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Firm Heterogeneity and Endogenous Regional Disparities

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Abstract

We exploit the census of Romanian firms to provide a microfounded analysis of the sources of regional disparities in the country. To this extent, we adapt to the regional case a decomposition of firm-level output dynamics based on semi-parametric productivity estimates. The methodology, robust to different techniques of TFP estimation, allows us to analyze the sources of regional disparities controlling for the heterogeneity in firms' characteristics. In particular, we measure various compositional effects of multinational enterprises (MNEs) on regional growth, finding that regional disparities are to a large extent endogenous to the interaction between firm-level dynamics and initial market conditions.

JEL classification: F12; F23; L10; P20

Keywords: regional convergence, multinational firms, productivity, transition economies.

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1 Introduction

The rise and persistence of income disparities across regions is a major topic of discussion in highly integrated economic areas like the US or the EU. For example, the European Commission has proposed to allocate a total of Euro 345 *billions* in the period 2007-2013 to correct for the regional disparities arising in the new member States of Central and Eastern Europe. However, lacking a precise assessment of the sources of these disparities, no generalized consensus exists on the policy options to be undertaken.

In fact, standard neoclassical economic theory suggests that, under diminishing returns and free movement of factors, per capita income levels within an economic area should converge over time to the same steady state value (Barro and Sala i Martin, 1991). Such a view has nevertheless been challenged since long by many authors (e.g. Durlauf and Johnson, 1995 or Quah, 1996, to quote the early contributions) which, using various econometric methods, have found a persistence of income disparities, arguing therefore that the pattern of cross-country growth is more consistent with endogenous growth, rather than neoclassical theories. The works of Canova and Marcet (1995) and De la Fuente (2002), to mention just two of a large set of contributions, have then confirmed by and large the persistence of income disparities also at the regional (within-country) level.

More recently, capitalizing on a series of contributions that have better identified the connection between micro and aggregate productivity, researchers have increasingly looked at the sources of growth taking into account the important role played by firm heterogeneity[1]. In particular, Kumar and Russell (2002) have employed non parametric production-frontier techniques to decompose international macroeconomic convergence (measured as labor productivity growth across countries) into components related to technological catch-up, technological progress and capital deepening while Bartelsman et al. (2004), starting from firm-level observations on productivity, provide a detailed descriptive evidence of the process of creative destruction taking place across 24 countries and 2-digit industries over the past decade.

And yet, to the best of our knowledge, no study has insofar tried to exploit our improved understanding of firm-level dynamics in order to precisely assess how firm heterogeneity might drive the evolution of aggregate output and thus the emergence of income disparities across regions[2]. Such a microfoundation of regional disparities is the aim of this paper.

[1] Among others Baily, Hulten and Campbell (1992), Griliches and Regev (1995), Liu and Tybout (1996), Olley and Pakes (1996), Haltiwanger (1997) and, more recently, the surveys of Foster et al. (2001) and Van Biesebrock (2003) discuss the relation between heterogeneous firm-level dynamics and aggregate industry productivity in different countries. Melitz (2003) brings the issue of firm heterogeneity and aggregate industry productivity into the theory of international trade.

[2] With similar premises, Ghironi and Melitz (2005) have recently started to analyze the role of firm heterogeneity in international macroeconomic models.

The latter gap in the literature might seem surprising if one considers the parallelism existing between the sources of aggregate output growth identified by the macroeconomic literature as possible drivers of income disparities, i.e. technological diffusion (Keller, 2002) and reallocation of productive factors (e.g. De la Fuente, 2002)[3], and the channels that the previously quoted micro-literature, starting from firm-level observations, has identified as driving changes in aggregate industry productivity: a within-plant component deriving from plant-level changes in productivity (and hence related to technology diffusion), a between-plant component that reflects changes in the allocation of inputs, and the effect of entry and exit of firms. Nevertheless, notwithstanding this parallelism, the relationship between standard aggregated measures of firms'productivity and aggregate output dynamics is not straightforward: starting from firm-level observations of Total Factor Productivity (TFP), significant problems exist in aggregating TFP measures in order to recover the evolution of output and thus identify in an unbiased way the ensuing sources of income disparities.

To provide a possible solution to these problems, we adapt to the regional case a decomposition of firm-level output dynamics based on semi-parametric productivity estimates. We then apply this methodology to the case of Romania, a large country in Eastern Europe for which the full census of firms' data is available to us since 1996. Romania represents a very interesting 'natural experiment' for our purposes since, before the start of the transition from plan to market in 1995, the country experienced limited factor movements across its regions, associated to low regional disparities. After 1995, i.e. since when we have census data, disparities started to increase along the transition process, thus providing us with an ideal control for initial conditions.

Through our methodology we decompose for each year the aggregate country's output across its regions and along the previously discussed channels of firm-level changes in productivity, input reallocation and net entry dynamics. Based on this analysis, we are able to derive a micro-founded explanation for the sources of aggregate growth and the rise and persistence of regional inequalities in Romania, exploring at the same time the role played by firm heterogeneity.

In particular, by comparing the performance of domestic and multinational (MNE) firms operating in the country, we investigate the extent to which heterogeneity in ownership leads to different productivity, reallocation and net entry dynamics across regions. We can thus provide a precise accounting of what has been called a 'compositional effect' of MNEs (Barba Navaretti and Venables, 2004), i.e. the idea that if MNEs entering in a region are outperforming their local counterparts, the greater their share in the total composition of output, the higher the income

[3] Among others, Boldrin and Canova (2001) show that most of the regional income differences in their EU sample of regions can be attributed to differences in total factor productivity (TFP) originating from technology diffusion rather than differences in per worker capital stocks.

growth of a given region. Although detecting positive evidence of such a compositional effect related to an unbalanced net entry of multinationals across regions, we find however that the largest driver of regional disparities is represented by the diverging performance in restructuring by incumbent firms, i.e. regional disparities are in large part endogenous to the interaction between firm-level dynamics and initial market conditions, a finding which sheds some new light on the relation between economic geography and firms' heterogeneity. We also control for the presence of regional spillovers from MNEs to domestic firms, finding unbalanced effects across regions and thus providing a microfounded explanation for the eventual persistence of regional disparities over time.

The paper is structured as follows. Section 2 introduces the methodological framework through which it is possible to nest plant-level productivity estimates within a regional dimension, recovering a microfounded decomposition of aggregate output growth at the regional level. Section 3 discusses our dataset and presents the decomposition of the aggregate sources of growth in Romania, together with some robustness checks with respect to the firm-level estimation of TFP, among which a modified version of the Levinsohn and Petrin (2003) semi-parametric algorithm adapted to the regional case. Section 4 explores in detail the firm-level drivers of regional disparities, including possible spillovers arising from MNEs, while Section 5 concludes.

2 Methodological framework

Let ω_{jt} denote the aggregate total factor productivity of a given industry j at a point in time t. The latter has been usually measured as the residual obtained subtracting the predicted log output $\hat{y}_{jt}$ from the actual log output y_{jt} of the considered $j-$industry. In particular, $\hat{y}_{jt}$ has been in general calculated using log inputs x_{jt} within a Cobb-Douglas aggregate production technology characterized by a vector β of coefficients. Hence

$$\omega_{jt} = y_{jt} - \hat{y}_{jt} = y_{jt} - \beta' x_{jt} \tag{1}$$

As it is well known, a shortfall of this methodology is that it implies that any redistribution of inputs across plants results in the same aggregate output, which might not be the case if, for example, firms within the industry are hetereogeneous in productivity levels and more inputs flow to the most productive firms. Hence, the literature has started to employ firm-level TFP estimates of the form

$$\omega_{ijt} = y_{ijt} - \hat{y}_{ijt} = y_{ijt} - \beta' x_{ijt} \tag{2}$$

where the sub-index denotes firm i[4]. Industry-level TFP estimates are then obtained aggregating firm-level measures through productivity indexes of the form $\Omega_{jt} = \sum_{i=1}^{N} s_{ijt}\omega_{ijt}$, where a measure Ω_{jt} of the industry-level TFP is obtained as a weighted average of the firm-specific productivity ω_{ijt}, using output or input shares s_{ijt} as weights[5].

As noted by Levinsohn and Petrin (2003), the construction of the index Ω_{jt} implies two shortfalls which are crucial for our aggregation problem. First, due to the weights employed in the summation, no function of aggregate productivity Ω can reproduce the dynamics of aggregate output y_{jt}[6]. Second, since Ω_{jt} is an index with no clear unit of measurement, aggregations and comparisons across industries (e.g. within a region) are problematic. Because of these two shortfalls, the traditional methodology employed for the aggregation of firm level productivities cannot be used as a tool to explore the regional dynamics of output.

In order to solve these drawbacks, Levinsohn and Petrin (2003) have proposed to aggregate firm-specific TFP measures using a different weighting system. This can be easily seen reworking Equation (2) to obtain

$$Y_{jt} = \sum_{i=1}^{N} z_{ijt} TFP_{ijt} \tag{3}$$

where Y_{jt} is the aggregate output (in levels) of our $j-$industry, $TFP_{ijt} = e^{\omega_{ijt}}$ is the exponentiated measure of TFP, and $z_{ijt} = e^{\beta' x_{ijt}}$ is what Levinsohn and Petrin (2003) refer to as an input index. In doing so, every element in the sum has as units the original unit in which output is measured, and hence aggregations and comparisons across industries become possible.

Moreover, denoting $\Delta Y_{jt} = \sum_{i=1}^{N} z_{ijt} TFP_{ijt} - \sum_{i=1}^{N} z_{ijt-1} TFP_{ijt-1}$ and manipulating this expression in order to take into account the entry and exit of firms, it is possible to decompose the changes in output of the j-industry, ΔY_{jt}, as

$$\Delta Y_{jt} = \sum_{i \epsilon C} [z_{ijt-1} \Delta TFP_{ijt} + \Delta z_{ijt} TFP_{ijt-1} + \Delta z_{ijt} \Delta TFP_{ijt}] +$$

$$+ \sum_{i \epsilon E} z_{ijt} TFP_{ijt} - \sum_{i \epsilon X} z_{ijt-1} TFP_{ijt-1} \tag{4}$$

[4]In the analysis we will be using firm, rather than plant-level information. The limitation, common in the literature on transition countries due to the availability of data, is not too restrictive in our case, since we do not have evidence of a significant presence of multi-plant corporations in Romania.

