entry of multinationals in both intermediates and consumption goods industry. We check these assumptions against empirical evidence, exploring agglomeration patterns of multinational and domestic firms at the regional level, and constructing an econometric model able to measure the interactions between the two classes of firms. We find evidence going in the direction of both direct spill-overs and backward and forward linkages between domestic and multinational firms.

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MULTINATIONAL CORPORATIONS AS CATALYST FOR INDUSTRIAL DEVELOPMENT. THE CASE OF POLAND

1. Introduction

One of the main political and economic events in the next years will be the accession of some of the Central and Eastern European Countries (CEECs) to the European Union (EU). This process started with the fall of the Berlin Wall in 1989 and was followed by the transition of those countries from a socially-planned to a market economy, a phenomenon receiving widespread attention.

Among economists and political scientists a whole series of theories dedicated at analysing and predicting the path of such a transition have been developed (Blanchard, 1997; Repkine and Walsh, 1999); several EU Institutions are devoting significant resources to finance the set up of market structures in those countries in light of their accession, while multinational enterprises (MNEs), mainly European, have already acquired significant market shares in different industrial sectors of the CEECs¹. In light of these processes, it is therefore interesting to explore the ways in which the industrialisation of the main CEECs has developed during the transition towards a market economy and the role played by MNEs with this respect, since in these countries, burdened with the legacy of large and obsolete state owned enterprises (SOEs) and distorted industrial structures, foreign investments can play an important role as tools of economic development and industry restructuring.

At the theoretical level, there is a reasonable agreement that MNEs can play a leading role as an agent of change. The creation of linkages and spillovers with local suppliers, superior technological content, marketing and management skills, result in higher productivity and technical efficiency, able to stimulate local rivals to a higher rate of innovation. Current foreign investments may also have a demonstration effect on other potential investors (Blomstrom and Kokko, 1997). MNEs, however, can also affect the entire structure of the industry by changing supply and demand conditions in a number of related industries. They may modify competitive conditions, damaging domestic industries in one sector but benefiting firms in other downstream sectors through price reduction and forward linkages to customer firms, or increasing the demand for local inputs and strengthening domestic supply industries through backward linkages. These linkages, in turn, may feed other local firms through spillover effects, hence generating endogenous growth (Markusen and Venables, 1999; Borensztein *et al.*, 1998). Obviously, the magnitude and the sign of these effects may vary in relation to the characteristics of the countries/regions involved, the strategies followed

¹ Alessandrini (2000) provides a complete survey of this phenomenon.

by MNEs and the characteristics of the industry in which foreign firms operate, thus resulting in different net effects (Aitken and Harrison, 1999).

In this paper we will therefore try to understand whether and to what extent Western European firms may act as a catalyst for local industrial development. At this purpose, we will apply to the case of Poland, the biggest and one of the most advanced accession countries, a theoretical model developed by Markusen and Venables (1999), discussed in Section 2 of the paper and modified in order to take into account the transition experience of Poland. Section 3 shows some static evidence of the phenomenon, presenting patterns of specialisation of multinational enterprises in Poland relative to domestic firms, with a regional and industry dimension. Section 4 develops and tests an econometric model able to measure the interactions between the two classes of firms. Section 5 concludes with some policy implications.

2. Theoretical background

The increasing evidence of large flows of intra-industry trade, in contrast with the predictions of the traditional trade theory, and the existence of similar regions with very different production structures, has brought economists to develop models of trade which could account for those findings, therefore introducing the hypothesis of increasing returns and imperfect competition. Within this theoretical framework, it is possible to explicitly model some of the aggregation forces already listed by Marshall (1890) under three headings: technological externalities, labour market pooling and intermediate goods supply and demand (pecuniary externalities).

These models, known under the headline of “New Economic Geography” (NEG), try to formalise the phenomenon of self-reinforcing cumulative causation that can lead very similar regions – in terms of their underlying structure – to endogenously differentiate into rich “core” regions and poor “peripheral” zones².

When applying the general results of the NEG literature to the case of transition countries, it is however necessary to take into account the causes and patterns of the transition process and in particular the nature of the evolution of firms’ activities in the area. In fact, there is nowadays a growing empirical evidence on the fact that the industrialisation process of the CEECs has been strongly influenced by the presence of Western multinational enterprises³. As a result, it seems appropriate to analyse the geography of industrial activities in the area using a model that not only considers the role of FDI, but goes also beyond simple country-level dynamics, exploring regional and industry patterns of agglomeration of firms.

² See Ottaviano and Puga (1998) for a survey of these models.

³ See Repkine and Walsh (1999), Konings (2000).

At this purpose, Markusen and Venables (1999) have recently shown the conditions under which MNEs can act as a catalyst for industrial development, leading to mechanisms of *dynamic* cumulative causation in the activities of domestic firms, generating therefore local agglomeration patterns.

Markusen and Venables start from a world where three kinds of firms are present: multinational (*m*), domestic (*d*) and foreign (*f*, i.e. exporting to the local markets) firms. Thanks to a standard Dixit-Stiglitz product differentiation hypothesis, they assume firms to be symmetrical within types, except for the fact that each produces a slightly different variety of product, being therefore a monopolist over its own variety⁴. There is a single domestic economy and two monopolistically competitive industries: a downstream industry (*c*, consumption) and an upstream industry (*i*, intermediates). In the Markusen and Venables framework, consumer goods can be supplied by all three types of firms, while intermediates, being non-tradable, can be supplied only by domestic firms⁵.

However, the hypothesis relative to the intermediate industry is particularly restrictive when matched with the empirical evidence⁶; therefore, we have considered the Markusen and Venables framework allowing for multinational firms to be present also in the intermediate sector. As a result, there are five types of firms in the model. We indicate the total number of each type of firms operating in the host economy as follows:

domestic firms in <i>i</i> -industry:	n_i^d
multinational firms in <i>i</i> -industry:	n_i^m
domestic firms in <i>c</i> -industry:	n_c^d
multinational firms in <i>c</i> -industry:	n_c^m
foreign exporting firms in <i>c</i> -industry:	n_c^f

Our additional assumptions further adds on the analytical complexity of the model, leading to different patterns of possible agglomeration effects in a given economy. However, being the paper aimed at exploring the empirical evidence of those effects, any possible theoretical solution would have implied unrealistic assumptions. As a result, we have decided to work only on the conclusions of the Markusen and Venables model, adding some hypotheses on the effects of an entry of multinationals in the *i*-industry (i.e. an increase in

⁴ An implication of this standard framework in NEG models is that it is able to take into account intra-industry trade.

