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Firm growth, European industry dynamics and domestic business cycles

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Abstract

Based on the empirical firm growth literature and on heterogeneous (microeconomic) adjustment models, this paper empirically investigates the impact of European industry fluctuations and domestic business cycles on the growth performance of European firms. Since the implementation of the Single market program (SMP) the EU 27 member states share a common market. Accordingly, the European industry business cycle is expected to become a more influential predictor of European firms' behavior at the expense of domestic fluctuations. Empirically, the results of a two-part model for a sample of European manufacturing firms reject this hypothesis. Additionally, subsidiaries of Multinational Enterprises (MNEs) constitute the most stable firm cohort throughout the observed business cycle.

JEL Codes: L11, L16, L25
Keywords: Firm growth, industry dynamics, domestic business cycle, European integration, multinational enterprises, two-part model

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1 Introduction

The global economy, especially industrialized regions such as the United States of America (USA) and the European Union (EU), has been facing a severe downturn since the midyear of 2008. Recent data of EU 27 total manufacturing industry production have shown negative annual growth rates since May 2008 with a maximum (in absolute terms) of about minus 19.4 percent in April 2009 (EUROSTAT 2009). At the same time, the harmonized unemployment rate increased from 6.8 percent in May 2008 to 8.9 percent in May 2009 (EUROSTAT 2009). However, countries within the EU 27 are asymmetrically affected by the recession. For instance, in December 2008 Lithuania reported an annual total manufacturing industry production growth rate of -3.9 percent while the Czech Republic (preliminary) reports a 17 percent decline in total manufacturing industry production (EUROSTAT 2009).

Additionally, some sectors within the European manufacturing industries seem to be more affected by the general downturn. For example, news on TV and in the print media stress the dramatic downturn in the car manufacturing industry, where prestigious producers such as the US *Ford Motor Company* or the German *OPEL AG* struggle for their survival. In contrast other manufacturing industries seem to be confronted with regular cyclical production movements.

With the implementation of the Single Market Program (SMP) in the European Communities in 1992 the member states of the European Union (EU) committed themselves to dispose all remaining barriers to the free flow of goods, services, persons and capital. The SMP aims at finally constituting a single (European) market. Therefore, this common market forms the target market of most firms located within the boundaries of the EU 27.[1] However, the domestic market might still be important, especially for small firms, since these firms more probably serve the domestic market only (see, e.g., Aw and Lee 2008).

This paper contributes to the understanding of the influence of business cycles on firm performance in three ways: (i) It disentangles the impacts of

[1] Geroski and Gugler (2004) empirically investigate the hypothesis of convergence in firm sizes within European industries after the implementation of the SMP and find no evidence for increased convergence due to the SMP.

(overall) European industry fluctuations and domestic business cycles, (ii) it takes non-reaction of firms (i.e. zero growth rates) explicitly into account and (iii) it distinguishes between purely national firms and subsidiaries of multinational enterprises (MNEs).[2] In addition, this paper combines the empirical firm growth literature and heterogeneous (microeconomic) adjustment models and tests for heterogeneous reaction to business cycle movements of different firm cohorts.

In general, the empirical firm growth literature tests for the (ir)-relevance of certain firm characteristics with respect to the growth dynamics of individual firms. Thereby, special attention has been put to the effect of (initial) firm size, usually measured in terms of employment, on firm growth (*Gibrat's law* of proportionate growth) and whether convergence in firm size for a given age cohort is observable (see Evans 1987a; Sutton 1997; Audretsch, Klomp, Santarelli and Thurik 2004; Bellak 2004; Cabral 2007 for surveys on the empirical firm growth literature).

Based on the seminal contribution of Caballero and Engel (1993), the heterogeneous (microeconomic) adjustment models explain the probability of reaction and the extent of the reaction to a common external shock as a function of the absolute difference between the desired and the actual state of a certain microeconomic unit.[3] Consequentially, some microeconomic units (i.e. firms) react to a common shock while others remain in their actual state. This, in turn, generates heterogeneity in the observed reactions. The overall reaction depends on the cross-sectional distribution of the difference between the desired and the actual state across all units.[4]

Combining the empirical firm growth literature and heterogeneous adjustment models, the empirical specification in this paper allows for heterogeneous adjustment to European industry fluctuations and domestic business cycles of several firm cohorts. The structure of the European firm level

[2]European industry fluctuations and domestic business cycles are measured using value added data, whereas firm growth is measured in terms of employment.

[3]Some extensions of the basic structure of the heterogeneous adjustment model, investigations of special policies and studies of lumpy investment behavior have been put forward by i.a., Caballero and Engel (1999); Cooper, Haltiwanger and Power (1999) and Adda and Cooper (2000).

