

Oberhofer, Harald; Pfaffermayr, Michael

Working Paper

Firm growth in multinational corporate groups

Working Papers in Economics and Finance, No. 2010-07

Provided in Cooperation with:

Department of Social Sciences and Economics, University of Salzburg

Suggested Citation: Oberhofer, Harald; Pfaffermayr, Michael (2010) : Firm growth in multinational corporate groups, Working Papers in Economics and Finance, No. 2010-07, University of Salzburg, Department of Social Sciences and Economics, Salzburg

This Version is available at:

<https://hdl.handle.net/10419/71855>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



FIRM GROWTH IN MULTINATIONAL CORPORATE GROUPS

HARALD OBERHOFER AND MICHAEL PFAFFERMAYR

WORKING PAPER No. 2010-07

WORKING PAPERS IN
ECONOMICS AND FINANCE

Firm Growth in Multinational Corporate Groups

Harald Oberhofer¹ and Michael Pfaffermayr^{2,3}

February, 2010

Abstract

This paper formulates an econometric firm growth model that explicitly accounts for interdependence of growth performance within multinational corporate networks. We apply a recently introduced IV-estimation procedure for peer group effects to directly test for externalities within multinational corporate networks. Using European firm level data, our results reveal positive externalities within vertically organized multinational networks, while they are negative for horizontally organized ones. In the former case, multinational corporate groups are more stable and adjust faster on average. In the latter case, externalities lead to more heterogeneity in the firm growth processes within the network and slower average size adjustment.

JEL Codes: C21, F23, L23, L25

Keywords: Firm growth, Size Adjustment, Multinational Corporate Groups, Peer Group Effect Estimation.

¹Department of Economics and Social Sciences, University of Salzburg, Kapitelgasse 5-7, 5010 Salzburg, Austria. E-mail address: harald.oberhofer@sbg.ac.at.

²Department of Economics, University of Innsbruck, Universitaetsstrasse 15, 6020 Innsbruck, Austria. E-mail: michael.pfaffermayr@uibk.ac.at.

³Austrian Institute of Economic Research, PO-Box 91, A-1103-Vienna, Austria.

1 Introduction

In recent decades an ever growing number of manufacturing firms has invested abroad and operated plants in several countries. These multinational firms are different from lone standing national firms. They serve geographically separated markets locally rather than exporting to them, they draw on common firm specific assets or they are vertically integrated across borders. The very existence of multinational corporate groups suggests that these firms take advantage of externalities within their multinational network that are not available to lone standing national firms (Markusen 1984, Caves 1996). Naturally, they exhibit an intertwined growth process and the expansion of one affiliate affects the other subsidiaries within the same multinational network.

So far, empirical research on firm growth has almost exclusively tested economic theories under the assumption of independent firms. These include Gibrat's Law (Gibrat 1931), Penrose Effects (Penrose 1959), adjustment costs (Hamermesh and Pfann 1996), learning theories (Jovanovic 1982), financial constraints (Cabral and Mata 2003) and organizational capabilities (Slater 1980). In a world with pronounced prevalence of multinational firms, the firms' organization in multinational corporate networks should not be ignored in empirical firm growth models.

A major finding in the empirical firm growth literature states that young firms are usually smaller than the efficient steady state firm size, but grow

faster than their older counterparts.¹ Therefore, the initially skewed firm size distribution of a given age cohort of firms tends to converge to a more symmetric one. Moreover, the observation of fast growing young (small) and slowly growing old (large) firms rejects Gibrat's Law of proportionate growth. The other firm growth theories mentioned above provide arguments for the inefficient small size of young firms. However, these arguments refer to lone standing firms only.

In this paper we formulate and estimate an empirical firm growth model, which explicitly accounts for (potential) interdependence within multinational corporate enterprises and is in line with the above mentioned economic theories on firm growth. More precisely, based on the theory of multinational enterprises (MNEs), we hypothesize that the growth rate of a single affiliate is related to the average growth rate of the corporate network which the firm belongs to. In this way, we are able to provide a direct test on externalities within multinational corporate networks. Due to an apparent endogeneity problem in the proposed firm growth equation, we implement a recently developed instrumental variable estimation procedure for peer group effects elaborated by Lee (2007) to obtain consistent estimates.

Our estimation results reveal positive externalities within vertically organized multinational networks, but negative ones in horizontally organized MNEs. In comparison to a hypothetical lone standing firm (i.e. absence of

¹Surveys on the firm growth literature for lone standing firms are available in Evans (1987*a*), Sutton (1997), Audretsch, Klomp, Santarelli and Thurik (2004), Bellak (2004) and Cabral (2007).

group externalities) subsidiaries of vertically integrated MNEs exhibit more homogenous growth patterns within the network and adjust faster on average. In contrast, subsidiaries of a horizontal MNE network show heterogeneity within the network and slower average adjustment. Consequently, the speed of adjustment of subsidiaries of horizontally and vertically integrated MNEs systematically differs from the well-known adjustment dynamics of lone standing firms.

The remainder of the paper is organized as follows: Section 2 surveys the existing related literature and describes previous empirical findings. In Section 3 the firm growth model which accounts for interdependence within corporate groups is introduced and the econometric framework is explained. Section 4 describes the used data, while Section 5 discusses our findings. Finally, Section 6 provides our conclusions.