[5]Baily et al. (1992) where among the firsts to calculate in this way the aggregate productivity index using as weights the output shares of each firm. Foster et al. (2001) however argue that, being output dependent from productivity, it is better to use input shares as weights, hence $s_{it} = X_{it} / \sum_j X_{jt}$, where $X_{it} = e^{x_{it}}$. Van Biesebroeck (2003) warns that using inputs as weights nevertheless induces a lower productivity average, as plants that improve productivity most are those that use less inputs per unit of output, and hence receive a low weight.

[6]For example, the change in industry output while holding industry inputs constant cannot be recovered as the product of output at $t-1$ times $\Delta\Omega$. Similar critiques to the aggregation Ω_{jt} are also pointed out by Van Biesebroeck (2003).

where the total number of plants N has been decomposed in three sets: those who continue their business over time (C), those who enter at a given time (E) and those who exit (X). The first term in square brakets measures the changes to aggregate output induced by changes in productivity, holding the inputs constant, while the second term captures the extent of restructuring, i.e. the variation in the use of inputs, keeping productivity constant; the third term is the covariance between productivity growth and input changes[7]. The second and third addendum measure instead the effect of net entry on aggregate output growth. Equation (4) is very flexible, since essentially it decomposes the changes in aggregate output of industry j starting from firm-level data, thus allowing us to analyze the impact of different dimensions of firm heterogeneity.

In particular, we can further decompose Equation (4) to incorporate the effects of heterogeneity in ownership, distinguishing domestic from multinational firms. This can be simply done by distinguishing the input indexes z_{it}^{M} and productivity TFP_{it}^{M} of multinational firms from the domestic ones, z_{it}^{D} and TFP_{it}^{D}, with M and D denoting the multinational or domestic ownership of each firm, respectively. Hence, it is possible to rewrite Equation (4) as

$$\Delta Y_{jt} = \sum_{H=M,D} \{ \sum_{i \epsilon C} [z_{ijt-1}^{H} \Delta TFP_{ijt}^{H} + \Delta z_{ijt}^{H} TFP_{ijt-1}^{H} + \Delta z_{ijt}^{H} \Delta TFP_{ijt}^{H}] +$$

$$+ \sum_{i \epsilon E} z_{ijt}^{H} TFP_{ijt}^{H} - \sum_{i \epsilon X} z_{ijt-1}^{H} TFP_{ijt-1}^{H} \} \tag{5}$$

Finally, exploiting the additivity property of our decomposition across industries, given a region r composed of M industries, the changes in the regional aggregate output ΔY_{t}^{r} can be easily obtained as

$$\Delta Y_{t}^{r} = \sum_{j=1}^{M} \Delta Y_{jt}^{r} \tag{6}$$

Equations (5) and (6) provide a microfoundation of the sources of regional output growth starting from the underlying firm-level dynamics. In particular, they allow us to distinguish the channel of productivity changes from restructuring, the role of multinational firms, the effects of changes in market structures (entry and exit of firms), and the specific contribution of each industry, thus allowing us to precisely analyze the drivers of regional disparities.

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[7]Technically the z_{it} are not weights, since they do not sum to 1. Hence, Δz measures the extent to which a firm is increasing or decreasing its level of inputs, rather than the change in market share of the same firm. The present methodology is thus different from the decompositions of productivity indexes traditionally used by the literature (e.g. Haltiwanger, 1997; Griliches and Regev, 1995). We will further discuss the peculiarity of our approach when fitting the decomposition to the dataset.

3 Firm heterogeneity and output growth

3.1 The Romanian dataset

The previously discussed decomposition has been applied to the case of Romania, a large transition country displaying significant dynamics across the eight administrative regions making up its territory. In particular, Table 1 shows the per capita GDP of the Romanian regions as a percentage of the national average from 1995 to 2001. As it can be seen, regions started to diverge since the beginning of transition in 1995: the standard deviation of regional per capita GDP (a measure of regional disparities known as $\sigma-$convergence) more than doubled in the considered period. In particular, only three regions (Vest, Centru and Bucuresti), which we will refer to as 'Top 3' regions, have displayed income dynamics in line or above the national average, with the capital region, Bucuresti, clearly outperforming all the others[8].

To analyze the micro sources of these increasing disparities, we employ a dataset composed of domestic firms and affiliates of multinational enterprises (MNEs) operating for the period 1996-2001 in Romania, as retrieved from AMADEUS. The latter is a dataset provided by a consulting firm, Bureau van Dijck, containing balance sheet data in time series for a sample of roughly 7,000,000 companies operating in various European countries. In the case of Romania, the dataset covers the entire census of operating firms, since it reports the information recorded by the Romanian Chamber of Commerce and Industry, the institution to which all firms have to be legally registered and report their balance sheet data. In particular, we have retrieved information on the location of each firm within each of the eight Romanian regions, the industry in which these firms operate (at the NACE-4 level), as well as yearly balance sheet data on tangible and intangible fixed assets, total assets, number of employees, material costs, revenues (turnover) and value added.

Given the nature of the data, we have first to address three methodological issues. First of all, the estimation of a production function in industries other than manufacturing and construction is not straightforward, potentially generating biases that we want to exclude in the analysis. Second, data in AMADEUS are stratified, i.e. information on new firms is progressively added, with the dataset thus including both active and inactive firms. Third, information on the ownership structure is not available for all firms.

In order to cope with these issues, we have concentrated our analysis on the manufacturing and construction industries only. Restricting our observations to these industries is however

[8] The case of Romanian regions is in line with the dynamics experienced by other countries in the area. The Third Report on Economic and Social Cohesion of the European Commission (2004) reports in fact that growth in the Countries of Central and Eastern Europe has been disproportionately concentrated in a few regions, particularly in capital cities and surrounding areas.

not problematic: as discussed in Annex 2, regional disparities calculated on official data for manufacturing and construction only are correlated 0.89 with the official figures for all industries reported in Table 1. Second, we have considered firms as active when at least one observation of revenues is available over the considered time span. More specifically, the year in which the first observation of revenues is recorded denotes a firm's entry, while exit is assumed to take place in the year after which no new information is available in the dataset[9]. Third, we have included in the sample only those firms for which information on the ownership structure is available: in particular, we have considered a firm as foreign if more than 10 per cent of its capital belongs to a MNE, and domestic otherwise. A detailed discussion of all these methodological issues, together with a detailed validation of the dataset, is presented in Annex 2.

The dataset retrieved from the Romanian census is analyzed in Table 2, and consists of 39,799 active firms at the beginning of the period (of which 36,634 domestic and 3,165 MNEs), then becoming 48,718 in 2001 (of which 41,981 domestic and 6,737 MNEs). These figures correspond to 95 per cent of all official firms operating in Romania in manufacturing and construction, with the exception of 2001, where this percentage drops to 85 per cent. Entry rates tend to overcome the exit of firms at the beginning of the period, while exit rates grow larger towards the end, a dynamic not surprising for a transition country, where soft budget constraints are progressively removed. Moreover, the share of multinational enterprises increases from 8 to 14 per cent of the total. For both the domestic and multinational firms, the food (NACE-15) and construction (NACE-45) industries are the two largest in terms of number of entities over the considered time span.

In terms of validation, the sample coverage is lower if we consider only those firms for which information is available in time series for all the variables of interest in the calculus of TFP, as reported in Annex 2[10]. Nevertheless, even the latter restricted sample, covering around 50 per cent of all official firms, is unbiased with respect to our research objective. In fact, aggregating each firm's value added in each region as a proxy of regional GDP, the resulting correlation between the per capita regional value-added as retrieved from our restricted sample and the official figures of Table 1 is 0.87 (see Annex 2 for a detailed discussion). Hence our dataset, even when cleaned for missing observations on all the variables of interest taken jointly, is in any case able to reproduce without biases the dynamics of regional disparities in Romania.

[9]For example, a firm whose first observation is recorded in 1997 and last observation is recorded in 2000 is considered active from 1997 to 2000, even if data for 1998 or 1999 are missing. See Annex 2 for further details.

[10]For example, while the time series of revenues tend to be complete for every active firm, the data on employment present more missing observations.

3.2 Production function estimation and decomposition of output

As already discussed, the first step of our methodology relies on a correct estimation of individual firms' TFP. To calculate firm-specific productivity we have first assigned our firms to the NACE2 industries reported in Table 2, and then we have applied the Levinsohn and Petrin (2003a) semi-parametric estimation technique to each industry[11]. This has allowed us to solve the simultaneity bias affecting standard estimates of firm-level productivity, as well as to derive TFP estimates from heterogeneous, industry-specific production functions (see Annex 1 for further details)[12]. Furthermore, to account for heterogeneity in firms' ownership possibly leading to different productivity dynamics between MNEs and domestic firms (De Backer and Sleuwaegen, 2003), we have always run separately the production function estimations of domestic and multinational firms within the same industry.

More specifically, in the estimations output is proxied by turnover, deflated using NACE2 industry-specific price indices (setting 1995 as the base year) retrieved from the Eurostat New Cronos and the Vienna Institute of International Economics (WIIW) databases. Material costs in each industry are deflated by a weighted average of the producer price indices of the supplying sectors, with the weights extracted by the Romanian input-output matrix (1998 release) and representing the proportion of inputs sourced from any given sector. The labor input is measured by the number of employees, while capital is proxied by the value of tangible fixed assets deflated using the GDP deflator. In order to check the appropriateness of our correction for simultaneity, Table 3 shows, for both domestic and multinational firms, the typical upward bias in the labor coefficient that emerges when confronting the results of the semi-parametric estimates of productivity with standard OLS results[13].

In Table 4 we exploit the productivity estimates so obtained for calculating the decomposition of changes in national output ΔY_t aggregating Equation (5) across all industries, thus ignoring

[11]The tobacco and fuel industries (NACE16 and 23) have displayed insufficient variation to identify the input coefficients. Moreover, we have excluded the recycling industry (NACE37) as well, since in the latter case the estimation of a production function is, again, not straightforward. Accordingly, these industries have been eliminated altogether in all the reported Tables.