⁵ Rodriguez-Clare (1996) in a similar theoretical framework assumes that firms can gain access to intermediate goods produced outside the home country by becoming multinationals, i.e. by establishing headquarters in the home country and production plants in the host economy.

⁶ Markusen and Venables (1997) already developed a model with MNEs operating in both intermediates and consumption goods industries, although not fully exploring possible catalyst effects arising within this framework. Alessandrini (2000) provides empirical evidence for the presence of MNEs in both intermediate and consumption goods industries in the CEECs.

n_i^m), and leaving to other lines of research the development of a full theoretical model related to these issues.

2.1 The entry of multinationals in the downstream industry

An exogenous increase in n_c^m affects the host country's industrial structure in two ways (Fig. 1a): first of all, there is a standard *product competition* effect, according to which the increased volumes available for consumption depress the price of the *c*-goods, leading to a reduction of profits of the domestic firms operating in the *c*-industry, hence to the exit of part of them and a reduction in their number, n_c^d . Secondly, there is a *backward linkage* effect: multinationals may raise the total demand for intermediates, increasing therefore the domestic firms' profits in the *i*-industry. This, in turn, can lead to an increase in the number of domestic firms operating in the *i*-industry, n_i^d , as postulated by Markusen and Venables.

The increase of demand faced by *i*-type domestic firms is such to create a *forward linkage* effect: given the assumption of downward sloping average cost curves, the increased production of the domestic firms in the *i*-industry will be undertaken at greater levels of efficiency, thus resulting in increased volumes of the available intermediates at lower prices. This will have a positive effect on the profitability of domestic firms operating in the *c*-industry, and would result at the end in an increase of the number of these firms, n_c^d .

At this stage, the effect of the entry of *c*-type MNEs on the total number of domestic firms operating in the economy, that is, $n_i^d + n_c^d$, leads to an *a priori* undetermined outcome. In order to end up with a *catalyst* effect, it is in fact necessary that either one condition is matched: *i*) MNEs use local intermediates more intensively than the domestic firms they displace in the *c*-industry; or *ii*) MNEs displace only foreign firms, with no effects on domestic firms⁷.

If one of these conditions occurs, the overall increased number of *c*-types domestic firms will increase the demand for intermediates, which will further contribute to the efficiency of *i*-type firms, creating therefore a mechanism of self-reinforcing cumulative causation.

[Figure 1 about here]

2.2. The entry of multinationals in the upstream industry

⁷ This would happen if one accepts the controversial hypothesis of FDI and trade as substitute.

Our additional assumption of the possibility of an entry of MNEs also in the i -industry generates a more complex set of interlinkages among multinationals and domestic firms.

First of all, we can apply the same logic as before (Fig. 1b). The entry of a multinational firm in the i -industry (increase in n_i^m), thanks to the higher efficiency reached in the i -industry characterised by increasing returns to scale, can make more profitable the production of c -goods, thus increasing n_c^d through forward linkages; the increased demand of intermediates so generated creates a backward linkage effect, stimulating production by domestic firms in the same industry (increase in n_i^d not displaced by product competition effects generated by the entry of i -type MNEs); the subsequent lower cost of intermediates in turns has again positive effects on n_c^d , hence generating a mechanism of cumulative causation, leading to the agglomeration of economic activities and as a result to a catalyst effect of FDI over the local economy.

However, the simultaneous presence of multinationals and domestic firms in both industries, may also reduce, eliminate or even turn negative the catalyst effect. The entry of c -type MNEs can lead to an increase in the number of multinational firms operating in the intermediate industry, n_i^m , rather than an increase in the number of domestic firms in the same industry, n_i^d (Fig. 1c), as well as an increase in n_i^m may positively affect multinationals rather than domestic firms operating in the downstream industry (Fig. 1d). Taking this logic to the limit, there could be an equilibrium outcome where the self-reinforcing agglomeration pattern accrues only to multinational firms, thus generating a full crowding out of domestic production.

In conclusion, the dynamic interaction of domestic and multinational firms may arise several outcomes, depending on the starting conditions, the extent of displacement of domestic firms by multinational ones (a function of the degree of use of local intermediates by multinational firms and of the incumbent market structure), and the shape of the production function eventually yielding increasing returns to scale. In order to get a clear understanding of the phenomenon in the case of a transition country, it seems therefore appropriate to start from the empirical evidence available on those effects, combining it with the developed theoretical framework in order to derive an econometric model able to pinpoint the significant interactions arising among firms. The remaining of the paper is devoted to this exercise.

3. The geography of FDI: a brief description

In this section we examine the spatial and sectoral distribution of multinationals in Poland during the 1990s in order to investigate whether multinational firms concentrate in

particular regions (i.e. border regions) and/or sectors, whether these location patterns have changed over time and whether multinationals follow the same spatial distribution of domestic ones. These questions draw on the theoretical and empirical findings according to which the generation of backward and forward linkages is more likely in geographically concentrated industries (Holmes, 1995; Hansen, 1993).

In order to give a clear answer to our research questions, we have computed synthetic measures of the spatial distribution of FDI at sector and region levels. We have chosen as basic unit of analysis the (cumulated) number of firms, indicated by n^h (with $h = d$ for domestic firms; m for multinationals) in a branch j of manufacturing, expressed as a share, either of the total number of FDI (domestic firms) in region k , or of the entire country, at time t^8 . To explore if multinationals (n^m) and domestic firms (n^d) located in one region concentrate in few manufacturing branches, we take the absolute values of the difference between these shares, summed over all manufacturing branches:

$$K_{kt}^h = \sum_j abs \left(\frac{n_{jkt}^h}{\sum_j n_{jkt}^h} - \frac{\sum_k n_{jkt}^h}{\sum_k \sum_j n_{jkt}^h} \right) \quad (1)$$

The *Krugman specialisation index* (Krugman, 1991)⁹ so computed takes the value zero if a region k has a distribution of FDI (domestic firms) among manufacturing branches identical to the country average, and takes the maximum value of two if the distribution of FDI (domestic firms) in region k is totally different from the country average. Values of this index for each region over the period 1990-1997 are shown in table 1. Figures in bold refer to domestic firms, whose spatial distribution is known only for 1997. The table also reports in the last two rows the regional average in each year and the corresponding value for the services sector.

Looking first at average figures, we note in the manufacturing sector a steady fall in the K -index between 1991 to 1997, indicating that regional specialisation, i.e. FDI's concentration in specific sectors within regions, became more homogeneous across the country over time. The opposite happened in the service sector where the steady increase in the specialisation index over the period indicates a progressive concentration of FDI in few regions and branches.