2 Related Literature and Previous Findings

The standard learning model as proposed by Jovanovic (1982) implies that firms are faced with uncertainty with respect to their productivity level in their after birth period and the efficient firms tend to produce at an inefficient low output level initially. Over time, the firms learn their productivity and adapt their production and firm size to an efficient level. The assumption of uncertainty about productivity seems less plausible for start-ups within corporate groups. Indeed, the theory of multinational firms

(Caves 1996, Markusen 2002) suggests that members draw on common firm specific knowledge and firm specific assets. In case of MNEs there is more precise information on the individual and the corporate group specific productivity levels. Therefore, we expect that affiliates of MNEs adapt more rapidly to their long-run firm size.

Cabral and Mata (2003), among others, argue that financing constraints are especially relevant for (lone standing) young firms. In this case, the firm size distribution is expected to be significantly skewed to the right (i.e. with a large mass of small firms). Some of the young firms are small because their efficient firm size is small. Others are small because they are financially constrained and adjust faster to their efficient size as the financial constraints tend to weaken over time. However, this argument might not hold for affiliates of MNEs for two reasons: Within an MNE credits can more easily be granted among the group members (see Gugler, Kalkbrenner and Peev 2008, for example) and, secondly, large corporate groups usually have built up enough reputation to obtain credits easily, avoiding financial constraints. Therefore, young subsidiaries of the MNE network should be able to finance all their profitable investment projects and should reach their long-run firm size faster.

A similar argument applies to organizational capabilities and Penrose effects. While a lone standing young firm is more likely to face limited organizational capabilities and managerial resources, which might lead to an inefficient small firm size, firms within corporate groups can be expected to face

less restrictions. It seems plausible that the absolute amount of capabilities and managerial resources are higher and more flexible in corporate networks. Therefore, theories concerning organizational capabilities and Penrose effects can be expected to have limited explanatory power for firms which belong to a corporate network.

In a network of horizontal MNEs, production in one plant can be substituted against those in others so that the more efficient plants grow at the expense of the inefficient ones, suggesting negative externalities within horizontal MNEs (see Feinberg and Phillips 2004). On the other hand, ownership advantages or firm specific intangible assets induce positive externalities within horizontally organized MNEs. An increase in productivity of a plant, for example, can spill over to other subsidiaries without inducing additional costs, but are excludable vis-à-vis competitors (Caves 1996, Markusen 1984). This public good characteristic of ownership advantages and its costless transferability leads to multi-plant economies of scale, making multi-plant firms more efficient than two single lone standing firms of equal overall size. On these grounds, subsidiaries of horizontal MNEs are expected to exhibit an intertwined growth process and to adjust to efficient firm size more rapidly (Pennings and Sleuwaegen 2000). Overall, the impact of externalities within horizontal multinational networks on the growth performance of their affiliates is thus ambiguous.

In case of vertically integrated MNEs, plant growth is positively correlated within the corporate group due to forward and backward linkages. In

vertically integrated networks production stages are separated geographically (Helpman and Krugman 1985). Such companies usually produce a common final good, but organize individual production steps in different production facilities and complete the final good in one or more of its plants. Therefore, growth of vertically integrated MNE affiliates depends on the competitiveness in the final good's market and on the demand for that good. The vertical structure of those MNEs implies that each subsidiary of the group will be able to grow if demand for the final good increases.

Only a limited number of studies investigate the effects of corporate group networks (Variyam and Kraybill 1992, Harhoff, Stahl and Woywode 1998) and multinationality (Buckley, Dunning and Pearce 1984, Cantwell and Sanna-Randaccio 1993, Blonigen and Tomlin 2001, Feinberg and Phillips 2004, Belderbos and Zou 2007) on firm growth. Variyam and Kraybill (1992) find support for the fact that firm growth in terms of employment is significantly smaller for independent, single establishment firms compared to firms organized in a corporate group. Harhoff et al. (1998) find, taking selection into account, that growth of subsidiary firms is not different from that of non-subsidiaries in manufacturing and services industries, while they maintain a positive and significant differential for construction and trade industries in a large sample of German firms. Buckley et al. (1984) test for the effects of the nationality of the owners and the degree of multinationality on firm growth. Their findings suggest that the nationality of the owners is able to explain variations in the firm growth rates of the largest firms in

the world and that the degree of multinationality of production is not an additional driving force of firm growth differences if one controls for firm size, industry characteristics and nationality of the owners. The estimation results of Cantwell and Sanna-Randaccio (1993) suggest that domestic firms grow faster than their multinational counterparts for a data set of the largest multinationals and domestic firms in the world. Bloningen and Tomlin (2001) find that in the United States Japanese-owned manufacturing plants are much larger and grow faster than US domestic-owned plants. Feinberg and Phillips (2004) provide evidence for negative growth externalities among affiliates of US based MNEs. Specifically, small multinational networks with high R&D expenditures face significant growth trade-offs among their members, while these are less pronounced in large MNEs. Lastly, Belderbos and Zou (2007) provide evidence that MNEs use the flexibility created by their network to adjust employment more rapidly within their affiliates.

