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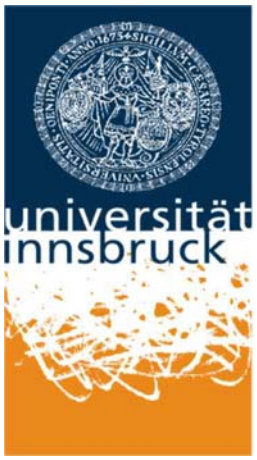

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Firm Growth in Multinational Corporate Groups

Harald Oberhofer and Michael Pfaffermayr

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Harald Oberhofer[†] and Michael Pfaffermayr[‡]

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Abstract

This paper formulates an econometric firm growth model that explicitly accounts for the interdependence of firm performance within corporate networks and is in line with several economic theories on firm growth. We estimate the model for national and multinational corporate groups (MNEs) using a recently introduced instrumental variable estimation procedure for peer group effects developed by Lee (2007). In our data for corporate groups the observation of fast growing young firms and slow growing old firms disappears if interdependence of firm performance within corporation networks is introduced.

JEL Codes: C21, F23, L25

Keywords: Firm Growth, Size Adjustment, Corporate Groups, Multinational Activity, Peer-Group Effect Estimation.

[†]Department of Economics, University of Innsbruck, Universitaetsstrasse 15, 6020 Innsbruck, Austria.
Tel.:(+43)512 507 7164. E-mail: harald.oberhofer@uibk.ac.at.
[‡]Department of Economics, University of Innsbruck, Universitaetsstrasse 15, 6020 Innsbruck, Austria.
Tel.:(+43)512 507 7359. E-mail: michael.pfaffermayr@uibk.ac.at.
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1 Introduction

Empirical research on firm growth so far tests economic theories, such as *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), under the assumption of independent firms. In a world of rapidly increasing international mergers and acquisitions and high growth rates of foreign direct investment (FDI) the ignorance of firms' organization in corporate networks and the multinational dimension of their economic activities might induce misleading results. Specifically, the independence assumption maintained in empirical firm growth models seems no longer plausible.

A major finding in the empirical firm growth literature states that young firms are usually smaller than the efficient steady state firm size and 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 slow growing old (large) firms rejects Gibrat's Law of proportionate growth. The other firm growth theories mentioned above provide arguments

[1]Surveys 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).

for the inefficient size of young firms. However, these arguments refer to lone standing firms only.

In this paper we formulate an empirical growth model, which explicitly accounts for (potential) interdependence in firm growth within corporate groups and is in line with above mentioned economic theories on firm growth. More precisely, based on the theory of multinational corporate groups (MNEs) we hypothesize that the growth rate of a single firm depends on the average growth rate of the corporate network which the firm belongs to. In this respect, we also investigate differences between national and MNE corporate groups. 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 estimates suggest that the speed of adjustment to the efficient firm size within corporate groups is (at least partly) highest in large and old corporate groups, which seems to be in contrast to existing literature. The largest and oldest corporate groups usually are MNEs. Overall, within MNE corporate groups there seems to be pronounced competition among the member firms, at least in terms of employment leading to faster adjustment and less persistence in firm size as compared to lone standing firms. In contrast, between groups average firm size is more persistent. Our results furthermore indicate that neglecting the interdependence between firms leads to an overestimation of the adjustment speed, especially of young firms.

The remainder of the paper is organized as follows: Section 2 surveys 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 theory model as proposed by Jovanovic (1982) implies that firms do not entirely know their productivity level in the after birth period and, therefore, 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. There will be more precise information on corporate group specific productivity level and, therefore, firms which belong to a corporate group can be expected to adapt firm size more rapidly.

Cabral and Mata (2003), among others, argue that (lone standing) young firms might be credit rationed due to a lack of financial reputation. However, this argument might not be true for firms which belong to a corporate group for two reasons. Within corporate groups inter-firm credits can more easily be granted (see Gugler, Kalkbrenner and Peev 2008, for example) and secondly

large corporate groups usually have built up enough reputation to obtain credits. Therefore, young parts of the corporate group should be able to finance all profitable investment projects and should reach efficient firm size much faster.

A similar argument applies for organizational capabilities and Penrose effects. While a lone standing young firm more probably faces 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 will be higher and more flexible in corporate networks. Therefore, theories concerning organizational capabilities and Penrose effects are expected to have limited explanatory power for firms which belong to a corporate network.

In most cases corporate networks are formed to serve markets in different countries and therefore become multinational corporate groups. The most well known framework to explain multinational activity of companies is the eclectic paradigm based on seminal contributions by John H. Dunning (1977; 1981; 1988). The central condition that corporations have to satisfy to act as multinationals is linked to the possession of an ownership advantage. A company must possess special characteristics which allow to have lower production costs and/or achieve higher prices compared to indigenous competitors. Such particular characteristics induce interdependence among the

members of a multinational network and include e. g. patents, a trademark or superior knowledge.

In a network of horizontal MNEs there might be competition among plants so that the most efficient plants grow at the expense of the inefficient ones. In addition, ownership advantages that can be exploited within a company without inducing additional costs (Caves 1996), for example intangibles assets, can be seen as intra-corporate group public goods. An increase in productivity within one plant of the corporate group, for example, can easily be transferred to other plants within the corporate group without inducing additional costs. The 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 plant firms of equal size. According to Markusen (1984) multi-plant economies of scale arise from the existence of a joint input whose productivity is independent of the number of plants kept by the corporate group. For this reason firms within horizontally integrated MNEs are expected to adjust to efficient firm size more rapidly.

In case of vertically integrated (multinational) firms plant growth is positively correlated within the corporate group due to forward and backward linkages. In vertically integrated firm groups production stages are separated geographically (see 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 corporate group parts

depend on the competitiveness in the final good and on the demand for it. The structure of those corporate groups implies that each part of the group will be able to increase growth if demand for the final good increases. However, also in this case it seems plausible that the members of a corporate group are able to adjust faster.