[12]Using ordinary least squares when estimating productivity implies treating labor and other inputs as exogenous variables. However, profit-maxizing firms immediately adjust their inputs (in particular capital) each time they observe a productivity shock, which makes input levels correlated with the same shocks. Since productivity shocks are unobserved to the econometrician, they enter in the error term of the regression. Hence, inputs turn out to be correlated with the error term of the regression, biasing the OLS estimates of production functions. Olley and Pakes (1996) and Levinsohn and Petrin (2003a) have developed two similar semi-parametric estimation procedures to overcome this problem, using investment and material costs, respectively, as proxies for these unobservable shocks.

[13]Olley and Pakes (1996) and Levinsohn and Petrin (2003a) also discuss in their estimates the possible selection bias arising from the exit of firms, possibly leading to an underestimation of the capital coefficients in the production function. However, both papers do not find significant changes when correcting for exit. In our case, we have re-estimated all the industry specific production functions both on the balanced and unbalanced samples, finding no significant differences in the coefficients.

for the time being the regional dimension. More specifically, we have aggregated all our (deflated) firm-specific observations on turnover and then we have calculated the yearly changes in national output ΔY_t (measured in thousands of real euros), reporting them in Column 2 of Table 4a. Through our TFP estimates, the same figure of output growth can be obtained as the sum of the four elements in which we can decompose ΔY_t (i.e. summing the figures under the "all firms" headings), thus deriving important information on the sources of output dynamics. First of all, note that the reported changes in national output are always negative for the considered period, but they tend to become smaller over the years. This pattern is entirely consistent with the transition experience of Romania: from 1995 onwards, official measures of Romania's GDP tend to display a U-shaped evolution over time. The latter confirms the previously discussed high correlation of our firm-level information with official data.

Before moving on with the analysis of the various components of ΔY_t and the ensuing sources of regional disparities, it is nevertheless important to assess the robustness of our methodology. As stated by Levinsohn and Petrin (2003), a major advantage of such a decomposition is that every element in the sum has as units the original unit in which output is measured (real euros), and hence it is possible to recover the exact dynamics of output through aggregations of the decomposed elements across industries and/or regions. An important caveat is however related to the fact that the decomposition uses as weighting function the input index z_{it}, whose terms do not sum to 1. As a result, rather than smoothing each individual observation within a weighted average, the decomposition becomes sensitive to missing observations and individual firms' sizes. The first of these issues is dealt with easily since, as already discussed, our dataset, even when cleaned for missing observations in all the variables of interest, is unbiased with respect to the actual evolution of regional output in the country. To cope with the second potential problem, instead, in all the following analyses we will check the robustness of our results with respect to different size cathegories of firms.

A second set of robustness checks deals with the different methods of TFP estimation. Given the nature of our data, we have followed the standard approach of proxying physical output with deflated revenues, using industry-specific price deflators. Klette and Griliches (1996) argue however that such a procedure might lead to an omitted price variable bias, due to the correlation between firms' prices and their used inputs. As a result, they propose to control in the estimation of the production function for the degree of imperfect competition on the demand side of the market[14].

We assess this critique in two ways: first of all, as already argued, we estimate different pro-

[14]The latter entails an estimation of production function coefficients which incorporate the (constant) term $\eta + 1/\eta$, where η is the elasticity of substitution between products. See De Loecker (2005) for a comprehensive treatment of this problem.

duction functions for domestic and multinational firms, thus implicitly allowing for differentiated mark-ups among the two cathegories of firms. In addition, we allow for spatial substitutability in demand (e.g. Syverson, 2005) through a slightly modified version of the original Levinsohn and Petrin (2003) algorithm, i.e. estimating separately for domestic and multinational firms an industry-specific production function augmented with regional fixed-effects[15]. The decomposition calculated using the latter productivity measures is presented in Table 4b. As it can be seen, there is no evidence of significant differences in the overall dynamics with respect to the decomposition reported in Table 4a, which employs TFP measures retrieved from semi-parametric production function estimations considered only in their inter-industry variation.

As a further check, we have estimated TFP using the alternative version of the Levinsohn and Petrin (2003) algorithm, which takes value-added as the dependent variable. Such a methodology is in principle more suited to our purposes, since we want to correlate our decomposition to regional aggregate changes in value added (GDP), although the algorithm imposes the coefficient of material costs $\beta_m = 1$ across all industries, a very restrictive assumption. Nevertheless, when aggregating firm-level observations using TFP measures retrieved from a production function estimation in value-added, the overall signs and relative magnitudes of our decomposition remain the same, with the only difference being a slight reduction in the relative weight of the restructuring term in favor of the other addenda[16].

Unfortunately, we cannot implement in our sample the Olley and Pakes (1996) algorithm of TFP estimation, since the latter technique uses investment rather than material costs as the proxy for the unobservable shocks, but (due to an invertibility condition) can consider only plants that report non-zero investments. Now, for most transition countries (and Romania is no exception), any proxy of investment is likely to contain a large number of zeros or negative values, due to the substantial restructuring of the capital stock that had to be undertaken in the early years of the transition process, especially for domestic firms. In particular, in our sample the percentage of firms reporting zero or negative investments is around 70 per cent. Thus, the use of the Olley and Pakes (1996) technique would introduce a significant selection bias in the analysis. As a further robustness check we have therefore used simple OLS estimates of TFP. Knowing that the latter estimates suffer from a simultaneity bias affecting the consistency of the coefficients (see Table 3), it is not surprising that the decomposition calculated using OLS measures of TFP, reported in Table 4c, displays a different order of magnitude for the various

[15]Note that, when running the original Levinsohn and Petrin (2003) semi-parametric technique for all firms belonging to a given industry across regions, the intercept β_0 of the production function is not separately identified in the estimation (see Annex 1). In our modified procedure, instead, the regional fixed-effects are specifically observable in our measure of predicted output. As a result, we can retrieve firm-specific TFP measures corrected for region-specific effects.

[16]The results are available upon request.

addenda. Nevertheless, it again delivers the same messages in terms of sign and evolution over time of each component, thus confirming the overall robustness of our methodology.

Coming to the results, Table 5 (top) reproduces the decomposition presented in Table 4a, this time expressed in percentage terms, i.e. where the sum of the 'all firms' headings of the decomposition sums to -100 per cent (i.e. a positive variation implies a positive contribution to output changes, reported in the first column)[17]. Limiting for the time being our attention to the 'all firms' headings, it can be seen that the negative changes in output are largely driven by the channel of restructuring ($\Delta z_{it} TFP_{it-1}$), i.e. by the fact that firms in Romania are decreasing their absolute level of inputs Δz_{it} as a reaction to the transition from plan to market. Changes in output pertaining to productivity dynamics ($z_{it-1} \Delta TFP_{it}$) are also negative, but are much smaller. The intuition that a restructuring process is ongoing in the country is also confirmed by the fact that the covariance term ($\Delta TFP_{it} \Delta z_{it}$), initially very low, increases over time: as restructuring progresses, the reallocation of inputs becomes more correlated with productivity changes. Finally, net entry tends to positively contribute to the dynamics of output.

All these results are robust across the different TFP measures previously discussed and employed in the decompositions. Quite reassuringly, the results are also consistent with the general experience of transition, as well as with the most recent studies which have applied productivity decompositions to transition countries[18]. We take this as a further indication that our methodological framework, decomposing output rather than productivity, allows us to microfound the underlying sources of output dynamics in an unbiased way.

3.3 The role of firm heterogeneity

One important feature of the decomposition presented in Table 5 (top) is the possibility to control for firm heterogeneity. First of all, it is possible to identify separately the contributions of domestic and multinational firms to the evolution of aggregate output. By doing so, one observes that MNEs' affiliates tend to generate, as expected, a positive contribution to aggregate output via the channel of productivity changes ($z_{it-1} \Delta TFP_{it}$), in contrast with the negative, productivity-induced output changes experienced by domestic firms. Moreover, the restructuring processes ($\Delta z_{it} TFP_{it-1}$) of MNEs tend to end sooner than the one of domestic firms, thus signalling the greater ability of multinationals to rapidly enforce a change in inputs with respect

[17]For example, Table 5 shows that in 1997 MNEs, via the channel of productivity changes, have contributed positively for 3 per cent of total output changes (-2 150 499) in Romania: this corresponds to the figure of 63 358 (thousands of real euros) reported in Table 4a.

[18]In particular, in their cross-country comparison, Bartelsman et al. (2004) find that the within-firm (productivity) component plays a lesser role in explaining productivity growth in transition countries, while De Loecker and Konings (2005) find, in the case of Slovenia (another transition country), that a substantial positive contribution in terms of job creation and growth comes from the net entry of new firms.

to their local counterparts. The latter is also consistent with the larger negative size of the covariance term ($\Delta z_{it}\Delta TFP_{it}$), implying that, throughout the entire time span, the restructuring processes in the case of MNEs tend to be more correlated with productivity gains then for domestic firms[19]. Multinationals also generate a larger positive contribution to output changes via the channel of net entry.

The microfounded analysis allows us to address two further sources of heterogeneity which might potentially drive our results. In particular, the sample of 'continuing' firms in our decomposition changes every year, due to net entry: it is therefore possible that our dynamics of restructuring are driven by the changes in the composition of the sample rather than from a change in firms' behavior. Moreover, as already discussed, the figures reported in our decomposition are the sum of individual firms' changes, and thus do not allow us to understand whether larger or more productive firms behave differently than their counterparts.

To address these two issues, in the bottom part of Table 5 we have reported an analysis disentangling the two addenda of productivity and restructuring across different firms' size and productivity cathegories, for both the balanced (firms active throughout the entire time span) and the unbalanced sample. The results of the analysis show that, on average over the considered period, smaller firms (in terms of average input index z_{it-1}) tend to display larger negative changes in productivity, which tend to become positive as the firm's size grows. Moreover, firms which are initially more productive (larger average TFP_{it-1}) tend to restructure less when controlling for the scale effect (i.e. calculating $\Delta z_t/z_{t-1}$), with even positive changes in inputs experienced by firms with larger initial values of TFP. Finally, comparing domestic and multinational firms within the same cathegories, it is always true that MNEs tend to outperform domestic firms in terms of productivity changes and restructuring. These results hold in both the balanced and unbalanced samples.