3 The Econometric Specification of the Firm Growth Equation for Corporate Groups

Following Geroski (2000, 2005) and Geroski and Gugler (2004) the typical specification of the firm growth regression can be written as:

$$g_i = \alpha_i + \pi S_{0i} + \mathbf{x}_i \boldsymbol{\gamma} + \epsilon_i, \tag{1}$$

where g_i denotes the average annual growth rate of company i (typically measured in the log differences of firm size) and S_{0i} is the log of the initial size of firm i . Other controls like log age (A_i), log age-squared, market growth, and other industry characteristics are collected in \mathbf{x}_i . Lastly, ϵ_i is the iid error term. Firm growth is faster for young firms due to sunk costs, initial financial constraints that become less restrictive over time and adjustment costs (see e.g. Evans 1987*a*, Cabral 1995, Cabral and Mata 2003) and we expect $\pi < 0$. Persistence in firm size typically differs across age cohorts and in many applications the persistence parameter π is assumed to decline with firm age. This suggests measuring the persistence of firm size by $\pi = (\beta_0 + \beta_1 A_i)$, where $\beta_0 < 0$ and $\beta_1 > 0$ and including an additional interaction term between log initial firm size and log firm age.

Formally, the specification implies that log firm size follows a first-order autoregressive process with some, but not perfect, persistence and it allows deviations from Gibrat's law of proportionate growth – i.e., the absence of a unit root. Geroski (2005) emphasizes that this specification is flexible enough to cover the most important models of firm growth put forward by economic theory such as adjustment costs and learning, sunk costs, Penrose effects, and organizational capabilities. As in almost all applications, this specification refers to lone standing firms which act independently from each other.

For plants or firms that are part of a multinational corporate network the assumption of independence of growth performance does not seem to be plausible. Rather, the growth performance of a single plant is likely to inter-

act with that of the other members of the corporate group. To account for possible dependence among the affiliates of a multinational corporate group, we apply an econometric model recently proposed by Lee (2007) (see also Bramoulle, Djebbari and Fortin 2009). Specifically, we hypothesize that the growth process of affiliate i can be described by a generalized firm growth equation that includes the average growth performance of the corporate group members as additional explanatory variable as well as group fixed effects.² The latter capture systematic differences in long-run efficient sizes of corporate groups vs. their lone standing counterparts, see Manski (1993) and Lee (2007):

$$g_{ir} = \lambda \frac{1}{m_r - 1} \sum_{\substack{j=1 \\ i \neq j}}^{m_r} g_{jr} + \pi S_{0ir} + \mathbf{x}_{ir} \boldsymbol{\gamma} + \mu_r + \epsilon_{ir}, \quad (2)$$

where g_{ir} measures the average annual growth rate of firm i in corporate group r and $\frac{1}{m_r - 1} \sum_{\substack{j=1 \\ i \neq j}}^{m_r} g_{jr}$ captures the endogenous peer group effect. m_r denotes the number of group members and \mathbf{x}_{ir} includes all control variables.

μ_r denote group fixed effects and ϵ_{ir} are the iid disturbances.³

²Ideally, one would apply a more general weighting scheme to capture the dependence among firms in a general spatial autoregressive econometric model. However, under unequal group sizes the panel is unbalanced. Econometric estimators for spatial unbalanced panels with fixed effects are not available in the econometrics tool box so far.

³Formally, such a model can be derived as a solution of a linearized system of differential equations that relates the growth rate of a firm to initial size and additionally includes a spillover term in growth rates so that the growth of a single firm is affected by all other members' growth rates. See Pfaffermayr (2009) for details in a different application.

Equation (2) represents a structural form (dynamic) spatial autoregressive (SAR) Model with global (within group) growth spillovers (see Anselin 2003). The growth performance of every unit i in a given MNE corporate group r is related to that of all other group members and indirectly also the outcome of itself. Moreover, the specification could be considered as dynamic SAR model, since the transmission of the spatial lag effect could have some time lag as well (see Manski 1993).

This econometric specification is designed to capture externalities in both the short term adjustment of firm size and the long-run firm size. Externalities in short term adjustment are captured by the impact of the average growth rates of the other firms in the network, while the long-run expected efficient firm size depends on individual determinants as well as on group specific externalities captured by fixed group effects. Consequently, the average long-run affiliate size differs systematically across MNEs in the presence of fixed group effects. However, identification is based on the within transformed model and, therefore, the fixed group effects cannot be estimated.

Following Lee (2007), one can establish the ‘within’ and ‘between’ equations of the generalized firm growth equation. The latter refers to average growth of the MNE group members, the former allows for heterogeneity within the MNE corporate group. First, we rewrite (2):⁴

$$g_{ir} = \frac{\lambda}{m_r - 1} (m_r \bar{g}_r - g_{ir}) + \pi S_{0ir} + \mathbf{x}_{ir} \boldsymbol{\gamma} + \mu_r + \epsilon_{ir}. \quad (3)$$

⁴This follows because $m_r \bar{g}_r = \sum_{j=1}^{m_r} g_{jr}$ and, therefore, $\sum_{\substack{j=1 \\ i \neq j}}^{m_r} g_{jr} = (m_r \bar{g}_r - g_{ir})$.