Only a limited number of studies investigate the effects of corporate group networks (Variyam and Kraybill 1992) and multinationality (Buckley, Dunning and Pearce 1984, Cantwell and Sanna-Randaccio 1993, Bloningen and Tomlin 2001, Belderbos and Zou 2007) on firm growth. Variyam and Kraybill (1992) find support to 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. Buckley et al. (1984) test (among other things) 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 dataset 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.

Belderbos and Zou (2007) provide evidence that MNEs use the flexibility created by their network to easily adjust employment more rapidly within their affiliates.

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

Following Geroski (1999), Geroski (2005), and Geroski and Gugler (2004) the typical specification of the firm growth regression can be written as:

$$g_i = \alpha_i + (\beta_0 + \beta_1 A_i) S_{0i} + \mathbf{x}_i \boldsymbol{\gamma} + \epsilon_i, \tag{1}$$

where g_i denotes the average annual growth rate of company i (typically measured in the difference in logs of firm size). A_i is the log of the age and S_{0i} is the log of the initial size of firm i. Other controls like log age, log age-squared, firm specific productivity, market growth, and other industry characteristics are collected in $\mathbf{x}_i$. Lastly, ϵ_i is the iid error term.

In this specification persistence in firm size differs across age cohorts. Firm growth is typically faster for young firms due to sunk costs, financial constraints and adjustment costs (see e.g. Evans 1987*a*, Cabral 1995, Cabral and Mata 2003). This suggests to measure persistence in firm size by $(\beta_0 + \beta_1 A_i)$, where $\beta_0 < 0$ and $\beta_1 > 0$. Formally, the specification implies that log firm size follows a first-order autoregressive process with some, but not

perfect, persistence, allowing for 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. It is important to emphasize that 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 independent growth performance seems implausible. Rather, as argued above, the growth of a single plant is likely to depend on the growth performance of the other members of the corporate group. To account for the dependence among the the members (plants) of a corporate group, we apply an econometric model recently proposed by Lee (2007). We hypothesize that the growth process of firm i can be described by a generalized firm growth equation that includes the average growth performance of the other group members as additional explanatory variable as well as contextual exogenous variables and group fixed effects. The latter two capture systematic differences in long run efficient sizes of corporate groups vs. their

lone standing counterparts, see Manski (1993) and Lee (2007):

$$g_{ir} = (\beta_0 + \beta_1 A_{ir}) S_{0ir} + \lambda \frac{1}{m_r - 1} \sum_{\substack{j=1 \\ i \neq j}}^{m_r} g_{jr} + \mathbf{x}_{ir}\boldsymbol{\gamma}_1 + \frac{1}{m_r - 1} \sum_{\substack{j=1 \\ i \neq j}}^{m_r} \mathbf{x}_{ir}\boldsymbol{\gamma}_2 + \mu_r + \epsilon_{ir}, \quad (2)$$

where g_{ir} measures the average annual growth rate of firm i in corporate group r, $\frac{1}{m_r - 1} \sum_{\substack{j=1 \\ i \neq j}}^{m_r} g_{jr}$ captures the endogenous peer group effect and $\frac{1}{m_r - 1} \sum_{\substack{j=1 \\ i \neq j}}^{m_r} \mathbf{x}_{ir}$ captures contextual effects, where m_r denotes the number of group members. Equation (2) represents a structural form (dynamic) spatial autoregressive (SAR) Model with global (within group) spillovers and exogenous contextual effects. The growth performance of every unit i in a given group r is related to all other group members and, therefore, each member influences the outcome of all other group members, as well as indirectly also the outcome of itself. In econometric terms such a model is called a global SAR model (see Anselin 2003). 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 specification is designed to capture externalities in short term adjustment of firm size. In fact, in the long run expected efficient firm size is constant. Equation (2) then implies that externalities affect firm size of each group member only via exogenous contextual effects and fixed group specific fixed effects. Following Lee (2007), one can establish the 'within'

and 'between' equations of the generalized firm growth equation.

$$g_{ir} = \frac{\lambda}{m_r - 1}\left(m_r \overline{g}_r - g_{ir}\right) + \beta_0 S_{0ir} + \beta_1 A_{ir} S_{0ir} + \mathbf{x}_{ir,1}\boldsymbol{\gamma}_1 + \left(\frac{1}{m_r - 1}\sum_{\substack{j=1 \\ i \neq j}}^{m_r} \mathbf{x}_{ir,2}\right)\boldsymbol{\gamma}_2 + \mu_r + \epsilon_{ir} \tag{3}$$

$$\text{because} \quad m_r \overline{g}_r = \sum_{j=1}^{m_r} g_{jr} \quad \text{and, therefore,} \quad \sum_{\substack{j=1 \\ i \neq j}}^{m_r} g_{jr} = \left(m_r \overline{g}_r - g_{ir}\right).$$

$\mathbf{x}_{ir,1}$ includes all control variables, while $\mathbf{x}_{ir,2}$ comprises the control variables entering additionally as exogenous contextual effects. Taking the average for each group $r = 1, \ldots, R$ from (3) leads to the 'between' group equation, which describes the average growth performance of the corporate group:

$$\overline{g}_r = \frac{\lambda}{m_r - 1}\left(m_r \overline{g}_r - \overline{g}_r\right) + \beta_0 \overline{S}_{0r} + \beta_1 \overline{AS}_{0r} + \overline{\mathbf{x}}_{r,1}\boldsymbol{\gamma}_1 + \overline{\mathbf{x}}_{r,2}\boldsymbol{\gamma}_2 + \mu_r + \overline{\epsilon}_r$$

$$\text{with: } \overline{AS}_{0r} = \tfrac{1}{m_r}\textstyle\sum_{i=1}^{m_r} A_{ir} S_{oir},$$

$$\overline{g}_r = \lambda \overline{g}_r + \beta_0 \overline{S}_{0r} + \beta_1 \overline{AS}_{0r} + \overline{\mathbf{x}}_{r,1}\boldsymbol{\gamma}_1 + \overline{\mathbf{x}}_{r,2}\boldsymbol{\gamma}_2 + \mu_r + \overline{\epsilon}_r,$$

so that:

$$\overline{g}_r = \frac{1}{1 - \lambda}\left(\beta_0 \overline{S}_{0r} + \beta_1 \overline{AS}_{0r} + \overline{\mathbf{x}}_{r,1}\boldsymbol{\gamma}_1 + \overline{\mathbf{x}}_{r,2}\boldsymbol{\gamma}_2 + \mu_r + \overline{\epsilon}_{r.}\right) \tag{4}$$