We can therefore draw some first, general conclusions from the analysis of the decomposition: most of the u-shaped, negative variations of output in Romania are related to the restructuring process, with productivity changes and net entry dynamics playing a smaller role. Firm heterogeneity with respect to ownership is relevant, since MNEs influence the output dynamics to a greater and different extent than domestic firms. These conclusions hold true when assessing them against other possible dimensions of heterogeneity (size, productivity and entry behavior) in our sample.

[19] Although we do not have reliable information on the firms' mode of entry (i.e. greenfield vs. brownfield FDI), the scale and restructuring intensity of these MNEs are consistent with a brownfield modality of FDI.

4 Towards a microfoundation of regional disparities

Based on the evidence insofar discussed, the relevant increase in regional disparities observed in Romania can be attributed to two different explanations, not mutually excludable. On the one hand, regional divergences could have arisen due to the standard drivers of economic geography: once factors were free to move after the beginning of the transition process, some regions might have started to attract an higher number of firms and/or workers, due to either better endowments and/or a mechanism of cumulative causation. On the other hand, however, regional disparities might be endogenous to the observed heterogeneity of firms: once free from the requirements of the planned economy, firms across regions might have started to respond differently, in terms of productivity or restructuring dynamics, to the changing market conditions[20].

To shed further light on these issues, we have divided regions in 'Top 3' vs. 'others', consistently with the findings of Table 1. Based on the data of our sample, we have then calculated the shares of employment for each NACE 2 industry within the two groups of regions: variations in these shares over the years 1996 to 2001 resulted to be very limited and mostly concentrated around zero for both groups of regions, thus excluding a correlation between the emergence of regional disparities and a change in industry specialization. Moreover, the total share of jobs in Top 3 regions as measured from our sample increasead by only 1 per cent in the considered period, from an average of 43 to 44 per cent of the national figure, with industry-by-industry changes also limited (standard deviation of changes was 7 per cent): hence, we can also rule out massive job reallocation across regions as a major source of the regional divergence detected in our sample[21]. These findings are all consistent with the general consensus that labor markets have been quite rigid in the early phases of transition.

Having excluded labor mobility across regions as a channel driving regional disparities, we have turned our attention to the location dynamics of firms and their contribution to output growth. To this extent, we have implemented the decomposition of output for the two groups of regions combining our Equations (5) and (6), i.e. splitting the decomposition reported in Table 5 in the two above mentioned clusters of regions (Top 3 vs. others). The results are presented in Table 6. The first clearly visible difference between the two clusters is related to multinational firms, whose positive net entry contribution is strongly unbalanced in favour of the top three regions[22]. The latter finding might generate an unbalanced compositional effect

[20]The idea of institutional changes affecting the dynamics of firms' productivity or restructuring has been recently explored by Eslava et al. (2004) in the case of Colombia.

[21]We recall that the regional disparities retrieved from the data contained in our sample are 0.87 correlated with the disparities measured from official sources. The results pointing to a lack of labor mobility are similar for both the balanced and the unbalanced samples. Detailed data are available upon request.

[22]Note that the effect is heterogeneous across the cathegories of firms: the net entry dynamics of domestic firms

of new MNEs on regional output, as postulated by Barba Navaretti and Venables (2004), if the yearly performance of the newly entered MNEs positively contributes to the regional output variations[23]. To this extent, Table 7a shows that, on average, MNEs which have entered in the top three regions after 1996 positively account for 20 per cent of the total output variations in this regional cluster, while the same figure averages only 5 per cent in the other regions. Such a different compositional effect across the two regional clusters is thus partly responsible for the emergence of regional disparities.

The results of Table 7a show however that newly entering MNEs and the compositional effect they generate do not drive the bulk of output variations within regions. Indeed, we already know from Table 6 that for both regional groups the largest source of output changes is firms' restructuring. To investigate the extent to which such a channel leads to significant regional disparities, Table 7b presents the restructuring rates of firms at the regional group level, computed from Table 6 as $\Delta z_{it} TFP_{it-1}/Y_{t-1}$, i.e. restructuring per unit of output of the previous year. To disentangle the effects of newly entering firms from incumbent ones, the restructuring rates are calculated on both the balanced and unbalanced samples. One finding is evident: the negative restructuring rates in the top three regions tend to be smaller throughout the years, thus providing a key explanation for the observed divergences in income. More in detail, in both the balanced and unbalanced samples, domestically-owned firms do not display systematic differences in the restructuring rates across regional groups, while MNEs in the lagging-behind regions show restructuring rates which are significantly higher then the ones of their counterparts in the Top 3 cluster, especially in the first three years of the time span, i.e. at the beginning of the transition process[24]. Moreover, the restructuring rates of incumbent firms (balanced sample) are always higher than the ones incorporating the entire population of firms.

To shed further light on this additional driver of regional disparities induced by MNEs, we have computed the restructuring rates for each of the six size cathegories of multinationals already analyzed in Table 5 at the national level, this time comparing them across the two diverging regional groups. While no systematic differences have been found in the restructuring behavior of multinationals in the first five size cathegories, a striking divergence has emerged with respect to the largest MNEs (those with turnover larger than 500,000 euros). Within this

seem in fact to be similar across the two clusters of region. Note also that, since we have not found evidence of strong cross-regional job reallocation, the unbalanced net entry of MNEs might be consistent with a higher job reallocation taking place within the top three regions.

[23]Working with the 1996-2001 sample, the first year of entry of new MNEs is 1997. The compositional effect in any given year $t > 1997$ is measured by the yearly performance of the MNEs which have entered the considered region starting from 1997, and the net entry of new MNEs at time t.

[24]The latter finding is also confirmed by looking at the decomposition presented in Table 6, where it is shown that the negative restructuring term becomes progressively smaller and finally turns positive for multinationals in Top 3 regions, suggesting the idea of a faster restructuring process

size cathegory, MNEs in the lagging behind regions are on average substantially bigger then their counterparts in the Top 3 cluster, and display higher negative restructuring rates throughout the time span (see Table 8a). Since the latter cathegory of multinationals accounts on average for 75 per cent of total MNEs' output and for 85 per cent of total restructuring, the restructuring dynamics generated by these multinationals (Table 8a) account almost entirely for the ones reported for the total sample of MNEs (Table 7a). Moreover, we have evidence that the entry of new, large MNEs is very limited in the considered period, especially in the early years of transition.

It then follows that, in addition to the compositional effect, a large part of the emerging regional disparities can be attributed to the diverging restructuring rates of incumbent, large foreign-owned firms[25]. Such an heterogeneous behavior of firms across the regional clusters is likely to be partly correlated with initial market conditions. The data in our sample show in fact that, in lagging-behind regions, MNEs are relatively more active in industries traditionally characterized by higher restructuring rates during transition[26]. However, even within each industry we still find that in most cases MNEs in lagging-behind regions show on average deeper restructuring rates and larger average sizes (see Table 8b).

Hence, we can draw a second general conclusion from our analysis: heterogeneity in ownership is an important source of regional disparities, with MNEs, more than domestic firms, being a very powerful driver of divergence. The nature of the effects that MNEs induce is more complex than originally thougth. On one side, we recover evidence of a compositional effect, according to which an unbalanced entry of MNEs in a group of regions tends to magnify disparities. On the other side, we find what we can call a 'second-order' compositional effect: the heterogeneity within the same firms (in our case, within the same MNEs), acting in combination with some types of distortions in regional market structures, leads to diverging patterns in the reallocation choices of inputs and thus to a further source of regional disparities.

4.1 The long-run dynamics of regional growth

The evidence collected insofar points to an increase in regional disparities likely originating from the interplay between firm heterogeneity and different initial conditions across the two clusters of regions[27]. Such a finding is *prima facie* reassuring from a policy point of view: as soon as the

[25]In order to be consistent with our decompositions, we present the analysis performed on the unbalanced sample of MNEs. As a robustness check, we have performed the analysis of restructuring rates across the different size cathegories of MNEs only whitin the balanced sample, finding, as expected, no significant differences.

[26]For example, 39 per cent of the output of largest MNEs in lagging behind regions is concentrated in the manufacturing of metal products, machinery and transport equipment (NACE 27, 29 and 34, respectively) vs. 11 per cent in the Top 3 regions.

[27]For instance, firms (both domestic and MNEs) in the Top 3 cluster are on average characterized by higher TFP levels than their counterparts in lagging-behind regions.

restructuring process is over, the rise in inequalities should slow, while a policy action aimed at correcting the initial imbalances in the regional endowments might restore a convergence process. Nevertheless, regional inequalities might tend to persist over time if eventual spillovers from MNEs to domestic firms are biased towards the top three regions.

To this extent, the literature on spillovers has identified several channels through which MNEs might affect domestic firms' productivity, but no conclusive evidence has been reached on the issue[28]. Limiting our attention to the empirical evidence available for transition countries, Damijan et al. (2003), Djankov and Hoekman (2000) and Konings (2001) find in fact mixed evidence of spillovers from the presence of multinationals on domestic firms in the same industry. More recently, Smarzynska Javorcik (2004), working on Lithuanian regional data and exploiting a measure of firm level productivity which, as in our case, controls for the simultaneity bias in firms' decisions, has detected significant positive spillovers arising trough backward linkages, i.e. generated through contacts between multinational affiliates and local input suppliers. She finds instead no clear evidence in favour of neither intra-industry spillovers, nor forward linkages.

In order to investigate the possible long-run dynamics of regional disparities in the case of Romanian regions, we explore along similar lines the link between the presence of MNEs and the productivity performance of domestic firms across the regional clusters. In particular, following the approach of Smarzynska Javorcik (2004), the baseline specification of our econometric model is:

$$\Delta \ln(TFP)_{ijrt} = \alpha_0 + \alpha_1 HP_{jr(t-1)} + \alpha_2 BP_{jr(t-1)} + \alpha_3 FP_{jr(t-1)} + \alpha_4 X_{j(t-1)} + \alpha_5 Z_i + \alpha_t + \alpha_r + \alpha_j \tag{7}$$

where i denotes the firm, j the industry and r the region at year t, on the basis of the classification of our dataset. The dependent variable $\Delta \ln(TFP)_{ijrt}$ is the change (in logs) of the total factor productivity undergone by firm i, in sector j and region r, from year $(t-1)$ to year t, calculated according to the Levinsohn and Petrin (2003a) methodology previously discussed, and used for our decomposition of output.