⁸ The core data on multinationals used in our analysis are derived from PECODB data base, a unique database on FDI which provides detailed firm level information at sector and region level on foreign investments undertaken by Western European firms in Central and Eastern Europe (Alessandrini, 2000). Domestic firms' figures, instead, come from AMADEUS CD-ROM, a pan European financial database provided by Bureau Van Dijk Electronic Publishing S.A. Both type of firms have been classified by regional classification according to the level-3 Nomenclature of Territorial Units for Statistics (NUTS). In addition, firms are classified by 3-digits NACE Rev. 1 code on the basis of their main production.

⁹ Following the most relevant empirical studies on this topic, "specialisation" refers to the geographical perspective, while "concentration" to a sectoral one. See among others Hallet (2000), Amiti (1998 and 1999).

[Table 1 about here]

Turning to individual regions, we observe that at the beginning of the period, only a small set of regions shows a FDI specialisation completely different from the country's pattern. It includes, apart from the capital region, the old industrial poles of Poznan (Wielkopolskie), Lodz (Lodzkie) and Lubel (Lubelskie). However, while Warsaw seems to have lost its specialisation immediately¹⁰, the other industrial poles maintain it for all the early 1990s, becoming more similar to other regions' specialisation patterns only from 1993 onwards. The other regions which show a specialisation different from the national average were the Western border regions, and particularly the south-western region of Zachodnio Pomorskie, whose *K*-index was very close to the superior bound in 1991-1993¹¹. After 1995, the *K*-index behaved homogeneously in all regions, indicating that most of changes in the location patterns of FDI had occurred in 1993-1995, as shown by the absolute changes of the index. In 1997, only one region, i.e. Podlaskie, differs significantly from the country average in terms of FDI hosted ($K=1.71$), although the figure is decreasing progressively. This is probably due to the delay with which FDI started to be located in such a peripheral region, located in the North-eastern part of the country, at the Belarus border.

Several interesting conclusions emerge from this static analysis. First of all, FDI in Poland seem to follow an homogeneous pattern of dispersion over time. MNEs were located initially in the old industrial poles (Warsaw included), and then spread off all over the country, following what can be defined an "hub and spoke" pattern (Alessandrini and Contessi, 1999). This pattern implies that, in terms of geographical concentration, FDI location choices have likely been driven by market targets or strategic motivations rather than by the presence of other multinationals. Secondly, proximity to Western Europe does not seem to have been a driving factor in terms of location of FDI, at least in the early phase of transition.

Given these dynamics, the static analysis relative to the simple location of foreign investments supports only in part the idea of agglomeration phenomena among multinationals operating in Poland. More interesting is the fact that the location patterns of multinationals show an important similarity with those of domestic firms, since in 1997 the *K*-indexes are rather convergent. This result indicates, not surprisingly, that regional specific effects may have a role in attracting manufacturing plants in specific branches.

¹⁰ Warsaw shows a relative concentration of FDI in services much higher than in manufacturing.

¹¹ In this case, the Krugman specialisation index has to be interpreted with extreme caution, since it accounts for both positive and negative deviations from the average, i.e. it does not allow to distinguish between specialisation and de-specialisation dynamics in the location patterns of firms. A more in-depth analysis would show that border regions display a specialisation patterns of FDI barely different from the national ones (Altomonte and Resmini, 1999).

The *sectoral perspective* of the spatial patterns of multinational and domestic firms in Poland has been measured by the following coefficient of variation (Hallet, 2000):

$$V_{jt}^h = \frac{1}{\bar{S}_{jkt}^h} \sqrt{\frac{\sum_k (S_{jkt}^h - \bar{S}_{jkt}^h)^2}{N}} \quad (2)$$

where¹²:

$$S_{jkt}^h = \frac{n_{jkt}^h}{\sum_j n_{jkt}^h} \bigg/ \frac{\sum_k n_{jkt}^h}{\sum_k \sum_j n_{jkt}^h}$$

and

N = total number of regions ($N=16$)

$T=1990, \dots, 1997$ for multinationals (n^m) and only 1997 for domestic firms (n^d)

V_{jt}^h is a measure of concentration and captures the spatial dispersion of firms. Table 2 presents the results by branches and over time.

[Table 2 about here]

Two interesting patterns emerge from our findings. First of all, in 1990 multinationals were spatially concentrated in all sectors but apparels (NACE Code 18). Secondly, the coefficients of variation follow for most branches a decreasing trend, confirming the hypothesis that multinationals were more spatially concentrated at the beginning of the transition. This process of de-concentration has been particularly strong for furniture (36), metal products (28), electrical machinery and apparatus (31). In 1997, concentration of FDI was particularly higher in six sectors, i.e. tobacco (16), printing products (22), metals (27), computers and automatic data processing machines (30), medical and precision instruments (33) and other transport equipment (35). Finally, at the end of the period, the spatial distribution of multinationals is consistent with that of domestic firms.

The convergence of the patterns of location of the two groups of firms indicates the existence of a relationship between them; the statistical analysis shows the existence of a significant positive correlation between the presence of multinational firms in a given sector/region and their domestic counterparts (Table 3). The theoretical model previously

¹² The interpretation of S_{jkt}^h index is straightforward: When $S_{jkt}^h = 1$ sector j share of multinationals (domestic firms) in region k matches that of the average of all the regions in Poland. Instead, if $S_{jkt}^h > 1$ ($S_{jkt}^h < 1$) sector j share of multinationals (domestic firms) in region k is greater (less) than the average of all the regions in the country; therefore, multinationals (domestic firms) in region k is more (less) concentrated in sector j than the average of all the regions. For a more in depth-discussion of the properties of this index, see Altomonte and

sketched explains such agglomeration patterns through the creation of backward and forward linkages generated by the entry of multinationals, which significantly affects the performance of domestic firms, leading eventually to an increase in their number (catalyst effect). It is therefore worth using econometric techniques to check whether the forces responsible for such agglomeration patterns are actually those identified by the economic theory.