Taking the average of (3) for each group $r = 1, \dots, R$ leads to the between group equation, which describes the average growth performance of the corporate group:

$$\begin{aligned}\bar{g}_r &= \frac{\lambda}{m_r - 1} (m_r \bar{g}_r - \bar{g}_r) + \pi \bar{S}_{0r} + \bar{\mathbf{x}}_r \boldsymbol{\gamma} + \mu_r + \bar{\epsilon}_r, \text{ or} \\ \bar{g}_r &= \frac{1}{1 - \lambda} (\pi \bar{S}_{0r} + \bar{\mathbf{x}}_r \boldsymbol{\gamma} + \mu_r + \bar{\epsilon}_r).\end{aligned}\quad (4)$$

The within group equation describes an individual firm's performance relative to the average of the corporate group it belongs to. For each unit i , it is calculated by subtracting the between equation (4) from equation (3) to obtain:

$$\begin{aligned}(g_{ir} - \bar{g}_r) &= \frac{\lambda}{m_r - 1} (m_r \bar{g}_r - g_{ir}) + \pi S_{0ir} + \mathbf{x}_{ir} \boldsymbol{\gamma} + \mu_r + \epsilon_{ir} \\ &\quad - (\lambda \bar{g}_r + \pi \bar{S}_{0r} + \bar{\mathbf{x}}_r \boldsymbol{\gamma} + \mu_r + \bar{\epsilon}_r),\end{aligned}\quad (5)$$

or equivalently:

$$(g_{ir} - \bar{g}_r) = -\lambda \frac{(g_{ir} - \bar{g}_r)}{(m_r - 1)} + \pi (S_{0ir} - \bar{S}_{0r}) + (\mathbf{x}_{ir} - \bar{\mathbf{x}}_r) \boldsymbol{\gamma} + (\epsilon_{ir} - \bar{\epsilon}_r). \quad (6)$$

In the between group regression the spillover parameter λ is not identified. Rather it is the within group equation that allows the identification of the

corporate group effect. Solving (6) yields the reduced form:

$$(g_{ir} - \bar{g}_r) = \frac{m_r - 1}{m_r - 1 + \lambda} \left(\pi(S_{0ir} - \bar{S}_{0r}) + (\mathbf{x}_{ir} - \bar{\mathbf{x}}_r)\boldsymbol{\gamma} + (\epsilon_{ir} - \bar{\epsilon}_r) \right) \quad (7)$$

The impact of group specific externalities on the persistence in firm size and the implied speed of convergence are measured by the size of the gap (defined as deviation from long-run firm size) that is closed per year on average in course of the adjustment process. This allows to distinguish between average persistence of the whole MNE corporate group and within group persistence as deviation from the group specific persistence. Formally, the between and within adjustment speed is given by the parameter of \bar{S}_{0r} in (4) and $(S_{i0r} - \bar{S}_{0r})$ in (7), respectively. Thereby, we assume that the exogenous variables and thus long-run firm size remains constant over time. Hence, the between group convergence speed is given by:

$$\frac{\pi}{1 - \lambda} = \frac{1}{1 - \lambda} (\beta_0 + \beta_1 \bar{A}_r). \quad (8)$$

At positive λ , the growth processes of affiliates in a multinational corporate group reinforce each other due to group specific externalities. The average growth rate in the MNE group is enhanced and adjustment of affiliate size is faster as compared to a counterfactual situation where the very same firms are lone standing and act independently. A negative estimated λ means that the growth of one single firm is hampered by that of the remaining group members. This is observed, if, for example, financial or other

constraints lead to competition among the plants of a corporate group. Positive growth externalities within corporate groups are expected in case of vertically organized MNEs or in the presence of multi-plant economies of scale (Markusen, 2002), while negative ones are observed in case of horizontal MNEs that can substitute production of the individual affiliates. We estimate the within group convergence speed by:

$$\frac{(m_r - 1)\pi}{m_r - 1 + \lambda} = \left(\frac{m_r - 1}{m_r - 1 + \lambda} \right) (\beta_0 + \beta_1 A_{ir}). \quad (9)$$

The first term in brackets reflects the impact of within group externalities and depends on the persistence parameter λ and the group size m_r of the corporate group. Here, the persistence term is inversely related to λ and positively to group size. Hence, at positive λ adjustment of individual affiliates is slower, but this effect is less pronounced in larger groups. Therefore, corporate groups with positive externalities and a large number of group members tend to be more stable and exhibit lower heterogeneity in growth rates at given age, but higher growth rates on average as compared to a set of identical, but independent firms. The second term is well known from the analysis of the growth process of lone standing firms and depends on the individual firm persistence term $\beta_0 + \beta_1 A_{ir}$. It accounts for the observation that older firms exhibit a more persistent growth pattern. For large corporate groups the first terms of (9) tend to 1 and externalities are low in this case.