To measure eventual spillovers, we regress the change in the TFP of domestic firms over three foreign penetration indexes. In particular, HP_{jrt} is an index of horizontal penetration, capturing the intra-industry presence of MNEs and calculated as the ratio of multinational employees over total employment in the considered industry j, region r and year t. The index BP_{jrt} measures the foreign presence in industries from which industry j's domestic firms are sourcing their inputs, thus accounting for forward linkages from MNEs to domestic firms. It is computed as the weighted sum of the horizontal penetration figures of all the suppliers' industries, according

[28]In their survey Gorg and Greenaway (2004) discuss the inconclusive evidence emerging from several empirical contributions analyzing various channels of MNEs' spillovers.

to the formula $BP_{jrt} = \sum_{k\ (ifk \neq j)} \alpha_{jk}\ HP_{krt}$, where α_{jk} is the proportion of industry j's total inputs sourced from industry k, an information retrieved from the 1998 Romanian Input-Output Matrix. Analogously, the index FP_{jrt} measures the presence of multinationals' affiliates in industries which are sourcing inputs from sector j, thus accounting for backward linkages from MNEs to domestic firms. Specularly to the BP index, it is defined as $FP_{jrt} = \sum_{m\ (ifm \neq j)} \beta_{jm}$ HP_{mrt}, where β_{jm} is the proportion of output sold from industry j to m, out of industry j's total sales[29].

The covariates $X_{j(t-1)}$ control for the market structure that might affect the domestic firms' productivity: in particular, we have included in the specification for each industry j the Herfindahl Index, calculated using the market shares of all the sample's firms, and the minimum efficient scale, proxied by the median firms' employment. Both covariates enter in the regression with their lagged values. Firm-specific heterogeneity in the dependent variable is also captured by two different proxies Z_i. In one specification we introduce the variable measuring the year of entry of each firm, which allows us to test for eventual structural differences in the productivity performance of different cohorts of entrants; in the other specification we control for the initial level of TFP of the domestic firms in the year of entry, thus testing whether initially less productive firms tend to experience higher productivity growth rates.

The specification reported in Equation (7) allows us to control for endogeneity and the unobserved firm, time, region and industry-specific characteristics that might affect the correlation between firm productivity and foreign presence. We deal with these problems by lagging one period the penetration indexes, by first differencing the dependent variable and by including the time, region and industry fixed effects α_t, α_r, and α_j[30]. Another typical econometric concern of this kind of estimates, i.e. the simultaneity bias in the measure of firm-level productivity, is addressed using the already discussed Levinsohn and Petrin (2003a) methodology in order to calculate firm-level productivity estimates. Finally, since we perform a regression on micro units using mainly aggregate variables as covariates (at the regional and industry level) we control for the potential downward bias in the estimated errors by clustering the standard errors for all firm-level observations belonging to the same region-industry pair.

The first two columns of Table 9 simply prove the better productivity performance of MNEs with respect to domestic firms, regressing the (log) change in productivity for all firms (domestic

[29]Clearly, in the calculation of both the BP and FP indexes we have always excluded from the computation the inputs supplied and sourced within the same industry in order to avoid a double counting of the foreign presence, since any potential intra-industry effect is already taken into account by the HP index.

[30]Contrary to standard practice, we have opted to lag, not to time-difference, the covariates related to the MNEs' presence. In fact, first differencing the covariates imposes the assumption that changes in productivity of domestic firms are driven only by changes in the presence of MNEs, which is not necessarily true, since domestic firms might be affected differently by the same stock of MNEs over time, e.g. due to a learning process or threshold effects.

and MNEs) on a dummy *foreign* which takes value 1 if the considered firm is a multinational. Not surprisingly, the dummy is always positive and significant, even when controlling for fixed effects and the other covariates. The spillover regression is presented, for all regions pooled, in the third to fifth column of Table 9. As it can be seen, we can exclude at the national level a negative effect accruing to domestic firms from the presence of MNEs. Actually, if anything, we find hints of positive horizontal spillovers, robust to the inclusion of covariates controlling for the underlying market structure and domestic firms' heterogeneity.

In Table 10 we present the results of the spillover regression differentiated for the two clusters of regions previously discussed (Table 10a) and across regions (from the Top 3 to the other regions, Table 10b). As it can be seen, in the top three regions we detect positive horizontal spillovers as well as a positive effect on productivity changes from MNEs sourcing their products from domestic firms (backward linkages). The latter result is consistent with the findings of Smarzynska Javorcik (2004) in the case of Lithuania, another transition country. None of these effects is instead present in the under-performing regions (Table 10a). Moreover, we find that the presence of MNEs in the top three regions tends to be negatively associated with the productivity performance of domestic firms in the lagging behind regions (Table 10b)[31].

Putting things together, a third general conclusion can be inferred from our analysis: the effects of MNEs on domestic firms are heterogeneous across regions, with positive spillovers detected within the top three Romanian regions, no spillovers within the lagging-behind regions, and evidence of negative spillovers from the MNEs located in the best performing regions towards the other regions. As a result, due to the unbalanced effects induced by the presence of foreign investment, regional disparities might tend to persist in the long run.

5 Conclusions

In this paper we have exploited a methodology, robust to different techniques of TFP estimation, which allows to decompose and reaggregate output across industries and classes of firms (domestic vs. MNEs), and thus makes it possible to track the micro sources of growth and regional disparities controlling at the same time for the heterogeneity in firms' characteristics[32].

In the case of Romania, a transition economy characterized by increasing regional divergences, the results show that, by and large, most of the u-shaped, negative variations in national

[31] These findings are robust to different specifications of the productivity variable, i.e. measured through the modified Levinsohn and Petrin (2003a) semi-parametric estimates augmented with regional fixed-effects or through standard OLS techniques.

[32] Clearly, the same framework, starting from firm-level observations, can be applied to cross-industries or cross-countries comparisons according to the different research and policy objectives, provided that suitable micro-data can be exploited.

output are related to the restructuring process of firms, with productivity changes playing a minor role, especially in the first years of transition. Heterogeneity in ownership matters, since a significant role in the output dynamics is played by MNEs, which are outperforming their local counterparts in terms of productivity, restructuring and net entry dynamics. These findings are consistent with various strands of literature on transition countries, an indication that the methodological framework allows us to microfound the sources of growth analyzed in the macro literature (technological diffusion and industrial restructuring) without distortions.

In particular the methodology allows us to precisely identify the micro sources of regional disparities. On one side, the analysis recovers evidence of a compositional effect, according to which an unbalanced entry of MNEs in a group of regions, associated with the better performance of these firms with respect to domestic ones, tend to magnify disparities. On the other side, we find what we can call a 'second-order' compositional effect generated by MNEs: more than domestic firms, multinationals display a great deal of heterogeneity in their restructuring processes, possibly correlated with some types of distortions in regional market structures. Such a behavior leads to different output dynamics across regions, and thus to a further source of divergence. Finally, we also find that the spillover effects of MNEs onto domestic firms are unbalanced across regions, with positive spillovers detected only in the best performing areas and some evidence of crowding out of domestic firms in the lagging-behind regions.

We have thus recovered evidence that MNEs have not only magnified different initial conditions in the considered regions, but, with their heterogeneous behavior over time both in terms of restructuring rates and spillovers to domestic firms, they are also endogenously driving regional disparities. The latter might therefore persist in the long run unless appropriate policy actions are undertaken.

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Annex 1: Levinsohn and Petrin (2003a) productivity estimates

Let y_t denote (the log of) a firm's output in a Cobb-Douglas production function of the form

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \omega_t + \eta_t \tag{A1.1}$$

where l_t and m_t denote the (freely available) labour and intermediate inputs in logs, respectively, and k_t is the logarithm of the state variable capital. The error term has two components: η_t, which is uncorrelated with input choices, and ω_t, a productivity shock unobserved by the econometrician, but observed by the firm. Since the firm adapts its input choice as soon as it observes ω_t, inputs turn out to be correlated with the error term of the regression, and thus OLS estimates of production functions yield inconsistent results.

To correct for this problem, Levinsohn and Petrin (2003a), from now on LP, assume the demand for intermediate inputs m_t (e.g. material costs) to depend on the firm's capital k_t and productivity ω_t, and show that the same demand is monotonically increasing in ω_t. Thus, it is possible for them to write ω_t as $\omega_t = \omega_t(k_t, m_t)$, expressing the unobserved productivity shock ω_t as a function of two observables, k_t and m_t.

To allow for identification of ω_t, LP follow Olley and Pakes (1996) and assume ω_t to follow a Markov process of the form $\omega_t = E[\omega_t|\omega_{t-1}] + \xi_t$, where ξ_t is a change in productivity uncorrelated with k_t. Through these assumptions it is then possible to rewrite Equation (A1.1) as

$$y_t = \beta_l l_t + \phi_t(k_{t,} m_t) + \eta_t \tag{A1.3}$$

where $\phi_t(k_{t,} m_t) = \beta_0 + \beta_k k_t + \beta_m m_t + \omega_t(k_t, m_t)$. By substituting a third-order polynomial approximation in k_t and m_t in place of $\phi_t(k_{t,} m_t)$, LP show that it is possible to consistently estimate the parameter $\widehat{\beta}_l$ and $\widehat{\phi}_t$ in Equation A1.3. For any candidate value β_k^* and β_m^* one can then compute a prediction for ω_t for all periods t, since $\widehat{\omega_t} = \widehat{\phi}_t - \beta_k^* k_t - \beta_m^* m_t$ and hence, using these predicted values, estimate $E[\omega_t \widehat{|\omega_{t-1}}]$. It then follows that the residual generated by β_k^* and β_m^* with respect to y_t can be written as

$$\widehat{\eta_t + \xi_t} = y_t - \widehat{\beta}_l l_t - \beta_k^* k_t - \beta_m^* m_t - E[\omega_t \widehat{|\omega_{t-1}}] \tag{A1.4}$$

Equation (A1.4) can then be used to identify β_k^* and β_m^* using the following two instruments: if the capital stock k_t is determined by the previous period's investment decisions, it then does not respond to shocks to productivity at time t, and hence $E[\eta_t + \xi_t|k_t] = 0$; also, if the last period's level of intermediate inputs m_t is uncorrelated with the error period at time t (which is plausible, e.g. proxying intermediate inputs with material costs), then $E[\eta_t + \xi_t|m_{t-1}] = 0$.