[Table 3 about here]

4. The econometric model

In principle, many different factors can be responsible for the generation of agglomeration effects, deriving from both NEG theories and the traditional location determinants identified by neo-classic theories. In particular, in order to disentangle “pure” NEG effects, we have to control for region-specific endowments and industry-specific dynamics (Brülhart, 1998, p. 796). Failing to do so would lead us to a critical identification problem: if multinationals gravitate towards more productive industries or regions, then the possible correlation between the presence of multinationals and the performance of domestically-owned firms will not necessarily be dependent on the positive impact of foreign investments (Aitken and Harrison, 1999, p. 606). The theoretical approach previously described rests however on an intra-industry mechanism of backward and forward linkages that explicitly models these firm interactions through industry specific effects (consumption versus intermediate goods); such a structure should allow us to overcome, at least in principle, the identification problem. Thus, the model to estimate has to be based on the following general structure:

$$(A) \quad \Pi_{jkt}^{id} = \alpha_0 + \alpha_1 n_{jkt}^{im} + \alpha_2 n_{jkt}^m + \alpha_3 n_{jk}^d * n_{jkt}^{im} + \alpha_4 I_{jt}^i + \varepsilon_{jkt}$$

$$(B) \quad \Pi_{jkt}^d = \alpha_0 + \alpha_1 n_{jkt}^m + \alpha_2 n_{jkt}^{im} + \alpha_3 n_{jk}^{id} * n_{jkt}^m + \alpha_4 I_{jt}^i + \varepsilon_{jkt}$$

where the superscripts indicate the type of firm (domestic d vs. multinational m) and industry (intermediate i vs. consumption, where no indication appears), while the subscripts indicate the j^{th} sector of the k region in year t . In order to measure backward and forward linkages, each sector j is considered in its two components of consumption and intermediate goods production (see Annex 2), allowing us to identify backward and forward linkages accruing on the upstream (equation A) vs. downstream (equation B) domestic firms.

The dependent variable is the performance (Π_{jkt}) of upstream (downstream) domestic firms, which is, according to the theory, affected by multinationals through three channels:

- i*) a direct product competition effect generated by the presence of multinationals (measured by n) operating in the same upstream (downstream) industry of domestic firms;
- ii*) a backward (forward) linkage effect created by the presence of multinationals operating in the downstream (upstream) industry;
- iii*) the combination of a backward and forward linkage effect obtained via the interaction of multinationals in the upstream (downstream) industry and domestic firms in the downstream (upstream) industry.

On the right hand side of the equations, therefore, the first variable indicates product competition effects. The second variable measures backward (forward) linkages, relating multinationals and domestic firms operating in the two different industries: since this effect is a function of the degree with which multinationals use local intermediates, we have to control for that in the regression through the term I_{jt}^i . Finally, the third variable of the model captures the effect of the interaction between multinationals and domestic firms in the relevant industries.

Apart from the “catalyst” outcome, our theoretical hypotheses suggest also that, once allowing for the entry of multinationals also in the upstream industry, backward and forward linkages between multinationals and domestic firms may be weakened by the presence of self-agglomeration effects among multinationals (see fig. 1c and 1d). In order to estimate the importance of these effects, we have thus to consider also the following model:

$$(C) \quad n_{jkt}^{im} = \alpha_0 + \alpha_1 n_{jkt}^m + \alpha_2 n_{jk}^{id} + \alpha_3 n_{jk}^d + \alpha_4 I_{jt}^i + \varepsilon_{jkt}$$

$$(D) \quad n_{jkt}^m = \alpha_0 + \alpha_1 n_{jkt}^{im} + \alpha_2 n_{jk}^d + \alpha_3 n_{jk}^{id} + \alpha_4 I_{jt}^i + \varepsilon_{jkt}$$

where symbols have the usual meaning.

According to these equations the presence of upstream (downstream) multinationals in sector j , region k at time t , may be affected by:

- i*) a self-agglomeration process among multinationals, picked by the first variable on the right hand side of the equations (Wheeler and Mody, 1992);
- ii*) a product competition effect generated by the presence of domestic firms operating at the same stage of production, measured by the second explanatory variable of both equations;
- iii*) a backward (forward) linkage created by the presence of domestic firms operating in the downstream (upstream) industry, which is in turn a function of the degree of intensity in the use of intermediates (last two variables of the equations).

We recall that, in order to end up with a catalyst effect, self agglomeration processes among multinationals should not fully offset backward and forward linkages.

Integrating both specifications with a model design which appropriately controls for region specific endowments, as well as industry specific characteristics, as previously mentioned, should then lead to a correct identification of “pure” NEG effects operating within

the samples of firms (domestic vs foreign firms) in each type of industry (consumption goods vs intermediates in each sector j). For this reason, we control in both models for a full set of k region-specific dummy variables (ϕ_k) and of j sector specific dummy variables, ϑ_j . Moreover, in order to capture possible common aggregate shocks over the period considered, or some other unobserved time varying factors, we also include fixed time effects, τ_t . This implies that the error term of the model, ε_{jkt} , can be written as follows:

$$(E) \quad \varepsilon_{jkt} = \phi_k + \vartheta_j + \tau_t + \eta_{jkt}$$

where η_{jkt} is the standard i.i.d. residual.

4.1 Definition of variables and econometric issues

The combination of the regional and sector dimension yields a panel data specification of sectors j and regions k over time t (1995-1998). We have aggregated firm-level observations for both European multinationals and domestic firms over the defined 16 NUTS-III Polish regions (see Annex 1) for ten different manufacturing sectors: Food, Textiles, Chemicals, Metal Products, Motor vehicles, Domestic Appliances, Leather, Wood and Furniture, Paper and printing products. The distinction between intermediates and consumption goods industry is undertaken, in the absence of input-output tables for Poland, through the assignment of each firm (domestic or multinational) to the i - or c -industry according to the classification reported in Annex 2¹³.

The dependent variables proxying domestic firms' performance in the upstream and downstream industries (equations A and B) are the aggregated (over firm data) level of sales of domestic firms in each industry in sector j and region k in year t . We use as a dependent variable aggregated, and not per capita, sale figures since we are interested in exploring the impact of the presence of multinationals on the overall performance of the local industry, in terms of its possible expansion (and hence the birth of catalyst effects)¹⁴.

In order to avoid problems of simultaneity between the presence of multinationals and the performance of domestic firms, we have lagged one period all the observations related to

¹³ The classification is derived from the NACE-CLIO classification and coding of branches and products of the European Union, at the basis of the construction of input-output tables.

¹⁴ An entry of a multinational firm inducing, via forward linkages, an entry of a certain number of domestic firms, can be such to generate a decrease (and not an increase) of per capita domestic firms' sales. On the contrary, the relationship between aggregated domestic firms' sales and the number of multinationals operating in the industry can go only in an univocal direction according to the kind of effect generated.

MNEs, measuring their presence through the concentration of multinationals, calculated for the i - and c -type industries, operating in sector j in region k over time¹⁵.