Equation (6), which identifies group specific externalities, has to be estimated by IV-methods, since $\frac{(g_{ir}-\bar{g}_r)}{(m_r-1)}$ is clearly endogenous. Lee (2007) shows that the proper set of instruments can be based on the expected value of $\frac{(g_{ir}-\bar{g}_r)}{(m_r-1)}$. Therefore, the set of instruments comprises the set of all exogenous within transformed variables multiplied by $\frac{1}{(m_r-1)}$. So, variation in group size is crucial for identification. Furthermore, he shows that from the reduced form as given in (7) the best instrument can be derived, which is given by $\frac{1}{m_r-1}$ times the predicted value of the right side of equation (7). This suggests a two step approach. In the first step we use the exogenous variables multiplied by $\frac{1}{(m_r-1)}$ as instruments to obtain a consistent initial estimator of λ . In the second step we use this estimate to obtain the best instrument, which can be used to re-estimate the structural equation (5). Note in step two the model is just identified. Lee (2007) shows that this IV-estimator is consistent under a set of low level assumptions and asymptotically normal. His Monte-Carlo study indicates that the IV-estimator performs well in samples of reasonable size.

4 Data and Descriptive Statistics

The empirical estimations are based on cross-section firm level data provided by the AMADEUS database.⁵ The sample includes manufacturing firms cov-

⁵The Bureau van Dijk distributes the AMADEUS database, which includes financial statements, profit and loss accounts and information on companies' organizational structure of 8.8 million firms located in 40 mainly European countries.

ering the time period 1994-2008 and provides information about the organizational structure to form up MNE corporate groups in addition to measures of firm size, firm age and industry classification. More precisely, for one point in time the AMADEUS database reports ultimate owners of non-individual firms at. Using this information we classify all firms which share the same ultimate owner as affiliates of a multinational corporate group. Thereby, we only consider firms where the percentage of total ownership (direct ownership and indirect ownership) exceeds 25 percent.⁶ Since, by definition, MNE corporate groups run production facilities in at least two different countries, we exclude all corporate groups where all subsidiaries and the ultimate owner are located in one single country. Finally, we only include firms which are owned either by industrial companies or by individuals. The exclusion of corporate networks owned by other firms such as banks and insurance companies intends to eliminate ownership which is based on a risk diversification motive rather than on common control.

Table 1 shows descriptive statistics for the individual annual average firm growth rate and all explanatory variables used in the empirical firm growth model. The upper part of Table 1 corresponds to the whole sample of 14,905 MNE subsidiaries, while the remainder describes sub-samples of horizontally and vertically integrated MNEs. Thereby, the sub-sample of horizontally integrated MNEs only consists of those MNEs where all affiliates operate in the same NACE (rev. 1.1) 3-digit industry. The sub-sample of vertically

⁶With respect to the different corporate laws within Europe a 25 percent ownership guarantees a strategic position in the subsidiary firm.

integrated MNEs are composed of all MNE networks where at least one affiliate operates in a different NACE 3-digit industry. Finally, the subsample of majority vertically integrated MNEs consists of corporate groups where at least 50 percent of subsidiaries operate in industries different from the corporate group's primary industry.⁷

Affiliate size is measured in terms of log employment and its average growth rate is calculated using the difference between the last and the first available observation divided by the number of available years. This approach allows including all firms with at least two observations at different points in time in the analysis. Across the four considered groups (see Table 1), the annual average growth rates vary between 1 and 2.6 percent. Firms in horizontally integrated MNEs on average grow faster than the average affiliate in the whole sample. Additionally, subsidiaries of horizontally integrated MNEs are smaller and slightly younger than the sample average.

Since the individual growth performance is likely to be correlated with the development of the (macro-) economic environment of the affiliates, we additionally use country-industry specific growth rates as additional controls. The growth rates are based on NACE 3-digit industry level value added to factor costs data which are collected by the Austrian Institute of Economic Research. For the relevant time period value added to factor costs are reported for the EU 27 with the exceptions of Bulgaria, Luxembourg and Ro-

⁷The NACE 3-digit industry where a relative majority of firms within the corporate group operates is defined as its primary industry.

Table 1: Descriptive Statistics

Variable	No. of. obs.	Mean	Std. Deviation	Min	Max
All Groups					
Growth Rate	14,905	0.011	0.148	-0.857	0.906
Initial Size	14,905	308.569	1228.077	1	40495
Age	14,905	29.461	24.928	1	324
Industry-Country Growth	14,905	0.031	0.043	-0.214	0.386
Group size	14,905	27.171	39.432	2	232
Horizontal					
Growth Rate	1,390	0.026	0.144	-0.763	0.871
Initial Size	1,390	192.815	455.591	1	40495
Age	1,390	28.217	24.055	3	203
Industry-Country Growth	1,390	0.034	0.046	-0.157	0.386
Group size	1,390	4.974	4.631	2	25
Vertical					
Growth Rate	13,515	0.010	0.149	-0.857	0.906
Initial Size	13,515	320.474	1280.799	1	40495
Age	13,515	29.589	25.013	1	324
Industry-Country Growth	13,515	0.031	0.043	-0.214	0.386
Group size	13,515	29.454	40.703	2	232
Maj. Vertical					
Growth Rate	8,188	0.011	0.147	-0.852	0.899
Initial Size	8,188	297.422	1095.282	1	36575
Age	8,188	29.210	24.662	1	324
Industry-Country Growth	8,188	0.032	0.044	-0.200	0.386
Group size	8,188	34.904	48.657	2	232

mania. Interestingly, the country-industry growth rates, on average, exceed the average growth performance of our MNE subsidiaries.