The within equation describes an individual firm's performance relative to the average of the corporate group it belongs to. It is calculated by subtracting

for each unit i the between equation (4) from the equation (3):

$$
\begin{aligned}
(g_{ir} - \overline{g}_r) = \frac{\lambda}{m_r - 1}\left(m_r \overline{g}_r - g_{ir}\right) + \beta_0 S_{0ir} + \beta_1 AS_{0ir} + \mathbf{x}_{ir,1}\boldsymbol{\gamma}_1 \\
+ \left(\frac{1}{m_r - 1}\sum_{\substack{j=1 \\ i \neq j}}^{m_r} \mathbf{x}_{ir,2}\right)\boldsymbol{\gamma}_2 + \mu_r + \epsilon_{ir} \\
- \left(\lambda \overline{g}_r + \beta_0 \overline{S}_{0r} + \beta_1 \overline{AS}_{0r} + \overline{\mathbf{x}}_{r,1}\boldsymbol{\gamma}_1 + \overline{\mathbf{x}}_{r,2}\boldsymbol{\gamma}_2 + \mu_r + \overline{\epsilon}_r\right). \qquad (5)
\end{aligned}
$$

$$
\begin{aligned}
\left(1 + \frac{\lambda}{m_r - 1}\right)(g_{ir} - \overline{g}_r) = \beta_0(S_{0ir} - \overline{S}_{0r}) + \beta_1(AS_{0ir} - \overline{AS}_{0r}) + (\mathbf{x}_{ir,1} - \overline{\mathbf{x}}_{r,1})\boldsymbol{\gamma}_1 \\
+ \left(\frac{1}{m_r - 1}\right)(\mathbf{x}_{ir,2} - \overline{\mathbf{x}}_{r,2})\boldsymbol{\gamma}_2 + (\epsilon_{ir} - \overline{\epsilon}_r). \qquad (6)
\end{aligned}
$$

In the between group regression the spillover parameter λ is not identified. Rather the within equation allows the identification of the corporate group effect by solving (6):

$$
\begin{aligned}
(g_{ir} - \overline{g}_r) = \frac{m_r - 1}{m_r - 1 + \lambda}\left(\beta_0(S_{0ir} - \overline{S}_{0r}) + \beta_1(AS_{0ir} - \overline{AS}_{0r}) + (\mathbf{x}_{ir,1} - \overline{\mathbf{x}}_{r,1})\boldsymbol{\gamma}_1\right) \\
- \frac{1}{(m_r - 1 + \lambda)}(\mathbf{x}_{ir,2} - \overline{\mathbf{x}}_{r,2})\boldsymbol{\gamma}_2 + \frac{(m_r - 1)}{(m_r - 1 + \lambda)}(\epsilon_{ir} - \overline{\epsilon}_r). \qquad (7)
\end{aligned}
$$

Equivalently, equation (6) can also be written as:

$$
\begin{aligned}
(g_{ir} - \overline{g}_r) = -\lambda\frac{(g_{ir} - \overline{g}_r)}{(m_r - 1)} + \beta_0(S_{0ir} - \overline{S}_{0r}) + \beta_1(AS_{0ir} - \overline{AS}_{0r}) \\
+ (\mathbf{x}_{ir,1} - \overline{\mathbf{x}}_{r,1})\boldsymbol{\gamma}_1 - \frac{(\mathbf{x}_{ir,2} - \overline{\mathbf{x}}_{r,2})\boldsymbol{\gamma}_2}{m_r - 1} + (\epsilon_{ir} - \overline{\epsilon}_r). \qquad (8)
\end{aligned}
$$

In the empirical application equation (8) is estimated by IV-methods, taking $\frac{(g_{ir}-\overline{g}_r)}{(m_r-1)}$ as endogenous variable. Lee (2007) shows that the proper set of instruments comprises the set of all exogenous variables multiplied by $\frac{1}{(m_r-1)}$. Hence, differences in group size are crucial for identification. Lee (2007) also shows that this IV-estimation is consistent under a set of low level assumptions. The Monte-Carlo Study indicates that the IV-estimator performs well in samples of reasonable size.

The persistence in firm size is estimated by taking the partial derivative of equations (4) and (7) with respect to initial size. This allows to distinguish between average persistence of the whole group and within group persistence as deviation of the group specific persistence. The partial effect of the initial size in the between groups equation is calculated in two steps. In the first step the effect of a marginal change of the initial size of one group member is calculated and in the second step it is averaged over each group r.

$$\frac{\partial \overline{g}_r}{\partial S_{0ir}} = \frac{1}{1-\lambda}\left(\frac{1}{m_r}\beta_0 + \frac{1}{m_r}\beta_1 A_{ir}\right) \tag{9}$$

Summing over all group members yields the group average effect:

$$\sum_{i=1}^{m_r} \frac{\partial \overline{g}_r}{\partial S_{0ir}} = \frac{1}{1-\lambda}(\beta_0 + \beta_1 \overline{A}_r) \tag{10}$$

The between groups persistence of firm size differences depends on the average age of the members of the corporate group as well as on the spillover parameter. The assumption that $\beta_0 < 0$ and $\beta_1 > 0$ implies that the speed

of adjustment of old corporate groups is slower than for younger ones, everything else equal.