The interaction term of domestic and multinational firms is calculated as the product of the share of upstream (downstream) multinationals in a given sector/region, lagged one period, times the number of downstream (upstream) domestic firms operating in the same sector/region, when modelling i - and c -type domestic firms, respectively. The intensity in the use of locally produced intermediates has been proxied by the international trade orientation of each sector, measured as the share of imports (exports) of the i -industry over the total import and export flows of the sector¹⁶. As a result, taking the natural logarithm of the total sales level of domestic firms, the baseline model to be estimated takes the following form:

$$(1A) \quad s_{jkt}^{id} = \alpha_0 + \alpha_1 q_{jkt-1}^{im} + \alpha_2 q_{jkt-1}^m + \alpha_3 n_{jk}^d * q_{jkt-1}^{im} + \alpha_4 IMP_{jt}^i + \alpha_5 \phi_k + \alpha_6 \vartheta_j + \alpha_7 \tau_t + \eta_{jkt}$$

$$(1B) \quad s_{jkt}^d = \alpha_0 + \alpha_1 q_{jkt-1}^m + \alpha_2 q_{jkt-1}^{im} + \alpha_3 n_{jk}^{id} * q_{jkt-1}^m + \alpha_4 EXP_{jt}^i + \alpha_5 \phi_k + \alpha_6 \vartheta_j + \alpha_7 \tau_t + \eta_{jkt}$$

Concerning equations C and D, we estimate possible self agglomeration effects considering the (cumulated) number of multinationals and domestic firms in region k , sector j and year t , operating in upstream (C) and downstream (D) industry. As before, explanatory variables referring to multinationals have been lagged one period to avoid simultaneity problems. Therefore, the equations to be estimated are specified as follows:

$$(1C) \quad n_{jkt}^{im} = \alpha_0 + \alpha_1 n_{jkt-1}^m + \alpha_2 n_{jk}^{id} + \alpha_3 n_{jk}^d + \alpha_4 IMP_{jt}^i + \alpha_5 \phi_k + \alpha_6 \vartheta_j + \alpha_7 \tau_t + \eta_{jkt}$$

$$(1D) \quad n_{jkt}^m = \alpha_0 + \alpha_1 n_{jkt-1}^{im} + \alpha_2 n_{jk}^d + \alpha_3 n_{jk}^{id} + \alpha_4 EXP_{jt}^i + \alpha_5 \phi_k + \alpha_6 \vartheta_j + \alpha_7 \tau_t + \eta_{jkt}$$

We use the cumulated number of multinationals rather than shares since in this model specification we are interested in capturing “pure” location patterns of the same multinationals, regardless of their concentration dynamics in each sector/region. Given the specification of Models 1A to 1D, standard fixed-effects panel estimation techniques have been employed for all models.

¹⁵ We use the following indexes of absolute concentration $q_{jkt}^m = \frac{n_{jkt}^m}{\sum_j (n_{jkt}^m + n_{jkt}^{im})}$ for the c -industry and

$q_{jkt}^{im} = \frac{n_{jkt}^{im}}{\sum_j (n_{jkt}^m + n_{jkt}^{im})}$ for the i -industry.

¹⁶ Data refer to the total trade flows of Poland with the EU, as derived from the COMEXT database.

4.2 Estimation Results

The first two columns of Table 4 show the results of the econometric estimation for equations 1A and 1B.

The combined analysis of the two equations reveals that multinationals can act as a catalyst for industrial development. An increase in the concentration of multinationals in the consumption goods industry has significant positive effects (backward linkage) on the level of sales of domestic firms in the upstream industry (column 1A). The reverse (evidence of a forward linkage) is true for the performance of domestic firms in the downstream industry (column 1B). The quantitative effect of these linkages appears to be strong in both industries¹⁷. The concentration of multinationals operating at the same stage of the production process of domestic firms seems not to affect significantly the performance of domestic firms, indicating that potential product competition effects do not weaken eventual backward and forward linkages. Concerning the interactions between domestic firms and multinationals, a positive relationship is recorded in both industries, although statistically significant only in the *c*-type industry. Finally, the fact that the coefficients of the export and import orientation of the intermediate sector are not statistically significant suggests that backward and forward linkages are not affected by the availability of locally produced intermediates. However, trade orientation is only an indirect measure of the underlying production structure; consequently, this last result has to be interpreted with extreme caution.

Interpreting the econometric outcome in light of the theoretical model behind this econometric exercise, we find therefore general support for the idea that the entry of multinationals can act, via backward and forward linkages, as an incubator of industrial development. In particular, we have shown that downstream domestic firms benefit from forward linkages of upstream multinationals and from forward linkages deriving from upstream domestic firms, which in turn take advantage of the backward linkages accruing from the presence of multinationals in the downstream industry. However, since we do not find a significant evidence of backward linkages from downstream to upstream domestic firms, we can not support the idea of an agglomeration pattern ignited by multinationals and then self-sustaining only among domestic firms, at least within this model design. In other words, according to our theoretical framework, the continuous entry of multinationals over time is a necessary condition for this economy to generate positive growth levels¹⁸.

¹⁷ These coefficients are relative growth rates, since domestic firm sales are in the log form.

¹⁸ Theoretically, this can be explained by the fact that, since in our framework downstream domestic firms are not forced to buy intermediates from upstream domestic firms (while Markusen and Venables (1999) model the intermediate sector as non-tradable), the possibility of exploiting upstream multinationals or importing the intermediate goods loosen their links with upstream domestic firms.

Finally, we find no evidence for time effects, while region and sector heterogeneity affect domestic firms' performance, as expected.

[Table 4 about here]

Following our theoretical framework, in order to evaluate the magnitude of the relationships previously discussed, we also need to consider the presence of potential self-agglomeration effects among multinationals. In this case, we are interested in understanding whether multinationals' location processes are driven by the presence of other, already established, foreign firms, rather than by domestic firms¹⁹. In fact, if self-agglomeration phenomena accrue on multinationals and depend negatively from the presence of domestic firms, a further entry of multinationals can offset the results previously discussed, eventually leading to the creation of "enclave" economies within the host country (Rodriguez-Clare, 1996; Hardy, 1998).

Table 5 provides the estimation results for equations 1C and 1D in its first two columns. Multinationals evaluate significantly and positively self-agglomeration benefits, but these accrue not only within multinationals, but also between multinationals and domestic firms, in line with the empirical evidence shown in section three. Again, sector and region heterogeneity exert a significant effect on the location decision processes of multinationals.

[Table 5 about here]

4.3 Robustness issues and sensitivity analysis

In order to check the robustness of our findings, we have tested alternative specifications of our general equations. We introduce two types of differences: first of all, we adopt different proxies for our explanatory variables; secondly, we impose some restrictions on the sample.