Through these two moment conditions, it is then possible to write a consistent and unbiased estimator for β_k^* and β_m^* simply by solving

$$\min_{(\beta_k^*, \beta_m^*)} \sum_h [\sum_t (\widehat{\eta_t + \xi_t}) Z_{ht}]^2 \tag{A1.5}$$

with $Z_t \equiv (k_t, m_{t-1})$ and h indexing the elements of Z_t.

Annex 2. The validation of the dataset

The dataset, retrieved from the census of Romanian firms through AMADEUS, includes those firms in the manufacturing and construction industries for which at least one observation of revenues is available over 1996-2001 and where information is provided in terms of ownership. This yields a coverage of 95 per cent of all official active firms operating in Romania in manufacturing and construction, with the exception of 2001, where this percentage drops to 85 per cent (see Table below). The coverage is however lower if one considers only those firms for which information is available for all the variables of interest in the calculus of TFP, due to missing observations. In particular, after cleaning for some outliers in the same variables, the coverage with respect to the census of Romanian firms is the following:

Year	Sample Coverage	TFP Sample Coverage
1996	0.97	0.42
1997	0.96	0.46
1998	0.96	0.48
1999	0.96	0.49
2000	0.94	0.50
2001	0.85	0.47

A crucial point for our analysis is the ability of the restricted sample to reproduce without biases the evolution of regional disparities in Romania. There are two sources of potential distortions: first of all, we have restricted the analysis to the manufacturing and construction industries only, while official regional disparities reported in Table 1 are measured using regional per capita GDP figures including all industries; second, the missing observations in our sample might be not randomly distributed, but rather concentrated in some regions. To assess these concerns, we present in what follows a Table A reporting the official figures of regional gross value-added in manufacturing and construction only (provided in nominal euros by the Romanian statistical office).

Regional GVA in manufacturing and construction

A. Official data, in percentage of national average

	1996	1996	1997	1998	1999	2001
RO-01	0.76	0.78	0.78	0.72	0.73	0.71
RO-02	1.02	0.99	1.00	1.07	0.89	0.96
RO-03	0.98	0.97	0.92	0.92	0.89	1.00
RO-04	0.81	0.79	0.83	0.79	0.78	0.78
RO-05	1.01	1.00	0.99	0.91	1.31	1.03
RO-06	0.86	0.88	0.89	0.92	0.89	0.85
RO-07	1.21	1.24	1.25	1.23	1.19	1.19
RO-08	1.52	1.52	1.54	1.63	1.66	1.70

B. Restricted sample, in percentage of nat. average

	1996	1996	1997	1998	1999	2001
RO-01	0.88	0.80	0.74	0.71	0.70	0.65
RO-02	0.81	0.91	0.83	0.78	0.81	0.72
RO-03	1.03	0.89	0.86	0.82	0.79	0.78
RO-04	0.51	0.55	0.48	0.48	0.44	0.39
RO-05	0.67	0.70	0.77	0.84	0.90	1.08
RO-06	0.90	0.97	1.04	1.02	1.02	1.07
RO-07	0.80	0.82	0.81	0.82	0.85	0.94
RO-08	2.54	2.60	2.78	2.92	2.90	2.84

The correlation between Table A and the official regional GDP figures for all industries reported in Table 1 in the paper is 0.89, i.e. the dynamics of regional disparities emerging in Romania when considering only the manufacturing and construction industries are highly correlated with the one emerging when considering the entire set of economic activities. Analogously, we report a Table B, where regional gross value-added in manufacturing and construction is measured as the sum of the value added of all the individual firms operating in each region, this time retrieved from our restricted sample. Again, the correlation between this Table B and the official regional GDP figures for all industries reported in Table 1 in the paper is 0.87, i.e. we have evidence that our restricted sample can produce an unbiased micro-foundation of Romanian regional disparities.

Given the nature of our data, another concern is related to our measurement of exit rates, since we have considered as exiting those firms which do not report any information after a given year. Clearly, by using the latter criterion, it could be the case that a firm has exited from the dataset, but not from the market. However, our exit rates so calculated are in line with the ones reported from official statistics for Romania (data available from the Romanian Chamber of Commerce), as shown in the following Table.

Year	Official exit rate	Sample exit rate
1997	7%	4%
1998	7%	5%
1999	6%	6%
2000	9%	7%
2001	10%	10%

It remains to be discussed how properly the data are able to tackle the issue of firms' ownership. To this extent, we have included in the sample only those firms for which detailed information on the ownership structure is available: in particular, we have considered a firm as foreign if more than 10 per cent of its capital belongs to a MNE and domestic otherwise. Ownership information is available for most firms of the census, but this information refers only to the year 2000/2001. Since we rely on this information in order to attribute ownership, we have to assess the probability of a change in ownership in the previous years to avoid a biased attribution. To this extent we have compared different yearly releases of AMADEUS. Due to the limited coverage of earlier versions of the dataset we have been able to identify a smaller sample of firms (802 firms, of which 711 domestic and 91 multinationals) for which it is possible to track the entire ownership history for the period 1997-2000. In particular, 17 of the 711 domestic firms we tracked became multinationals by the year 2000, while only 3 MNEs on 91 switched back to a domestic status. Hence, considering a MNE in year 2000, there is a 15 per cent chance that the same firm is a domestic one before that year, while the probability of the opposite event (a firm switching from MNE to domestic) is negligible. Such a type II error has thus to be considered when attributing the multinational status to our firms on the basis of the information available. However, since MNE affiliates are less than 15 per cent of the total number of firms, the overall bias in our sample is likely to be statistically not significant.

Table 1. Regional disparities in Romania, 1995-2001
(regional per capita GDP, as a percentage of the national average)

	1995	1996	1997	1998	1999	2000	2001
RO01 Nord-Est	0.78	0.79	0.76	0.90	0.97	0.67	0.69
RO02 Sud-Est	0.96	0.99	0.99	0.90	0.86	0.85	0.82
RO03 Sud	0.93	0.90	0.88	0.81	0.78	0.79	0.76
RO04 Sud-Vest	0.94	0.88	0.92	0.87	0.85	0.81	0.81
RO05 Vest	1.06	1.04	1.10	1.08	1.07	0.99	1.02
RO06 Nord-Vest	0.92	0.91	0.90	0.88	0.87	0.89	0.89
RO07 Centru	1.05	1.10	1.09	1.02	0.99	1.02	1.00
RO08 Bucuresti	1.34	1.38	1.37	1.54	1.61	1.98	2.02
Top 3 Regions (RO05-07-08)	1.15	1.17	1.19	1.21	1.22	1.33	1.35
Other Regions (RO01-02-03-04-06)	0.91	0.89	0.89	0.87	0.87	0.80	0.79
σ-convergence	*0.16*	*0.18*	*0.19*	*0.23*	*0.26*	*0.41*	*0.43*

Source: authors' elaboration on Eurostat data (REGIO dataset).
σ-convergence is measured as the standard deviation of the regional indexes

Table 2. The census of Romanian firms in Manufacturing and Construction (1996-2001, number of firms and rates)

Year	Sample Stock (AMADEUS)	Official Stock	Sample Coverage
1996	39799	41228	0.97
1997	43593	45432	0.96
1998	47491	49324	0.96
1999	50257	52295	0.96
2000	50246	53568	0.94
2001	48718	57086	0.85

of which:

	Domestic firms			Multinational firms					
Year	**Entry**	**Exit**	**Active Firms**	**Entry**	**Exit**	**Active Firms**	**MNEs Penetration**	**Entry Rate**	**Exit Rate**
1996			36634			3165	0.08		
1997	4771	1576	39829	728	129	3764	0.09	0.14	0.04
1998	5006	1827	43008	880	161	4483	0.09	0.14	0.05
1999	4606	2685	44929	1048	203	5328	0.11	0.12	0.06
2000	2514	3422	44021	1212	315	6225	0.12	0.07	0.07
2001	2228	4268	41981	1234	722	6737	0.14	0.07	0.10

Percentage of industry distribution over total sample:

	1996			2001		
NACE2	**All Firms**	**Dom**	**MNEs**	**All Firms**	**Dom**	**MNEs**
15	25.5%	25.4%	27.7%	22.5%	22.9%	19.8%
17	4.4%	4.4%	4.4%	3.9%	3.8%	5.1%
18	8.0%	8.2%	6.5%	7.7%	7.5%	9.4%
19	2.3%	2.2%	3.8%	2.6%	2.1%	5.6%
20	7.9%	7.9%	7.6%	8.4%	8.1%	10.4%
21	1.0%	0.9%	1.9%	1.0%	0.9%	1.7%
22	5.2%	5.1%	6.5%	5.4%	5.5%	4.7%
24	2.0%	1.9%	3.5%	2.1%	1.9%	3.1%
25	3.1%	2.9%	4.4%	3.0%	2.7%	4.5%
26	2.6%	2.6%	2.8%	2.7%	2.7%	3.1%
27	0.7%	0.7%	1.2%	0.8%	0.7%	1.2%
28	5.7%	5.9%	4.5%	6.0%	6.1%	5.3%
29	1.5%	1.4%	3.0%	1.7%	1.5%	3.1%
30	0.8%	0.7%	2.1%	0.9%	0.8%	1.2%
31	1.1%	1.1%	1.7%	1.2%	1.0%	1.8%
32	0.3%	0.3%	0.9%	0.3%	0.3%	0.7%
33	1.0%	1.0%	1.3%	1.0%	1.1%	0.9%
34	0.5%	0.5%	0.9%	0.6%	0.5%	0.9%
35	0.4%	0.4%	0.5%	0.5%	0.4%	0.7%
36	5.1%	5.1%	5.2%	5.3%	5.2%	5.8%
45	20.7%	21.7%	9.7%	22.3%	24.1%	11.0%
Total firms	**39799**	**36634**	**3165**	**48718**	**41981**	**6737**