Externalities within corporate groups as measured by λ mainly influences the speed of adjustment of firm size. An estimated $\lambda < 0 (> 0)$ implies a slower (faster) average rate of adjustment across corporate groups as compared to lone standing independent firms as can bee seen by (10).

The within group marginal effect of S_{0ir} can be established by taking the partial derivative of (7) using:

$$\frac{\partial(g_{ir} - \overline{g}_r)}{\partial S_{0ir}} = \left(\frac{m_r - 1}{mr - 1 + \lambda}\right)\left(\beta_0 + \beta_1 A_{ir} - \frac{1}{m_r}(\beta_0 + \beta_1 A_{ir})\right) \tag{11}$$

The first term in brackets measures the influence of the individual size on the growth of firm i, while the second term represents a single firm's impact on the group mean. Simplification of (11) finally leads to:

$$\frac{\partial(g_{ir} - \overline{g}_r)}{\partial S_{0ir}} = \left(\frac{m_r - 1}{mr - 1 + \lambda}\right)\left(\frac{m_r - 1}{m_r}\right)(\beta_0 + \beta_1 A_{ir}) \tag{12}$$

The within persistence depends on the individual firm persistence term $\beta_0 + \beta_1 A_{ir}$ and the group size m_r of the corporate group. At $\lambda < 0$ the first term is greater than one, implying that members of corporate groups exhibit lower persistence and adjust faster at given age, while at $\lambda > 0$ deviations of firm size from the average of the corporate group tend to be more persistent.

In economic terms, a negative λ implies an increased speed of adjustment within groups as the more efficient plants expand faster at the expense of less efficient ones. A positive λ indicates that the within group persistence in size differences is more pronounced. For large corporate groups the first two terms of (12) tend to 1. Since externalities are low, the speed of adjustment in large groups only depends on $\beta_0 + \beta_1 A_{ir}$, which is comparable to the speed of adjustment in models without group externalities. Note that the impact of the peer group effect λ on the within group speed of adjustment is the opposite compared to the between group equation. At $\lambda < 0$, as we find in our empirical application, we observe fast adjustment within corporate groups, but a higher average persistence across corporate groups. This implies that externalities within corporate groups imply more flexible adjustment within groups making the group as a whole more stable on average.

4 Data and Descriptive Statistics

The empirical estimations are based on firm level data provided by the AMADEUS database.[2] The sample includes manufacturing firms covering the time period 1996-2005 and provides information about the organizational structure to form up corporate groups in addition to measures of firm size, age and industry classification. Two different ownership measures are avail-

[2]The 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 European countries.

able upon which the definition of corporate groups can be based. Under the first definition all firms with a common shareholder belong to the same corporate group. The second approach uses a more global measure of ownership and collects all firms which possess the same ultimate owner into a corporate group. This concept is related to the widespread view that some big companies control a large number of firms or that many firms are part of a large corporate group.

In the AMADEUS database firms' which hold stocks of other firms equity are defined as shareholder. The majority shareholder of a firm or of a shareholder, which at least is in the possession of over 24.9 percent of the stock, is called ultimate owner. For this reason the corporate groups formed by shareholders or ultimate owners might differ as shareholders are often held by ultimate owners themselves. Therefore, an ultimate owner which holds a few shareholders of other firms will create a much larger corporate group than the shareholders themselves.[3]

We restrict the dataset to shareholders or ultimate owners which are themselves active in manufacturing industrial sectors. Within the two different corporate group definitions we distinguish between all groups (national and multinational) and purely multinational corporate groups.[4]

[3]The corporate group size of national and international shareholders varies between 2 and 120 members in employment reporting corporate groups. Ultimate owner groups contain between 2 and 604 firms.

[4]A corporate group is considered as a national group if the shareholder (ultimate owner) is located in the same country as all its subsidiaries.

Table 1 shows descriptive statistics of the size variables distinguished between the two different definitions and for all and only multinational corporate groups. The number of unconsolidated firms in the sample varies from 6,340 firms reporting operating revenues and being part of a multinational shareholder corporate group to 27,240 firms organized in national and multinational shareholder groups and provide information about their number of employees.[5] Only about 29 percent of the shareholder corporate groups in the sample employ labor force in more than one country. In contrast, about 68 percent of corporate groups which are defined through a common ultimate owner have employees in at least two countries.

The annual average growth rate of a firm i in a corporate group r is calculated by the difference in log firm size between last and first available observations divided by the number of available years. This approach allows to include all firms with at least two observations at different points in time in the analysis. Firm size is measured in terms of employees, however, we also look at operating revenues and total assets as alternative measures of firm size.

The annual average (employment) growth rate of firms in the sample varies between 2.5 and 1.4 percent. Firms in shareholder corporate groups on average grow faster than firms which belong to an ultimate owner corporate group. Moreover, firms in MNE corporate groups tend to have lower growth rates. The annual average operating revenues and total assets growth rates

[5]Shareholder and ultimate owner with consolidated financial statements are eliminated from the dataset to avoid double counting.

exceed employment growth by far. Operating revenues (total assets) of firms which are organized in a national or an international shareholder group is 8.5 percent (7.8 percent). Firms which are part of an ultimate owner network also tend to have slower rates of operating revenues- and total assets growth.

5 Estimation Results

As mentioned above, the econometric model is based on the within specification. Besides the age, initial firm size and its interaction (see Evans 1987*a*, Evans 1987*b*) the econometric model additionally includes firm specific productivity (defined as operating revenues per employee) and average group produvtivity as a contextual variable to control for differences in firm efficiency. In addition, the econometric specification includes 3 digit industry-country dummies. These account for all industry-country specific determinants like market growth, minimum efficient scale, entry and exit barriers and differences in the macroeconomic environment of the firms.