Concerning the first model, we consider a different measure of the presence of multinationals at sector and region level. In particular, we re-estimate equations A and B substituting the share of multinationals in each industry, sector and regions with the sectoral specification of the previously defined Krugman index, lagged one period. We therefore use a measure of *relative* and not absolute concentration. The results are shown in columns 2A and 2B of table 4. Coefficient magnitudes and patterns of significance are in line with those in the corresponding first two columns of table 4. In addition, the results clearly indicate the presence of a significant direct product competition effect in the *c*-industry, of a "pure" spillover effect in the *i*-industry, and a positive backward linkage effect accruing to upstream

¹⁹ Evidence for self-agglomeration effects among multinationals is provided by Wheeler and Mody (1992).

domestic firms from the interaction of upstream multinationals and downstream domestic firms and vice-versa. Although these results are perfectly consistent with our theoretical hypotheses, even strengthening the significance of our findings (we have here evidence of a catalyst outcome), it should be mentioned that the previously discussed ambiguity that characterises the interpretation of the Krugman index is not overcome by the econometric analysis. However, the fact that absolute and relative concentration measures exert the same impact on the performance of domestic firms reassuringly indicates that we might be considering specialisation and not de-specialisation patterns in both cases.

As far as the second model is concerned, we consider as a robustness test the explicit inclusion of regional characteristics. According to the literature on FDI determinants, multinationals consider in their decision processes the following location variables²⁰:

- the gross domestic product of each region k over time, denoted as \mathbf{gdp}_{kt} and derived by Eurostat, as a proxy for the absolute size of the local market²¹ (Wheeler and Mody, 1992);
- the distance of the quickest road link between the capital city of each region and Warsaw (\mathbf{distWA}_k) and a specific dummy for Western regions (\mathbf{border}), in order to test whether it exists a positive relationship between agglomeration effects and the proximity to the region with which the area is establishing an integration process (Hanson, 1998).

Columns 2C and 2D of table 5 show the results of this further estimation. Again, the results are very similar to the corresponding columns 1C and 1D. Regional characteristic variables have the expected sign and are statistically significant in the consumption good subsample, while multinationals operating in the intermediate industry positively react to an increase in the GDP level, indicating that they might prefer locations with better infrastructures. The lack of significance of the distance variable in this case might suggest that upstream multinationals serve prevalently local customers (both foreign and domestic).

In terms of sensitivity analysis, we re-estimate equations 1A and 1B imposing two restrictions on the sample. So far, we have in fact assumed that backward and forward linkages among multinationals and domestic firms accrue equally in all sectors and regions. This approach is somewhat restrictive. Some sectors produce goods that are intensive in some immobile inputs, while some regions, may have a concentration of firms, in absolute terms, structurally higher than other locations, increasing for that reason the probability to generate backward and forward linkages. In order to control for potential sample biases that could generate spurious results, we alternatively drop from the sample the Paper and printing sector,

²⁰We recall however that the focus of this paper is not an analysis of FDI determinants. Rather, we are interested in discovering whether multinationals, given their location, generate backward and forward linkages with domestic firms.

²¹ At the beginning, we included also two different measures of the level of infrastructures. We dropped both of them since they show a very strong correlation with the level of GDP.

which is relatively intensive in immobile resources (Hanson, 1998), and the observations relative to the capital region²².

Table 6 shows the results for equations 1A and 1B. Again the results are quite similar to those in the corresponding columns of table 4.

[Table 6 about here]

5. Conclusions and policy implications

This paper studies the impact of multinationals on the industrial structure of the host country. We focus on the generation of backward and forward linkages distinguishing effects accruing between multinationals and domestic firms from those involving only foreign-owned enterprises. The particular case we consider is Poland, one of the most advanced accession country, with a conspicuous inflow of FDI, coming mainly from Western Europe.

The results obtained seem consistent with the peculiar experience of this country. It has been already stated by the theory (Blanchard, 1997) and also by the empirical evidence (Alessandrini, 2000), that the early entry of multinationals in both stages of the production processes is likely to have disrupted historic ties between domestic firms operating along the value-added chain (the so-called “creative disruption”), forcing the same firms to go through costly restructuring, and only later stimulating economic growth, as witnessed by the u-shaped pattern of industrial output in transition countries over time. Our results fit nicely within this framework, since we find positive backward and forward linkages accruing from multinationals to domestic firms, and hence stimulating growth once multinationals are established, but not a significant interaction between upstream and downstream domestic firm, a signal that historic ties have been disrupted and (eventually) still need to be reconstructed. Another interesting fact emerging from our analysis is that multinationals seem to condition their location also on the presence of domestic firms.

These findings have some clear policy implications: the presence of FDI maximises its positive effects for the host country when multinationals can capitalise on a pre-existing structure of domestic firms, of which they enhance the performance and hence contribute, as “incubators”, to the creation of a sound local industrial structure. Once the presence of multinational firms is established, this becomes however a necessary condition for industrial development, since such a presence is not sufficient to generate a self-sustaining pattern of growth within domestic firms, given the fact that these firms do not seem to significantly interact among themselves. Hence, the need of policies aimed at either sustaining the entry of

²² We have not enough degrees of freedom to either consider simultaneously these restrictions or the possibility to drop other regions or sector from the sample.

multinationals over time or at (re)building stronger industrial ties among domestic firms, which in turn might stimulate the location of multinationals and generate the catalyst effects postulated by the theory.

Fig. 1. Entry of multinationals and catalyst effect on domestic firms

Figure 1a (Markusen and Venables, 1999):

$$\begin{aligned} \uparrow n_c^m &\Rightarrow \uparrow n_i^d \Rightarrow \uparrow n_c^d \Rightarrow \uparrow n_i^d \Rightarrow \\ &\text{(backward linkage) (forward linkage) (catalyst effect)} \\ &\Rightarrow \downarrow n_c^d \\ &\text{(product competition effect)} \end{aligned}$$

Figure 1b

$$\begin{aligned} \uparrow n_i^m &\Rightarrow \uparrow n_c^d \Rightarrow \uparrow n_i^d \Rightarrow \uparrow n_c^d \Rightarrow \dots \\ &\text{(forward linkage) (backward linkage) (catalyst effect)} \\ &\Rightarrow \downarrow n_i^d \\ &\text{(product competition effect)} \end{aligned}$$

Figure 1c

$$\begin{aligned} \uparrow n_c^m &\Rightarrow \uparrow n_i^m \Rightarrow \uparrow n_c^m \Rightarrow \uparrow n_i^m \Rightarrow \dots \\ &\text{(backward linkage) (forward linkage) (self-agglomeration of MNEs)} \\ &\text{(crowding out of domestic firms)} \\ &\Rightarrow \downarrow n_c^d \\ &\text{(product competition effect)} \end{aligned}$$