The above mentioned IV estimation procedure crucially depends on the variation in the MNE corporate group size. Table 1 shows that on average an MNE corporate group consists of 27 firms with a minimum (maximum) of 2 (232) firms. Evidently, in comparison to horizontally integrated MNEs vertically integrated MNE corporate groups are larger. However, the variation in the group size of horizontally integrated MNEs seems to be sufficiently large for the application of the IV estimation procedure.

5 Estimation Results

The econometric model is based on the within specification. Besides firm age, initial firm size and its interaction (see Evans 1987*a*, Evans 1987*b*) the econometric specification additionally includes country-industry specific growth rates to control for differences in the sectoral and macroeconomic environment of the firms.

Table 2 provides the estimation results for the whole sample and the three different sub-samples of horizontally and vertically integrated MNEs. The estimated parameters of initial firm size vary around -0.059 indicating that at given age small affiliates grow faster on average in our sample of medium and large surviving subsidiaries. Ignoring the group spillover effect for a moment, this result is well in line with previous findings on lone standing firms.

With respect to corporate groups, Variyam and Kraybill (1992) report coefficients between -0.030 and -0.052 for different specifications of employment growth equations for small firms in Georgia, while Belderbos and Zou (2007) find similar results for the speed of adjustment effects in a sample of MNE affiliates.

Furthermore, our estimation results are in line with previous research concerning the relationship between firm age and growth that ignores corporate group effects. With the exception of the sample of horizontally integrated MNEs, the age effect is significantly negative but diminishes. Consequently, the impact of age on firm growth is smaller for old firms.⁸ Additionally, we find a stable positive influence of the interaction between initial size and age, indicating that persistence of firm size increases with age. Young subsidiaries are able to adjust their size quickly, while for old ones the random walk hypothesis seems to be more plausible. The effect of the interaction term is of the same magnitude across all sub-samples and comparable to previous research.

Summing up, in line with literature, *Gibrat's Law* of proportionate growth is rejected for the smaller and younger subsidiaries. The size of the older and in most cases also larger affiliates is highly persistent and *Gibrat's Law* seems a plausible description of their growth process (for surveys on previous similar findings see, Hart 2000, Audretsch et al. 2004, Bellak 2004, Fotopoulos and Louri 2004 and Cabral 2007). Additionally, the country-industry specific

⁸Formally, the age effect is U-shaped. However, the minimum of the age function is far above the relevant age range.

Table 2: MNECorporate Group Estimation of Affiliate Growth

Variable	All Groups	Horizontal	Vertical	Maj. Vertical
Corporate Group Effect	0.121 (0.094)	-0.421*** (0.098)	0.318** (0.139)	0.320** (0.157)
Initial Size	-0.059*** (0.003)	-0.053*** (0.008)	-0.059*** (0.003)	-0.059*** (0.004)
Age	-0.063*** (0.010)	-0.022 (0.023)	-0.066*** (0.011)	-0.068*** (0.014)
Age ²	0.007*** (0.002)	0.002 (0.004)	0.007*** (0.002)	0.007*** (0.002)
Initial Size * Age	0.010*** (0.001)	0.011*** (0.003)	0.011*** (0.001)	0.011*** (0.001)
Industry Growth	0.358*** (0.029)	0.388*** (0.080)	0.350*** (0.031)	0.299*** (0.038)
Within Group R^2	0.101	0.473	0.061	0.051
Observations	14,905	1,390	13,515	8,188

Notes: Standard errors are given in parenthesis. The symbols *, **, and *** stand for significant at the 10%, 5% and 1% level.

growth rates exert a positive and significant impact on the growth performance of subsidiaries of MNEs throughout. Interestingly, based on the within R^2 , *Gibrat's Law* type of regressions seem to describe more accurately the convergence process within horizontally integrated MNEs in comparison to vertically integrated MNEs.

The estimated spillover parameter λ reveals different types of externalities across vertically and horizontally integrated MNEs. Using the whole sample of all MNE networks, group externalities seem to be slightly positive, but insignificant. However, for subsidiaries of horizontally integrated MNEs the estimated externalities are significantly negative. These results suggest that in horizontally organized corporate groups the individual subsidiaries compete for resources and within a horizontal MNE group each subsidiary grows at the expense of the others. Additionally, the negative within group externalities (i.e. $\lambda < 0$) decrease the average speed of adjustment as shown by equation (8).

Conversely, within vertical MNE structures we observe reinforcing simultaneous growth (and decline) of all subsidiaries as measured by the positive spillover parameter (i.e. $\lambda > 0$) in Table 2. This holds true for both the sample of vertical and major vertical MNEs. Consequently, the average growth rate in the group as whole is enhanced as can be seen by (8), while the speed of adjustment within an MNE network is reduced (see equation (9)).