Tables 2 (and 5 and 6 in the Appendix) exhibit the estimation results using the annual average employment -, operating revenues - and total assets growth rates as dependent variable, respectively. For each of the three different growth variables the within equation is estimated for the four different definitions of corporate groups. Columns (1) and (2) of the tables provide the results for corporate groups formed by shareholders. Columns (3) and

Table 1: Descriptive Statistics of Annual Average Growth Rates

Annual Growth	No. of. obs.	Mean	Std. Deviation	Min	Max
All Shareholder Groups					
Employment	27,240	0.025	0.128	−0.549	0.719
Operating Revenues	19,485	0.085	0.179	−0.624	1.096
Total Assets	19,860	0.078	0.147	−0.432	0.941
Only Multinational Shareholder Groups					
Employment	7,980	0.023	0.123	−0.549	0.719
Operating Revenues	6,340	0.085	0.169	−0.610	1.096
Total Assets	6,609	0.074	0.142	−0.430	0.940
All Global Owner Groups					
Employment	14,874	0.019	0.132	−0.613	0.768
Operating Revenues	11,178	0.078	0.183	−0.690	1.139
Total Assets	11,364	0.072	0.152	−0.498	0.995
Only Multinational Global Owner Groups					
Employment	10,160	0.014	0.128	−0.613	0.768
Operating Revenues	7,922	0.079	0.178	−0.690	1.139
Total Assets	8,036	0.072	0.151	−0.485	0.992

(4) report the results for the ultimate owner corporate groups. Columns (1) and (3) include all corporate groups while in (2) and (4) only multinational corporate groups are considered.

The estimated parameter of the initial size on firm growth in the employment growth specification varies from -0.048 to -0.055 indicating that small firms at a given age grow faster on average in our sample of medium and large surviving firms. Ignoring the group spillover effect for a moment, this result is well in line with previous findings. For example, Variyam and Kraybill (1992) report coefficients between -0.030 to -0.052 for different specifications of employment growth equations for small firms in Georgia. Belderbos and Zou (2007) investigate a sample of affiliates and find similar results for adjustment speed and age effects. Evans (1987a, 1987b) uses only firms which survived the entire observation period. Beyond this, he splits the firm sample into young and old firms and reports an initial size effect of around -0.070 for young firms and -0.032 for old firms, indicating that the speed of adjustment of young firms exceeds that of their old counterparts.[6] The results concerning the operating revenues and total assets growth show a higher speed of adjustment. The effect for operating revenues varies between -0.091 and -0.100 and for total assets the impact ranges around -0.084.

Furthermore, our estimation results are in line with previous research concerning the relationship between firm's age and growth that ignores corporate group effects. The negative age effect diminishes so that the impact

[6]Firms which are six years old or younger are defined as being young firms.

of age on firm growth is smaller for old firms.[7] In contrast to the weak impact of age-squared on firm growth we find a stable positive influence of the interaction between initial size and age, indicating that persistence of firm size increases with age. Young firms are able to adjust their firm size quickly, while for old firms the random walk hypothesis seems to be more plausible. The effect of the interaction term is of the same magnitude for the operating revenues and total assets growth estimation and smaller using employment growth, however our findings are comparable to previous research.

Summing up, in line with previous research, *Gibrat's Law* of proportionate growth is rejected for the smaller and younger firms. For older and in most cases also larger firms, firm size is highly persistent and *Gibrat's Law* seems a plausible description of the growth process. Moreover, more productive firms seem to grow faster in all specifications, except for employment growth of firms organized in shareholder corporate groups, while average corporate group productivity hardly influences individual firm growth in most specifications.

The impact of corporate group performance on individual firm growth involves interesting and partly ambiguous results. In the employment growth estimation the corporate group effect is significantly negative for both definitions of corporate groups as well as for only multinational corporate groups. The negative effect seems to be more pronounced in multinational corporate groups than in national shareholder and ultimate owner groups. This

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

Table 2: Corporate-Group Estimation of Employment Growth

Variable	(1)	(2)	(3)	(4)
Corporate Group Effect	-0.143^{***} (0.035)	-0.244^{***} (0.065)	-0.135^{**} (0.065)	-0.318^{***} (0.094)
Initial Size	-0.055^{***} (0.002)	-0.049^{***} (0.003)	-0.051^{***} (0.002)	-0.048^{***} (0.003)
Age	-0.055^{***} (0.004)	-0.068^{***} (0.008)	-0.056^{***} (0.006)	-0.056^{***} (0.007)
Age^2	0.001^{*} (0.001)	0.004^{***} (0.001)	0.001 (0.001)	0.001 (0.001)
Initial Size * Age	0.008^{***} (0.001)	0.007^{***} (0.001)	0.009^{***} (0.001)	0.008^{***} (0.001)
Firm Productivity	0.001 (0.002)	-0.006^{***} (0.002)	0.004^{**} (0.002)	0.004^{**} (0.002)
Av. Group Productivity	-0.003 (0.003)	-0.002 (0.005)	-0.015^{***} (0.005)	-0.006 (0.008)
Industry-Country Fixed Effects	yes	yes	yes	yes
Within R^2	0.275	0.278	0.179	0.195
Observations	27,240	7,980	14,874	10,160

Notes: Standard errors are given in parenthesis. The symbols *, ** and *** stand for 10%, 5% and 1% significant. P-Values are given in parenthesis. Columns (1) and (2) give the results for corporate groups formed by shareholders. Columns (3) and (4) report the results for the ultimate owner corporate groups. Columns (1) and (3) include all corporate groups while in (2) and (4) only multinational corporate groups are considered.

result indicates that fast adjustments within corporate groups is predominant and implies that employment growth in some firms is associated with a decrease in employment in other parts of the corporate group.[8] Corporate groups seem to allocate resources with respect to the efficiency (productivity) of the firms. The competition for employment resources seems to be more distinct within multinational corporate groups. MNEs more often tend to reduce employment in inefficient firms and extend production in productive counterparts.