Figure 1d

$$\begin{aligned} \uparrow n_i^m &\Rightarrow \uparrow n_c^m \Rightarrow \uparrow n_i^m \Rightarrow \uparrow n_c^m \Rightarrow \dots \\ &\text{(forward linkage) (backward linkage) (self-agglomeration of MNEs)} \\ &\text{(crowding out of domestic firms)} \\ &\Rightarrow \downarrow n_i^d \end{aligned}$$

Table 1. Krugman specialisation index (K_{kt}^h) by region and year

	1990	1991	1992	1993	1994	1995	1996	1997	D	1992/1990	1995/1993	1996/1997
Dolnoslaskie*	n.a.	1.57	1.27	0.97	0.82	0.59	0.55	0.55	0.35	n.a.	-0.38	0.00
Kujawsko-Pomorskie	0.92	1.06	0.86	0.87	0.77	0.70	0.67	0.66	0.56	-0.06	-0.16	-0.02
Lubelskie**	1.69	1.69	1.78	1.17	0.98	0.97	0.93	0.92	0.96	0.08	-0.20	-0.01
Lubuskie*	n.a.	1.73	1.55	1.34	1.11	1.15	1.00	1.06	1.01	n.a.	-0.19	0.07
Lodzkie**	1.69	1.25	1.03	0.84	0.79	0.70	0.69	0.67	0.58	-0.66	-0.14	-0.01
Malopolskie	n.a.	1.76	1.35	1.39	1.08	0.80	0.81	0.81	0.57	n.a.	-0.59	0.01
Mazowieckie***	1.69	0.64	0.54	0.58	0.48	0.46	0.45	0.45	0.44	-1.15	-0.12	0.00
Opolskie	n.a.	n.a.	1.48	1.27	1.22	1.18	1.19	1.18	0.99	n.a.	-0.10	-0.01
Podkarpackie	n.a.	n.a.	1.38	1.30	1.10	1.06	0.90	0.90	0.59	n.a.	-0.24	0.00
Podlaskie	n.a.	n.a.	n.a.	n.a.	1.88	1.78	1.72	1.71	0.87	n.a.	n.a.	-0.01
Pomorskie**	1.23	1.61	1.04	0.71	0.65	0.66	0.68	0.69	0.98	-0.19	-0.05	0.01
Slaskie**	n.a.	1.76	1.36	0.91	0.87	0.80	0.63	0.65	0.72	n.a.	-0.10	0.02
Swietokrzyskie	n.a.	n.a.	1.48	1.53	1.50	1.21	1.10	1.11	1.19	n.a.	-0.32	0.00
Warminsko-Mazurskie	n.a.	1.76	1.25	1.21	1.05	1.02	1.06	1.05	0.92	n.a.	-0.19	-0.01
Wielkopolskie**	1.69	1.25	1.05	0.49	0.44	0.37	0.34	0.34	0.56	-0.64	-0.12	-0.01
Zachodnio-Pomorskie*	1.54	1.80	1.85	1.75	1.53	0.87	0.78	0.79	0.76	0.31	-0.88	0.01
<i>Average</i>	<i>1.49</i>	<i>1.49</i>	<i>1.28</i>	<i>1.09</i>	<i>1.02</i>	<i>0.89</i>	<i>0.84</i>	<i>0.85</i>	<i>0.75</i>	-0.21	-0.19	0.00
<i>Service sector</i>	<i>1.06</i>	<i>1.13</i>	<i>1.15</i>	<i>1.42</i>	<i>1.41</i>	<i>1.42</i>	<i>1.44</i>	<i>1.44</i>	<i>0.88</i>			

*Regions bordering with Western Europe. **Industrial poles. ***Capital Region.
 Figures in bold refer to domestic firms in 1997.

Table 2. Coefficients of variation (V_{jt}^h) by sector and year

	1990	1991	1992	1993	1994	1995	1996	1997	D
15	1.43	1.42	0.95	0.84	0.80	0.44	0.44	0.46	0.49
16		2.92	3.63	2.79	3.13	2.52	1.99	2.00	3.87
17		2.92	2.48	2.57	2.20	2.12	1.90	1.88	1.14
18	0.92	1.90	2.18	1.16	1.05	0.98	1.01	1.00	1.73
19	1.79	2.92	3.63	2.53	2.81	2.35	1.79	1.80	1.46
20	1.79	1.70	1.96	1.98	2.14	1.89	1.62	1.63	1.12
21			1.71	1.92	1.74	1.61	1.42	1.43	1.30
22		2.92	3.63	2.52	2.18	2.30	2.12	2.12	2.22
24	1.79	2.18	1.77	1.30	1.40	1.23	0.93	0.95	0.72
25	1.31	1.70	1.84	1.27	1.24	1.32	0.99	0.97	0.97
26		2.02	1.92	1.65	1.14	1.14	0.89	0.90	0.92
27			2.93	2.23	2.12	2.12	2.12	2.12	1.40
28		2.92	2.33	1.55	1.69	1.43	1.25	1.25	0.63
29	1.79	1.34	1.47	1.39	2.10	1.69	1.35	1.30	0.69
30			na	na	3.87	3.87	2.99	2.99	2.65
31		2.43	1.98	1.46	1.25	1.23	1.24	1.25	1.05
32		2.53	2.01	1.75	1.76	1.75	1.75	1.74	1.93
33		2.35	2.74	2.63	2.80	2.78	2.22	2.23	2.72
34	1.79	2.64	2.66	1.77	1.62	1.48	1.49	1.50	1.64
35	1.79	2.92	3.63	3.63	2.71	2.73	2.16	2.16	1.11
36		2.92	2.25	1.81	1.56	1.46	1.13	1.10	1.18

Figures in bold refer to domestic firms in 1997. Nace Rev. 1 codes in the left hand column are explained in the Annex.

Tab. 3 – multinationals vs domestic firms' patterns of location (t=1997)

	K_{kt}^d	V_{jt}^d
K_{kt}^m	0.798* (N=16)	
V_{jt}^m		0.690* (N=21)

Spearman's rho coefficient of correlation;

*correlation is significant at 0.01 level.