Source: author's elaboration from Amadeus data

Table 3. A comparison of productivity estimates for some selected industries

Domestic	**NACE**	**(15)**	**(19)**	**(20)**	**(22)**	**(24)**	**(26)**	**(36)**
Lev Pet (2003)	ln (labor)	0.027***	0.273***	0.085***	0.179***	0.071***	0.123***	0.117***
	ln (materials)	0.982***	0.968***	0.723***	0.362*	0.742***	0.674***	0.640***
	ln (capital)	0.074**	0.088***	0.189***	0.340***	0.147***	0.177***	0.208***
OLS	ln (labor)	0.133***	0.427***	0.301***	0.542***	0.267***	0.355***	0.355***
	ln (materials)	0.927***	0.716***	0.867***	0.761***	0.953***	0.820***	0.805***
	ln (capital)	0.033***	0.063***	0.026***	0.006	-0.050***	-0.006	0.003
	OLS bias in labor coeff.	+	+	+	+	+	+	+
	OLS bias in capital coeff.	-	-	-	not sign.	-	not sign.	not sign.
	N. of obs.	38301	3347	13000	8948	3449	4419	8184

MNEs	**NACE**	**(15)**	**(19)**	**(20)**	**(22)**	**(24)**	**(26)**	**(36)**
Lev Pet (2003)	ln (labor)	0.045***	0.329***	0.079***	0.312***	0.056***	0.201***	0.183***
	ln (materials)	0.939***	0.649***	0.870***	0.893**	0.926***	0.907***	0.864***
	ln (capital)	0.081**	0.143***	0.044	0.069**	0.109***	0.091**	0.075***
OLS	ln (labor)	0.123***	0.508***	0.253***	0.613***	0.238***	0.372***	0.354***
	ln (materials)	0.928***	0.588***	0.870***	0.682***	0.933***	0.804***	0.794***
	ln (capital)	0.045***	0.113***	0.017***	0.005	-0.015	-0.025**	0.017*
	OLS bias in labor coeff.	+	+	+	+	+	+	+
	OLS bias in capital coeff.	-	-	not sign.	not sign.	not sign.	-	-
	N. of obs.	6273	1535	2568	1529	1030	862	1632

Table 4. The decomposition of output - yearly changes in '000 of real €, all regions.

a) Using Levinsohn-Petrin (2003a) TFP estimates

All regions	ΔY_t	Productivity (z_{t-1} * ΔTFP_t)			Restructuring (TFP_{t-1} * Δz_t)			Covariance (ΔTFP_t * Δz_t)			Net Entry		
	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms
1997	-2 150 499	-63 494	63 358	-136	-1 129 921	-1 047 625	-2 177 546	10 819	-66 933	-56 114	34 796	48 500	83 296
1998	-353 142	-13 660	6 442	-7 218	-194 574	-204 466	-399 040	-15 119	-23 126	-38 245	36 531	54 829	91 360
1999	-397 785	-30 299	18 182	-12 117	-201 897	-218 413	-420 310	-7 764	-24 250	-32 013	19 827	46 828	66 655
2000	-226 356	-34 508	-3 838	-38 345	-110 937	-96 657	-207 594	-1 271	-15 117	-16 388	13 291	22 680	35 970
2001	-73 052	-7 722	-104	-7 826	-35 242	-5 120	-40 362	-10 899	-16 126	-27 025	2 531	-371	2 160

b) Using Levinsohn-Petrin (2003a) TFP estimates corrected with regional fixed effects

All regions	ΔY_t	Productivity (z_{t-1} * ΔTFP_t)			Restructuring (TFP_{t-1} * Δz_t)			Covariance (ΔTFP_t * Δz_t)			Net Entry		
	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms
1997	-2 150 499	-60 484	67 159	6 675	-1 131 162	-1 049 218	-2 180 380	9 051	-69 141	-60 090	34 796	48 500	83 296
1998	-353 142	-11 682	7 129	-4 553	-195 402	-205 026	-400 428	-16 269	-23 252	-39 521	36 531	54 829	91 360
1999	-397 785	-30 150	18 410	-11 740	-202 011	-218 611	-420 622	-7 798	-24 280	-32 078	19 827	46 828	66 655
2000	-226 356	-33 383	-4 049	-37 432	-111 598	-96 447	-208 044	-1 735	-15 116	-16 851	13 291	22 680	35 970
2001	-73 052	-7 147	-422	-7 568	-35 327	-4 869	-40 196	-11 389	-16 059	-27 448	2 531	-371	2 160

c) Using standard OLS estimates

All regions	ΔY_t	Productivity (z_{t-1} * ΔTFP_t)			Restructuring (TFP_{t-1} * Δz_t)			Covariance (ΔTFP_t * Δz_t)			Net Entry		
	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms
1997	-2 150 499	-355 996	-267 950	-623 946	-950 867	-881 124	-1 831 991	124 268	97 874	222 141	34 796	48 500	83 296
1998	-353 142	-41 129	-34 155	-75 285	-157 374	-171 579	-328 952	-24 850	-15 415	-40 265	36 531	54 829	91 360
1999	-397 785	-54 704	-21 450	-76 154	-170 966	-189 709	-360 675	-14 289	-13 322	-27 611	19 827	46 828	66 655
2000	-226 356	-59 297	-26 986	-86 284	-79 013	-78 381	-157 394	-8 405	-10 244	-18 649	13 291	22 680	35 970
2001	-73 052	-10 538	-33	-10 571	-23 833	1 740	-22 094	-19 491	-23 057	-42 548	2 531	-371	2 160

Table 5. The decomposition of output - yearly changes in percentage terms and firms' heterogeneity analysis, all regions.

All regions	ΔY_t	Productivity (z_{t-1} * ΔTFP_t)			Restructuring (TFP_{t-1} * Δz_t)			Covariance (ΔTFP_t * Δz_t)			Net Entry		
	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms
1997	-2 150 499	-0.03	0.03	0.00	-0.53	-0.49	-1.01	0.01	-0.03	-0.03	0.02	0.02	0.04
1998	-353 142	-0.04	0.02	-0.02	-0.55	-0.58	-1.13	-0.04	-0.07	-0.11	0.10	0.16	0.26
1999	-397 785	-0.08	0.05	-0.03	-0.51	-0.55	-1.06	-0.02	-0.06	-0.08	0.05	0.12	0.17
2000	-226 356	-0.15	-0.02	-0.17	-0.49	-0.43	-0.92	-0.01	-0.07	-0.07	0.06	0.10	0.16
2001	-73 052	-0.11	0.00	-0.11	-0.48	-0.07	-0.55	-0.15	-0.22	-0.37	0.03	-0.01	0.03

Unbalanced sample:

	DOM - Productivity		DOM - Restructuring		MNEs - Productivity		MNEs - Restructuring	
	avg. z_{t-1}	avg. ΔTFP_t	avg. TFP_{t-1}	avg. $\Delta z_t/z_{t-1}$	avg. z_{t-1}	avg. ΔTFP_t	avg. TFP_{t-1}	avg. $\Delta z_t/z_{t-1}$
I	2.13	-0.23	0.80	-0.16	2.27	-0.18	0.79	-0.08
II	7.17	-0.22	1.42	-0.12	7.31	-0.08	1.40	-0.04
III	22.47	-0.17	2.80	-0.10	24.68	-0.09	2.68	0.11
IV	70.13	-0.13	4.75	-0.03	71.08	-0.05	4.81	0.27
V	208.50	-0.08	6.80	0.10	222.47	-0.05	6.89	0.40
VI	2 390.36	-0.01	8.80	0.21	6 103.85	0.00	8.79	0.78

Balanced sample:

	DOM - Productivity		DOM - Restructuring		MNEs - Productivity		MNEs - Restructuring	
	avg. z_{t-1}	avg. ΔTFP_t	avg. TFP_{t-1}	avg. $\Delta z_t/z_{t-1}$	avg. z_{t-1}	avg. ΔTFP_t	avg. TFP_{t-1}	avg. $\Delta z_t/z_{t-1}$
I	2.62	-0.24	0.79	-0.20	2.63	-0.24	0.77	-0.26
II	7.24	-0.24	1.42	-0.14	7.40	-0.18	1.38	-0.12
III	23.16	-0.18	2.80	-0.12	25.45	-0.11	2.71	-0.02
IV	70.01	-0.13	4.72	-0.07	70.63	-0.06	4.72	0.13
V	211.77	-0.08	6.71	0.04	229.88	-0.06	6.84	0.32
VI	2 424.68	-0.01	8.89	0.01	8 007.72	0.01	8.91	0.72

Note: I = $z_{t-1} < 5$ or $TFP_{t-1} < 1$; II = $5 < z_{t-1} < 10$ or $1 < TFP_{t-1} < 2$; III = $10 < z_{t-1} < 50$ or $2 < TFP_{t-1} < 4$;

IV = $50 < z_{t-1} < 100$ or $4 < TFP_{t-1} < 6$; V = $100 < z_{t-1} < 500$ or $6 < TFP_{t-1} < 8$; VI = $z_{t-1} > 500$ or $TFP_{t-1} > 8$;

Table 6. The decomposition of output - yearly changes in percentage terms, regional clusters.