The corporate group performance in terms of operating revenues- and total assets growth shows a somewhat different picture. Table 5 in the Appendix illustrates that only in multinational shareholder corporate groups the group performance negatively influences the operating revenues growth of an individual firm, while for all other samples the impact turns out to be positive but insignificant. Moreover, the negative impact is less pronounced compared to the employment growth regressions.

For corporate groups, defined through a common ultimate owner, the results concerning total assets growth indicate positive externalities so that all firms in one corporate group adjust their capital stock simultaneously (see columns 3 and 4 in Table 6). So within groups adjustment is slower, but average adjustment of the group is faster. This finding suggests with mutually positive externalities within groups in investment activity. In corporate groups, defined through a common shareholder, the corporate group effect

[8]To some extent this effect can be explained by a general downsizing tendency in recent years (Pryor 2001).

is insignificant and investment of an individual firm in the group remains unaffected.

The results concerning the between corporate group size convergence are reported in Table 3. The results are obtained using equation (10) and reported for the 25% percentile, the median and the 75% percentile of the average firm age distribution.

The findings suggest that the speed of adjustment between corporate groups differs across the three size variables, employment, operating revenues and total assets. The group externalities scale the between group speed of adjustment by $\frac{1}{1-\lambda}$. The size persistence is least pronounced in total assets between corporate groups defined through a common ultimate owner and is most distinct in employment. Moreover, the persistence in size differences increases in all size variables for old corporate groups. This result is line with findings in previous firm growth studies for lone standing firms, where the speed of adjustment decreases with firm age.

The between convergence results are robust with respect to the two definitions of groups. The speed of adjustment in terms of total assets tends to be faster in ultimate owner groups, while convergence in employment tends to be faster in shareholder groups. The between groups convergence results concerning operating revenues do not induce clear results. However, the operating revenues speed of adjustment between MNE corporate groups is faster in the (larger) ultimate owner groups.

Table 3: Average Adjustment Speed Across Corporate Groups (Employment, Operating Revenues, Total Assets)

Av. Age Distribution	Employment	Operating Revenues	Total Assets
All Shareholder Groups			
25% Percentile	-0.030^{***} (366.07)	-0.056^{***} (516.59)	-0.049^{***} (503.73)
50% Percentile	-0.027^{***} (371.17)	-0.050^{***} (518.79)	-0.044^{***} (504.88)
75% Percentile	-0.024^{***} (364.87)	-0.044^{***} (505.49)	-0.039^{***} (494.15)
Only Multinational Shareholder Groups			
25% Percentile	-0.023^{***} (141.18)	-0.044^{***} (225.86)	-0.042^{***} (211.39)
50% Percentile	-0.021^{***} (141.04)	-0.039^{***} (221.46)	-0.038^{***} (208.56)
75% Percentile	-0.020^{***} (136.33)	-0.035^{***} (210.43)	-0.034^{***} (201.12)
All Globalowner Groups			
25% Percentile	-0.024^{***} (165.48)	-0.052^{***} (234.39)	-0.057^{***} (122.41)
50% Percentile	-0.022^{***} (165.67)	-0.048^{***} (234.63)	-0.053^{***} (122.64)
75% Percentile	-0.020^{***} (162.86)	-0.044^{***} (231.90)	-0.049^{***} (122.11)
Only Multinational Globalowner Groups			
25% Percentile	-0.019^{***} (116.11)	-0.047^{***} (114.81)	-0.054^{***} (63.92)
50% Percentile	-0.018^{***} (113.91)	-0.043^{***} (113.69)	-0.049^{***} (63.60)
75% Percentile	-0.016^{***} (109.65)	-0.040^{***} (111.56)	-0.046^{***} (62.98)

Notes: Values of F-Statistic from non-linear Wald test given in parenthesis. The symbol *** stands for 1% significant.

The within equation and its partial derivative with respect to initial firm size allows to calculate the persistence of size differences within corporate groups. According to equation (12) the within group speed of adjustment varies over the corporate group size and the individual firm age. Table 4 shows the within coporate groups speed of adjustment results using equation (12) for the adjustment in employment. Thereby, the third column is derived by multiplying the first (corporate group size effect) and second column (age effect).[9]

For all three size variables the findings for the within group convergence are in contrast to earlier results. Concerning the impact of firm age we find that the within corporate group persistence of size differences increases with firm age. Furthermore, the effect is more pronounced in MNE corporate groups and is similar for both group definitions. However, the within speed of adjustment is reduced through the effect of the corporate group size. The reduction of the speed of adjustment is most distinct for small corporate groups. In small corporate groups the possibility to adapt more efficient production processes is limited compared to large groups, where division of economic activities is observable more often. The corporate group size effect indicates that within convergence is more pronounced in large corporate groups while the age effect leads to a higher speed of adjustment of young firms.

[9]For example, the within group speed of adjustment of a firm, which is organized in a national or MNE shareholder corporate group and is located at the 25% percentile of the corporate group size and firm age distribution, is approximately 3.4 percent.

Table 4: Speed of Adjustment Within Corporate Groups in Employment

Age Distribution	Corporate Group Size[1]	Firm Age[2]	Overall Effect
All Shareholder Groups			
25% Percentile	0.583^{***} (310.39)	-0.058^{***} (785.85)	-0.034^{***} (937.30)
50% Percentile	0.718^{***} (440.78)	-0.055^{***} (843.92)	-0.039^{***} (1446.46)
75% Percentile	0.830^{***} (519.54)	-0.052^{***} (916.67)	-0.043^{***} (1296.48)
Only Multinational Shareholder Groups			
25% Percentile	0.759^{***} (73.98)	-0.052^{***} (238.57)	-0.039^{***} (312.38)
50% Percentile	0.852^{***} (101.66)	-0.048^{***} (264.90)	-0.041^{***} (334.49)
75% Percentile	0.925^{***} (120.02)	-0.045^{***} (300.52)	-0.042^{***} (341.75)
All Globalowner Groups			
25% Percentile	0.715^{***} (129.96)	-0.055^{***} (437.34)	-0.039^{***} (496.31)
50% Percentile	0.964^{***} (163.47)	-0.051^{***} (484.76)	-0.046^{***} (560.40)
75% Percentile	0.968^{***} (172.05)	-0.047^{***} (551.03)	-0.045^{***} (582.00)
Only Multinational Globalowner Groups			
25% Percentile	0.890^{***} (38.04)	-0.052^{***} (315.17)	-0.047^{***} (340.54)
50% Percentile	0.958^{***} (47.44)	-0.048^{***} (354.18)	-0.046^{***} (375.86)
75% Percentile	0.987^{***} (51.17)	-0.044^{***} (411.74)	-0.043^{***} (421.21)