Table 3 shows the speed of adjustment across and within corporate groups in more detail. The upper part of the Table is based on horizontally inte-

Table 3: Between and Within Convergence Speed in MNE Corporate Groups

Distribution	Between Adjustment ¹	Corporate Group Size ²	Firm Age ³	Within Adjustment ⁴
Horizontal MNEs				
Firm Age				
First Quartile	-0.017	1.379	-0.030	-0.041
Second Quartile	-0.014	1.367	-0.022	-0.030
Third Quartile	-0.013	1.352	-0.017	-0.023
Fourth Quartile	-0.011	1.357	-0.008	-0.011
# of Subsidiaries				
First Quartile	-0.014	1.727	-0.020	-0.034
Second Quartile	-0.014	1.267	-0.020	-0.025
Third Quartile	-0.014	1.130	-0.020	-0.023
Fourth Quartile	-0.012	1.047	-0.018	-0.018
Vertical MNEs⁵				
Firm Age				
First Quartile	-0.043	0.949	-0.037	-0.035
Second Quartile	-0.041	0.953	-0.030	-0.028
Third Quartile	-0.039	0.952	-0.025	-0.024
Fourth Quartile	-0.038	0.960	-0.017	-0.016
# of Subsidiaries				
First Quartile	-0.042	0.875	-0.028	-0.025
Second Quartile	-0.040	0.965	-0.027	-0.026
Third Quartile	-0.039	0.985	-0.027	-0.026
Fourth Quartile	-0.040	0.995	-0.027	-0.027

Notes:

- ¹ The between adjustment is calculated using $\frac{1}{1-\lambda}(\beta_0 + \beta_1 \bar{A}_r)$.
- ² The corporate group Size effect is given by $\left(\frac{m_r-1}{m_r-1+\lambda}\right)$.
- ³ The firm age effect is calculated using $\beta_0 + \beta_1 A_{ir}$. Finally, the within adjustment effect is given by the Corporate Group Size times the Firm Age effect.
- ⁴ Calculated as the product of columns 2 and 3 in this table.
- ⁵ Based on the estimates in column 3 of Table 2.

grated MNEs while the lower part provides results for vertically integrated corporate networks. The results correspond to the average between and within group speed of adjustment for affiliates located in different quartiles of the individual firm age and group size (i.e. number of affiliates) distributions. The between speed of adjustment is calculated using (8) and within adjustment is given by (9).

Evidently, Table 3 confirms the view that in horizontally integrated MNEs the within corporate group speed of adjustment exceeds the average adjustment of the group, while in vertically integrated MNEs the opposite effect prevails. Additionally, in comparison to lone standing firms (i.e. $\lambda = 0$) the average speed of adjustment within horizontal MNEs is smaller while the adjustment speed across lone standing firms is exceeded by the average adjustment dynamics observed across vertically integrated MNE networks. Finally, the within corporate group speed of adjustment is highest for young subsidiaries as well as for subsidiaries of MNE corporate groups with a small number of affiliates. This results holds for vertically and horizontally integrated MNE networks alike. The lower speed of adjustment of the older affiliates is well in line with related literature on lone standing firms and supports the view that newly founded or young firms are too small initially, but adjust to their long-run size more rapidly. The second result suggests that externalities diminish with the number of subsidiaries of MNE networks. In case of horizontally organized MNEs this finding is in line with the evidence provided by Feinberg and Phillips (2004).

6 Conclusions

The empirical firm growth literature so far is restricted to tests of different theories under the assumption of independent lone standing firms. This paper formulates an empirical firm growth model which explicitly incorporates interdependence within multinational corporate groups. Using a large cross-section (AMADEUS) of mainly European manufacturing firms, we are able to provide significant and direct evidence for externalities within multinational corporate groups as suggested by the theory of multinational firms. Furthermore, the estimation results are in line with most of the theories of firm growth.

In particular, our estimation results reveal positive externalities within vertically organized multinational networks, while they are found to be negative for horizontally organized ones. In the former case multinational corporate groups are more stable and adjust faster on average. In the latter case, externalities lead to more heterogeneity in the firm growth processes within the network, but slower average adjustment to long-run size. Consequently, the speed of adjustment of subsidiaries of horizontally and vertically integrated MNEs systematically differs from the well-known adjustment dynamics of lone standing firms.

References

- Anselin, L. (2003), 'Spatial Externalities, Spatial Multipliers and Spatial Econometrics', *International Regional Science Review* **26**(2), 153–166.
- Audretsch, D. B., Klomp, L., Santarelli, E. and Thurik, A. (2004), 'Gibrat's Law: Are the Services Different', *Review of Industrial Organization* **24**(3), 301–324.
- Belderbos, R. and Zou, J. (2007), 'On the Growth of Foreign Affiliates: Multi-national Plant Networks, Joint Ventures, and Flexibility', *Journal of International Business Studies* **38**(7), 1095 – 1112.
- Bellak, C. (2004), 'How Domestic and Foreign Firms Differ and Why does it Matter', *Journal of Economic Surveys* **18**(4), 483–514.
- Bloningen, B. A. and Tomlin, K. (2001), 'Size and Growth of Japanese Plants in the United States', *International Journal of Industrial Organization* **19**(6), 931–953.
- Bramouille, Y., Djebbari, H. and Fortin, B. (2009), 'Identification of Peer Effects through Social Networks ', *Journal of Econometrics* **150**(1), 41–55.
- Buckley, P. J., Dunning, J. H. and Pearce, R. D. (1984), 'An Analysis of the Growth and Profitability of the World Largest Firms 1972 to 1977', *Kyklos* **37**(1), 3–26.