Top 3 Regions	ΔY_t	Productivity (z_{t-1} * ΔTFP_t)			Restructuring (TFP_{t-1} * Δz_t)			Covariance (ΔTFP_t * Δz_t)			Net Entry		
	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms
1997	-829 528	-0.05	0.01	-0.04	-0.52	-0.48	-1.01	0.01	-0.02	-0.01	0.03	0.03	0.05
1998	-114 998	-0.02	0.02	0.01	-0.64	-0.65	-1.28	-0.08	-0.10	-0.18	0.16	0.31	0.46
1999	-120 875	-0.11	-0.04	-0.16	-0.53	-0.59	-1.12	-0.03	-0.05	-0.08	0.09	0.28	0.37
2000	-102 686	-0.17	-0.02	-0.19	-0.44	-0.48	-0.92	0.00	-0.08	-0.08	0.05	0.13	0.18
2001	-21 980	-0.14	0.17	0.03	-0.60	0.04	-0.56	-0.18	-0.42	-0.60	0.17	-0.05	0.12

Other Regions	ΔY_t	Productivity (z_{t-1} * ΔTFP_t)			Restructuring (TFP_{t-1} * Δz_t)			Covariance (ΔTFP_t * Δz_t)			Net Entry		
	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms	Dom	MNEs	All Firms
1997	-1 320 971	-0.02	0.04	0.02	-0.53	-0.49	-1.02	0.00	-0.04	-0.04	0.01	0.02	0.03
1998	-238 144	-0.05	0.02	-0.03	-0.51	-0.55	-1.06	-0.02	-0.05	-0.07	0.08	0.08	0.16
1999	-276 909	-0.06	0.09	0.03	-0.50	-0.53	-1.03	-0.01	-0.06	-0.08	0.03	0.05	0.08
2000	-123 670	-0.14	-0.02	-0.16	-0.53	-0.38	-0.92	-0.01	-0.06	-0.07	0.06	0.08	0.14
2001	-51 072	-0.09	-0.07	-0.17	-0.43	-0.12	-0.55	-0.14	-0.14	-0.27	-0.03	0.01	-0.01

Table 7a. Regional disparities and the compositional effect of MNEs.

Top 3	ΔY_t	ΔY_t	of which:		
	All Firms	**All MNEs**	**Incumbent MNEs**	**New MNEs**	**Compositional effect**
1997	-829 528	-388 145	-410 924	22 779	3%
1998	-114 998	-48 316	-84 035	35 718	31%
1999	-120 875	-49 668	-79 428	29 761	25%
2000	-102 686	-46 221	-52 408	6 187	6%
2001	-21 980	-5 706	-13 485	7 779	35%

Others	ΔY_t	ΔY_t	of which:		
	All Firms	**MNEs**	**Incumbent MNEs**	**New MNEs**	**Compositional effect**
1997	-1 320 971	-614 555	-640 276	25 721	2%
1998	-238 144	-118 004	-134 551	16 547	7%
1999	-276 909	-127 985	-134 509	6 525	2%
2000	-123 670	-46 711	-59 832	13 121	11%
2001	-51 072	-16 015	-16 488	473	1%

Note: ΔY_t for all firms and all MNEs are retrieved from the data shown in Table 6. The compositional effect is calculated as the absolute share of output variation of new MNEs on the total output variation ΔY_t.

Table 7b. Regional disparities and restructuring rates.

	Restructuring rates, unbalanced sample					
	All Firms		**Domestic**		**MNEs**	
	Top 3	**Others**	**Top 3**	**Others**	**Top 3**	**Others**
1997	-48%	-52%	-50%	-48%	-46%	-56%
1998	-18%	-21%	-18%	-18%	-18%	-24%
1999	-19%	-29%	-19%	-25%	-19%	-35%
2000	-17%	-17%	-17%	-17%	-16%	-17%
2001	-3%	-5%	-7%	-7%	0%	-3%

	Restructuring rates, balanced sample					
	All Firms		**Domestic**		**MNEs**	
	Top 3	**Others**	**Top 3**	**Others**	**Top 3**	**Others**
1997	-53%	-55%	-53%	-53%	-54%	-58%
1998	-21%	-26%	-20%	-23%	-22%	-29%
1999	-27%	-34%	-25%	-29%	-29%	-39%
2000	-21%	-22%	-21%	-20%	-22%	-23%
2001	-12%	-10%	-13%	-12%	-11%	-9%

Note: restructuring rates are calculated as the average restructuring component (as retrieved from Table 6) per unit of output in the previous year, i.e. $(TFP_{t-1} * \Delta z_t)/Y_{t-1}$.

Table 8a. Restructuring rates in largest MNEs (z_{t-1} > 500) – Top 3 vs. other regions

(by year, all industries)

	Avg. MNEs turnover ('000 real €)		*Restructuring rates*	
	Top 3	**Others**	**Top 3**	**Others**
1996	3330.9	5882.5	-	-
1997	2084.2	3965.2	-44%	-55%
1998	1762.7	3413.5	-18%	-25%
1999	1347.9	2290.5	-19%	-38%
2000	1304.7	1979.6	-16%	-17%
2001	1414.8	1741.7	5%	-3%

Note: restructuring rates are calculated as the average restructuring component (as retrieved from Table 6) per unit of output in the previous year, i.e. $(TFP_{t-1} * \Delta z_t)/Y_{t-1}$.

Table 8b. Restructuring rates in largest MNEs (z_{t-1} > 500) – Top 3 vs. other regions

(by NACE2 industries, all years)

	Avg. MNEs turnover ('000 real €)		*Industry share over total regional output*		*Restructuring. rate within industry*	
Nace2	**Top 3**	**Others**	**Top 3**	**Others**	**Top 3**	**Others**
15	2011.4	2568.0	32.9%	23.5%	-15%	-16%
17	723.5	1715.5	1.4%	4.8%	-27%	-19%
18	2233.4	959.3	3.2%	1.5%	-19%	-18%
19	1094.8	586.2	1.9%	0.2%	-11%	16%
20	1596.9	1601.0	1.6%	1.2%	0%	-22%
21	1279.5	3109.6	1.9%	2.4%	-17%	-25%
22	892.9	981.8	2.5%	0.4%	-11%	-12%
24	2345.1	4256.7	12.1%	7.7%	-26%	-34%
25	1210.7	2579.8	2.0%	2.6%	-17%	-35%
26	5580.7	2875.8	11.8%	4.5%	-39%	-36%
27	3268.4	6269.0	5.4%	12.9%	-38%	-36%
28	950.0	1386.8	1.4%	0.6%	-7%	-36%
29	2094.9	4731.0	4.1%	9.1%	-14%	-32%
30	2360.3	-	4.1%	-	8%	-
31	1851.4	2286.0	3.8%	2.6%	-10%	-24%
32	1436.8	1166.5	1.8%	0.1%	-20%	-43%
33	286.0	945.8	0.2%	0.1%	-37%	-33%
34	1716.3	11600.2	1.7%	16.5%	-19%	-36%
35	-	4027.2	-	8.4%	-	-23%
36	1787.3	1365.2	1.5%	0.4%	-26%	-39%
45	977.1	939.4	4.7%	0.2%	-1%	-11%

Note: restructuring rates are calculated as the average restructuring component (as retrieved from Table 6) per unit of output in the previous year, i.e. $(TFP_{t-1} * \Delta z_t)/Y_{t-1}$.

Table 9. Spillover analysis – all regions

Dep var: Δln(TFP)	All firms	All firms	Domestic firms	Domestic firms	Domestic firms
Dummy MNE	.025*** (.007)	.024*** (.007)	-	-	-
HP_{t-1} (Horizontal linkages)	-	-	.013** (.007)	.02*** (.007)	.013* (.007)
BP_{t-1} (Forward linkages)	-	-	-.028 (.019)	.014 (.019)	-.028 (.019)
FP_{t-1} (Backward linkages)	-	-	-.016 (.04)	.012 (.041)	-.02 (.042)
Herfindahl $_{t-1}$	-	-.138 (.137)	-	-.129 (.128)	-.169 (.133)
Median employment $_{t-1}$	-	-.002 (.003)	-	.007*** (.002)	.002 (.003)
Initial TFP level	-	-	-	-.150*** (.004)	-
Year of entry	-	.005*** (.001)	-	-	.002 (.001)
Region dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Industry dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
N. of obs	113159	113159	97799	97799	97799
Wald χ^2 of joint signif.	***	***	***	***	***

Semi-robust standard errors in parentheses, clustered for region-industry pairs
*** or ** significant at the 1 or 5 per cent level

Table 10. Spillover analysis – regional clusters

a) within regions

Dep var: Δln(TFP) *Domestic firms*	Top 3 regions	Top 3 regions	Top 3 regions	Other regions	Other regions	Other regions
HP_{t-1} (Horizontal linkages)	.037*** (.012)	.038*** (.013)	.037*** (.012)	.005 (.009)	.011 (.010)	.003 (.009)
BP_{t-1} (Forward linkages)	-.056 (.046)	.004 (.045)	-.057 (.045)	-.026 (.019)	.004 (.019)	-.028 (.021)
FP_{t-1} (Backward linkages)	.098** (.051)	.132*** (.048)	.099* (.053)	-.058 (.074)	-.023 (.079)	-.069 (.077)
Herfindahl $_{t-1}$	-	-.034 (.176)	-.05 (.167)	-	-.207 (.186)	-.266 (.205)
Median employment $_{t-1}$	-	.004 (.003)	-.001 (.004)	-	.008** (.003)	.004 (.003)
Initial TFP level	-	-.154*** (.007)	-	-	-.148*** (.004)	-
Year of entry	-	-	.002 (.003)	-	-	.001 (.002)
Region dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Industry dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Time dummies	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
N. of obs	38547	38547	38547	59252	59252	59252
Wald χ^2 of joint signif.	***	***	***	***	***	***

b) across regions

Dep var: Δln(TFP) *Domestic firms*	Other regions	Other regions	Other regions
HP_{t-1} (Horizontal linkages) in Top 3 regions	-.045* (.026)	-.045* (.026)	-.049* (.027)
BP_{t-1} (Forward linkages) in Top 3 regions	-.668*** (.127)	-.523*** (.117)	-.651*** (.118)
FP_{t-1} (Backward linkages) in Top 3 regions	-.596*** (.141)	-.599*** (.135)	-.624*** (.142)
Herfindahl $_{t-1}$	-	-.201 (.183)	-.261 (.204)
Median employment $_{t-1}$	-	.009*** (.003)	.004 (.003)
Initial TFP level	-	-.147*** (.004)	-
Year of entry	-	-	.001 (.002)
Region dummies	*Yes*	*Yes*	*Yes*
Industry dummies	*Yes*	*Yes*	*Yes*
Time dummies	*Yes*	*Yes*	*Yes*
N. of obs	59252	59252	59252
Wald χ^2 of joint signif.	***	***	***

Semi-robust standard errors in parentheses, clustered for region-industry pairs
*** or ** significant at the 1 or 5 per cent level