Notes: Values of F-Statistic from non-linear Wald test given in parenthesis. The symbol *** stands for 1% significant.

[1] The Corporate Group Size effect is calculated as $\left(\frac{m_r-1}{mr-1+\lambda}\right)\left(\frac{m_r-1}{m_r}\right)$. The effect is tested being different from 1.

[2] The firm age effect is calculated as $\beta_0 + \beta_1 A_{ir}$.

In our dataset firms organized in the large corporate groups are usually older than firms in small groups and large groups are more likely to act as MNE.[10] Our results indicate that the corporate group size effect tends to dominate the age effect. Therefore, the within speed of adjustment is high within large corporate groups containing old firms compared to small and young corporate groups. The only exception concerns MNE corporate groups which are formed by a common ultimate owner. In this group the speed of adjustment in firm size is highest for the corporate groups which are located at the 25% percentile in group size and individual firm age.

In Tables 7 and 8 in the Appendix the within corporate group convergence in operating revenues and total assets is displayed. The results are in line with the findings for employment convergence, with the exception of the speed of adjustment being higher for the different group definitions and all samples and persistence in firm size being least pronounced in MNE ultimate owner corporate groups. Size differences are least persistent in operating revenues. This result is not very suprising, since operating revenues might differ in its dynamics from input measures, such as employment and total assets. However, the speed of adjustment in total assets exceeds the corresponding effects for the employment convergence. This finding once more supports the hypothesis that during the observation period from 1996 to 2005 capital

[10]For example, the largest 10 percent of corporate groups defined through a common shareholder in the employment growth equation are on average 27.24 years old compared to an average of 23.74 years for the others and 62.34 percent of the largest corporate groups are MNEs while only 25.35 percent of the smaller corporate groups do business in more than one country.

became increasingly important in the production process within European corporate groups.

6 Conclusions

This paper proposes a firm growth model which explicitly incorporates interdependence in firm performance within corporate groups and is in line with most theories of firm growth. Using a large data base (AMADEUS) of manufacturing firms, the empirical investigation provides evidence for differences between national corporate groups and MNE corporate groups in terms of speed of adjustment.

The spillovers within corporate groups imply that the persistence in average coporate group size tends to be larger as compared to lone standing firms. However, competition within MNE corporate groups is more pronounced than in national corporate groups and within these corporate groups size adjustment is faster. Overall, within corporate groups the speed of adjustment in firm size systematically differs from the between corporate groups' speed of adjustment. Within large corporate groups size differences tend to be less persistent even if the firms are old. The empirical literature on firm growth thus seems to overestimate the speed of adjustment of young firms.

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Appendix Corporate Group Growth Results for Operating Revenues and Total Assets

Table 5: Corporate-Group Estimation of Operating Revenues Growth

Variable	(1)	(2)	(3)	(4)
Corporate Group Effect	0.029 (0.028)	-0.140^{***} (0.049)	0.033 (0.048)	-0.002 (0.078)
Initial Size	-0.100^{***} (0.003)	-0.094^{***} (0.004)	-0.091^{***} (0.003)	-0.094^{***} (0.003)
Age	-0.277^{***} (0.008)	-0.275^{***} (0.014)	-0.294^{***} (0.011)	-0.321^{***} (0.014)
Age^2	0.016^{***} (0.001)	0.014^{***} (0.002)	0.021^{***} (0.002)	0.021^{***} (0.002)
Initial Size * Age	0.017^{***} (0.001)	0.016^{***} (0.001)	0.015^{***} (0.001)	0.016^{***} (0.001)
Firm Productivity	0.036^{***} (0.003)	0.030^{***} (0.004)	0.034^{***} (0.003)	0.031^{***} (0.003)
Av. Group Productivity	0.004 (0.005)	0.015^{*} (0.008)	-0.016^{*} (0.008)	0.000 (0.012)
Industry-Country Fixed Effects	yes	yes	yes	yes
Within R^2	0.355	0.393	0.265	0.281
Observations	19,485	6,340	11,178	7,922

Notes: Standard errors are given in parenthesis. The symbols *, ** and *** stand for 10%, 5% and 1% significant. P-Values are given in parenthesis. Columns (1) and (2) give the results for corporate groups formed by shareholders. Columns (3) and (4) report the results for the ultimate owner corporate groups. Columns (1) and (3) include all corporate groups while in (2) and (4) only multinational corporate groups are considered.