- Cabral, L. M. B. (1995), ‘Sunk Costs, Firm Size and Firm Growth’, *Journal of Industrial Economics* **43**, 161–172.
- Cabral, L. M. B. (2007), ‘Small Firms in Portugal: A Selective Survey of Stylized Facts, Economic Analysis, and Policy Implications’, *Portuguese Economic Journal* **6**(1), 65–88.
- Cabral, L. M. B. and Mata, J. (2003), ‘On the Evolution of the Firm Size Distribution: Facts and Theory’, *American Economic Review* **93**(4), 1075–1090.
- Cantwell, J. A. and Sanna-Randaccio, F. (1993), ‘Multinationality and Firm Growth’, *Review of World Economics/Weltwirtschaftliches Archiv* **129**(2), 275–299.
- Caves, R. E. (1996), *Multinational Enterprise and Economic Analysis*, second edn, Cambridge University Press, Cambridge.
- Evans, D. S. (1987a), ‘Tests of Alternative Theories of Firm Growth’, *Journal of Political Economy* **95**(4), 657–674.
- Evans, D. S. (1987b), ‘The Relationship between Firm Growth, Size and Age: Estimates for 100 Manufacturing Industries’, *Journal of Industrial Economics* **35**(4), 567–581.
- Feinberg, S. and Phillips, G. (2004), ‘Growth. Capital Market Development and Competition for Resources within MNC’s’, *NBER Working Paper* **9252**.

- Fotopoulos, G. and Louri, H. (2004), 'Firm Growth and FDI: Are Multinationals Stimulating Local Industry Development', *Journal of Industry, Competition and Trade* **4**, 163–189.
- Geroski, P. (2000), The Growth of Firms in Theory and in Practice, *in* N. Foss and V. Mahnke (eds.), 'Governance, Competence and Entrepreneurship. Advances in Economic Strategy Research', Oxford University Press, pp. 168–186.
- Geroski, P. A. (2005), 'Understanding the Implications of Empirical Work on Corporate Growth Rates', *Managerial and Decision Economics* **26(2)**, 129–138.
- Geroski, P. A. and Gugler, K. (2004), 'Corporate Growth Convergence in Europe', *Oxford Economic Papers* **56(4)**, 597–620.
- Gibrat, R. (1931), *Les Inequalities Economiques*, Sirey, Paris.
- Gugler, K., Kalkbrenner, E. and Peev, E. (2008), 'Parent Firms, Subsidiaries and Investment', *Mimeo*.
- Hamermesh, D. S. and Pfann, G. A. (1996), 'Adjustment Costs in Factor Demand', *Journal of Economic Literature* **34(3)**, 1264–1292.
- Harhoff, D., Stahl, K. and Woywode, M. (1998), 'Legal Form, Growth and Exit of West German Firms. Empirical Results for Manufacturing, Construction, Trade and Service Industries', *Journal of Industrial Economics* **46(4)**, 453–48.

- Hart, P. (2000), 'Theories of Firms' Growth and the Generation of Jobs', *Review of Industrial Organization* **17**(3), 229–248.
- Helpman, E. and Krugman, P. R. (1985), *Market Structure and Foreign Trade. Increasing Returns, Imperfect Competition, and the International Economy*, Harvester Wheatsheaf, Brighton.
- Jovanovic, B. (1982), 'Selection and Evolution of Industry', *Econometrica* **50**(3), 649–670.
- Lee, L. F. (2007), 'Identification and Estimation of Econometric Models with Group Interactions, Contextual Factors and Fixed Effects', *Journal of Econometrics* **140**(2), 333–374.
- Manski, C. F. (1993), 'Identification of Endogenous Social Effects: The Reflection Problem', *Review of Economic Studies* **60**(3), 531–542.
- Markusen, J. R. (1984), 'Multinationals, Multi-Plant Economies and the Gains from Trade', *Journal of International Economics* **16**(3-4), 205–226.
- Markusen, J. R. (2002), *Multinational Firms and the Theory of International Trade*, MIT Press, Cambridge.
- Pennings, E. and Sleuwaegen, L. (2000), 'International Relocation: Firm and Industry Determinants', *Economics Letters* **67**(2), 179–186.

- Penrose, E. T. (1959), *The Theory of the Growth of the Firm*, Blackwell Publishing.
- Pfaffermayr, M. (2009), 'Conditional Beta- and Sigma-Convergence in Space: A Maximum Likelihood Approach', *Regional Science and Urban Economics* **39**(1), 63–78.
- Slater, M. (1980), 'The Managerial Limitation to the Growth of Firms', *Economic Journal* **90**(359), 520–528.
- Sutton, J. (1997), 'Gibrat's Legacy', *Journal of Economic Literature* **35**(1), 40–59.
- Variyam, J. N. and Kraybill, D. S. (1992), 'Empirical Evidence on Determinants of Firm Growth', *Economics Letters* **38**(1), 31–36.