Table 4: Testing for catalyst effects among multinational and domestic firms

Variables ^a	MODEL 1A	MODEL 1B	MODEL 2A	MODEL 2B
s^{id}	<i>DepVar</i>		<i>DepVar</i>	
s^d		<i>DepVar</i>		<i>DepVar</i>
q^m	4.24*** (1.18)	-.450 (.895)		
q^{im}	1.04 (1.25)	2.49*** (.713)		
K^m			3.53** (1.50)	-2.45** (1.21)
K^{im}			4.52*** (1.44)	3.86*** (.864)
$n^{id} * q^m$.014** (.006)		.010* (.006)
$n^d * q^{im}$.010 (.005)		.011** (.005)	
EXP ^l		-.129 (3.18)		.302 (3.12)
IMP ^l	4.08 (3.80)		5.18 (3.85)	
<i>Regional dummies</i> ^b	5.05***	3.76***	5.54***	3.89***
<i>Sector dummies</i> ^b	21.05***	7.01***	18.28***	11.64***
<i>Time dummies</i> ^b	.22	.03	.27	.01
Const	5.52*** (1.85)	12.02*** (.687)	5.75*** (1.88)	12.05*** (.649)
n. obs.	291	303	291	303
R. sq. (adj.)	.45	.39	.44	.41
F test	8.78***	7.41***	8.64***	8.01***

Standard errors in parenthesis.

^a All variables related to multinationals (m) are lagged one period.

^b The Table reports the Wald test of joint significance of coefficients

Table 5: Testing for self-agglomeration effects among multinationals

Variables ^a	MODEL 1C	MODEL 1D	MODEL 2C	MODEL 2D
n ^{im}	<i>Dep. Var</i>	.254*** (.058)	<i>Dep. Var</i>	.301*** (.061)
n ^m	.068*** (.024)	<i>Dep. Var</i>	.063*** (.024)	<i>Dep. Var</i>
n ^d	-.081 (.041)	.676*** (.065)	-.034 (.039)	.602*** (.066)
n ^{id}	.147*** (.034)	-.054 (.058)	.148*** (.034)	-.123** (.061)
EXP ⁱ		1.58 (3.73)		1.66 (4.03)
IMP ⁱ	-4.32 (2.53)		-4.25 (2.62)	
ln (gdp)			.679*** (.089)	.883*** (.156)
DistWA			-.001 (.001)	-.004*** (.001)
Border			.115 (.162)	.803*** (.282)
<i>Regional dummies</i> ^b	8.19***	12.38***		
<i>Sector dummies</i> ^b	13.20***	5.85***	12.88***	6.32***
<i>Time dummies</i> ^b	2.74**	1.76	.40	.47
Const	2.89** (1.23)	1.57 (.867)	-3.18** (1.46)	-4.00*** (1.52)
n. obs.	576	576	576	576
R. sq. (overall)	.37	.66	.33	.60
F test	12.45***	38.52***	16.57***	49.79***

Standard errors in parenthesis.

^a When entering in the estimations as independent variables, the cumulated number of MNEs in the upstream (downstream) industry has been lagged one period in order to avoid potential problems of simultaneity.

^b The Table reports the Wald test of joint significance of coefficients

Table 6: Sensitivity Analysis

Variables ^a	Model 3A (Paper Sector)	Model 3B (Paper Sector)	Model 4A (Capital Region)	Model 4B (Capital Region)
s^{id}	<i>DepVar</i>		<i>DepVar</i>	
s^d		<i>DepVar</i>		<i>DepVar</i>
q^m	4.08*** (1.18)	-.534 (.894)	3.51*** (1.1)	-.807 (.890)
q^{im}	1.10 (1.26)	2.53*** (.705)	.680 (1.18)	2.41*** (.695)
$n^{id} * q^m$.013** (.006)		.014** (.006)
$n^d * q^{im}$.010* (.005)		.020** (.008)	
EXP ⁱ		-.761 (3.24)		-.173 (3.21)
IMP ⁱ	4.32 (3.87)		4.05 (3.58)	
<i>Regional dummies ^b</i>	4.94***	4.78***	6.76***	4.19***
<i>Sector dummies ^b</i>	23.11***	7.58***	20.14***	8.13***
<i>Time dummies ^b</i>	.28	.11	.20	.02
Const	5.39*** (1.88)	12.26*** (.713)	5.59*** (1.73)	12.05*** (.691)
n. obs.	282	270	267	279
R. sq. (adj.)	.44	.42	.48	.41
F test	8.61***	7.83***	9.61***	7.65***

Standard errors in parenthesis.

^a All variables related to multinationals (m) are lagged one period.

^b The Table reports the Wald test of joint significance of coefficients

Models 3A and 3B exclude Paper and printing product sector; models 4A and 4B do not consider Warsaw region.

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Annex 1. The regional classification of Polish regions

Poland has revised its regional classification system since January 1999, passing from 49 non-homogeneous *voivodships* to 16 new regions, in line with the NUTS-III equivalent classification system (this implied a change of some of the internal borders). The following list classifies the new regions with their administrative capital city and their peculiar location.

Region	Capital city	location
1. Dolnoslaskie	Wroclaw	<i>West border</i>
2. Kujawsko	Bydgoszcz	
3. Lubelskie	Lublin	<i>Industrial pole</i>
4. Lubuskie	Gorzow	<i>West border</i>
5. Lodzkie	Lodz	<i>Industrial pole</i>
6. Malopolskie	Krakow	
7. Mazowieckie	Warszawa	<i>Capital region</i>
8. Opolskie	Opole	
9. Podkarpackie	Rzeszow	
10. Podlaskie	Bialystock	
11. Pomorskie	Gdansk	<i>Industrial pole</i>
12. Slaskie	Katowice	<i>Industrial pole</i>
13. Swietokrzyskie	Kielce	
14. Warminsko	Olsztyn	
15. Wielkopolskie	Poznan	<i>Industrial pole</i>
16. Zachodnio Pomorskie	Szczecin	<i>West border</i>

Annex 2 – The classification of industries

Industry	Consumption (Nace Rev. 1)	Intermediates (Nace Rev. 1)
Food and beverages	15	01, 02, 05; 2923, 2953, 2522
Textiles and Clothing	174, 175, 177, 18	171, 172, 173, 176, 2954, 247
Chemicals	243, 244, 245, 246	23, 241, 242
Constructions	45	263-268, 2922, 2523, 2812, 2863, 315
Metal products	282	27
Motor vehicles	341, 342	343, 2914, 251, 314, 3161
Domestic appliances	297	311, 312, 313, 3162
Leather and leather products	193	191, 192
Wood and Furniture	36	20
Paper and paper product	212, 221, 222	211

Industry codes are drawn from the NACE Rev. 1 (2-, 3- and 4-digits) classification of industrial activities of the European Union.



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