Table 6: Corporate-Group Estimation of Total Assets Growth

Variable	(1)	(2)	(3)	(4)
Corporate Group Effect	−0.033 (0.029)	−0.089 (0.050)	0.210*** (0.060)	0.181** (0.090)
Initial Size	−0.084*** (0.002)	−0.084*** (0.003)	−0.082*** (0.003)	−0.087*** (0.003)
Age	−0.148*** (0.006)	−0.176*** (0.012)	−0.168*** (0.010)	−0.204*** (0.012)
Age^2	0.003*** (0.001)	0.005*** (0.002)	0.005*** (0.001)	0.007*** (0.002)
Initial Size * Age	0.013*** (0.002)	0.014*** (0.001)	0.013*** (0.001)	0.015*** (0.001)
Firm Productivity	0.035*** (0.004)	0.032*** (0.003)	0.042*** (0.003)	0.043*** (0.003)
Av. Group Productivity	0.006 (0.004)	0.016** (0.007)	−0.007 (0.007)	0.018* (0.010)
Industry-Country Fixed Effects	yes	yes	yes	yes
Within R^2	0.323	0.354	0.174	0.234
Observations	19,860	6,609	11,364	8,036

Notes: Standard errors are given in parenthesis. The symbols *, ** and *** stand for 10%, 5% and 1% significant. P-Values are given in parenthesis. Columns (1) and (2) give the results for corporate groups formed by shareholders. Columns (3) and (4) report the results for the ultimate owner corporate groups. Columns (1) and (3) include all corporate groups while in (2) and (4) only multinational corporate groups are considered.

Table 7: Speed of Adjustment Within Corporate Groups in Operating Revenues

Age Distribution	Corporate Group Size[1]	Firm Age[2]	Overall Effect
Age	**All Shareholder Groups**		
25% Percentile	0.514^{***} (1080.68)	-0.106^{***} (1479.33)	-0.055^{***} (2046.56)
50% Percentile	0.676^{***} (1146.88)	-0.106^{***} (1573.77)	-0.068^{***} (2921.25)
75% Percentile	0.806^{***} (1181.10)	-0.094^{***} (1692.95)	-0.076^{***} (2511.82)
	Only Multinational Shareholder Groups		
25% Percentile	0.581^{***} (161.60)	-0.100^{***} (570.65)	-0.058^{***} (420.94)
50% Percentile	0.787^{***} (253.10)	-0.094^{***} (620.61)	-0.074^{***} (884.53)
75% Percentile	0.893^{***} (258.20)	-0.086^{***} (687.27)	-0.077^{***} (841.90)
	All Globalowner Groups		
25% Percentile	0.656^{***} $(488, 41)$	-0.097^{***} (822.10)	-0.064^{***} (994.02)
50% Percentile	0.871^{***} (466.40)	-0.091^{***} (909.82)	-0.079^{***} (1079.45)
75% Percentile	0.948^{***} (460.96)	-0.084^{***} (1034.67)	-0.079^{***} (1119.12)
	Only Multinational Globalowner Groups		
25% Percentile	0.800^{***} (163.25)	-0.102^{***} (689.99)	-0.081^{***} (770.18)
50% Percentile	0.923^{***} (163.49)	-0.094^{***} (766.19)	-0.086^{***} (853.82)
75% Percentile	0.962^{***} (163.55)	-0.085^{***} (875.07)	-0.082^{***} (935.91)

Notes: Values of F-Statistic from non-linear Wald test given in parenthesis. The symbol *** stands for 1% significant.

[1] The Corporate Group Size effect is calculated as $\left(\frac{m_r-1}{mr-1+\lambda}\right)\left(\frac{m_r-1}{m_r}\right)$. The effect is tested being different from 1.

[2] The firm age effect is calculated as $\beta_0 + \beta_1 A_{ir}$.

Table 8: Speed of Adjustment Within Corporate Groups in Total Assets

Age Distribution	Corporate Group Size[1]	Firm Age[2]	Overall Effect
Age	**All Shareholder Groups**		
25% Percentile	0.517^{***} (994.19)	-0.089^{***} (1507.93)	-0.046^{***} (1899.60)
50% Percentile	0.678^{***} (1066.23)	-0.084^{***} (1605.51)	-0.057^{***} (2935.28)
75% Percentile	0.807^{***} (1103.68)	-0.079^{***} (1726.96)	-0.064^{***} (2573.66)
	Only Multinational Shareholder Groups		
25% Percentile	0.549^{***} (222.98)	-0.090^{***} (614.23)	-0.049^{***} (440.08)
50% Percentile	0.773^{***} (290.61)	-0.084^{***} (668.68)	-0.065^{***} (951.90)
75% Percentile	0.886^{***} (312.48)	-0.078^{***} (741.20)	-0.069^{***} (915.59)
	All Globalowner Groups		
25% Percentile	0.603^{***} (584.84)	-0.088^{***} (912.26)	-0.053^{***} (981.10)
50% Percentile	0.849^{***} (451.62)	-0.082^{***} (1007.62)	-0.069^{***} (1227.04)
75% Percentile	0.940^{***} (421.90)	-0.076^{***} (1142.11)	-0.071^{***} (1259.03)
	Only Multinational Globalowner Groups		
25% Percentile	0.765^{***} (200.04)	-0.094^{***} (792.61)	-0.072^{***} (854.49)
50% Percentile	0.902^{***} (180.38)	-0.087^{***} (878.56)	-0.078^{***} (1005.63)
75% Percentile	0.955^{***} (174.41)	-0.079^{***} (1003.37)	-0.075^{***} (1090.81)

Notes: Values of F-Statistic from non-linear Wald test given in parenthesis. The symbol *** stands for 1% significant.

[1] The Corporate Group Size effect is calculated as $\left(\frac{m_r-1}{mr-1+\lambda}\right)\left(\frac{m_r-1}{m_r}\right)$. The effect is tested being different from 1.

[2] The firm age effect is calculated as $\beta_0 + \beta_1 A_{ir}$.

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University of Innsbruck

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Harald Oberhofer and Michael Pfaffermayr

Firm Growth in Multinational Corporate Groups

Abstract

This paper formulates an econometric firm growth model that explicitly accounts for the interdependence of firm performance within corporate networks and is in line with several economic theories on firm growth. We estimate the model for national and multinational corporate groups (MNEs) using a recently introduced instrumental variable estimation procedure for peer group effects developed by Lee (2007). In our data for corporate groups the observation of fast growing young firms and slow growing old firms disappears if interdependence of firm performance within corporation networks is introduced.

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