[4]Cooper (1998) surveys the heterogeneous (microeconomic) adjustment models and compares their policy implications with conclusions drawn from two other (large) strands of the theoretical business cycle literature (i.e. stochastic growth models and macroeconomic complementarities).

data at hand (provided by AMADEUS database) supports a two-part model. The first part allows to capture the probability of reaction to business cycle fluctuations whereas the second part examines the extent of the observed reaction.

In contrast to existing related empirical literature, this paper focuses on a large sample of firms observed over only one European business cycle (2000 to 2003). Higson, Holly and Kattuman (2002) and Higson, Holly, Kattuman and Platis (2004) analyze the impact of several business cycles on cross-sections of quoted firms in the United States and the United Kingdom. However, they are interested in the evolution of the long-run cross-sectional moments of the firm growth distribution over time while this paper analyzes the impact of short-run business type fluctuations on the growth performance of firm cohorts which share comparable characteristics.

We find that domestic business cycles more accurately predict the probability of reaction and the extent of the (non-zero) reaction compared to European industry fluctuations. Furthermore, within each cross-section firms tend to react homogeneously to European business cycle movements. In contrast, fluctuations in domestic demand lead to heterogeneous adjustment. Additionally, the growth performance of fast growing small and young firms is more sensitive to recessions and booms compared to larger and older firms as well as subsidiaries of MNEs.

The remainder of the paper is organized as follows. Section 2 describes the data and presents some descriptive statistics. Section 3 specifies the two-part model and outlines the estimation strategy. Section 4 presents the estimation results and Section 5 concludes.

2 Data and descriptive statistics

We base the empirical analysis on data for manufacturing industries provided by several sources. Industry level value added to factor costs data are collected by the Austrian Institute of Economic Research (WIFO) and are available at the NACE (revsion 1.1) 3-digit level (NACE codes 151 to 366) for the EU 27. Exceptions are Bulgaria, Luxembourg and Romania. These figures were collected from 1985 to 2006 if available and from the late 1990s onward for most Eastern European countries. The industry level data allow to construct annual (overall) European industry growth rates and country specific total manufacturing value added growth rates.

Firm level data is provided by the AMADEUS database.[5] Information concerning firm size and firm age is gathered from the update 146 (November 2006) version of AMADEUS, while older versions of AMADEUS are used to identify subsidiaries of MNEs. Accordingly, we extract the subsidiary status of a particular firm in each year using corresponding annual updates of the AMADEUS database. For example, information from the AMADEUS version November 2001 (update 86) is used to identify subsidiaries of MNEs in the year 2000. For this study the earliest available version of AMADEUS is from November 2001 and, therefore, limits the scope of the empirical investigation to the years from 2000 onwards. Additionally, the number of usable observations in the November 2006 version decreases dramatically for the years 2005 and 2006. For these two reasons, a reliable empirical investigation is limited to the time span between 2000 and 2004. Within this time period we observe three years (2000, 2001, 2004) with an average increase in European industry value added and two years (2002, 2003) with negative industry value added growth rates. The accomplished analysis is based on the years 2000 to 2003 to isolate the effects of one single business cycle. Additionally, to assure a reasonable comparison of the effects of business type fluctuations on firm growth only firms which are observed throughout the whole sample period are included. This leads to a final sample size of 122,493 firms within 14 European countries which are observed in all four years.[6]

In contrast to Boeri and Bellmann (1995) and Bhattacharjee, Higson, Holly and Kattuman (2009), this paper solely focuses on the impact of cyclical fluctuations on the performance of surviving firms. Since the AMADEUS database only poorly reports firm exit, a reliable analysis of these firms is impossible. However, existing empirical evidence indicates a limited importance of business cycles for firm exit (Boeri and Bellmann 1995; Bhattacharjee et al. 2009).

[5]The Bureau van Dijk distributes the AMADEUS database, which (in its update from November 2006) includes financial statements, profit and loss accounts and information on companies' organizational structure of 8.8 million firms located in 40 European countries.

[6]The list of countries include 2 new member states, namely Poland and Slovakia, and 12 countries which are part of the EU 15. The full list of countries is reported in Table 3.

Table 1: Sample composition of growing and non-growing firms and average firm specific firm growth rate, average European industry value added growth rate and average country specific total manufacturing value added growth rates

Year	Total Obs.	Obs.: $g_i \neq 0$	Obs.: $g_i = 0$	Share: $g_i = 0$	$\bar{g}_i$	$\bar{g}_j$	$\bar{g}_c$
2000	122,493	77,404	44,789	0.366	0.081	0.022	0.060
2001	122,493	75,983	46,510	0.380	0.041	0.025	0.023
2002	122,493	73,725	48,768	0.398	0.007	−0.007	0.010
2003	122,493	74,289	48,204	0.393	−0.007	−0.007	0.011

Notes: g_i, g_j, g_c denote firm growth rate, European NACE 2-digit industry value added growth rate and average country specific total manufacturing value added growth rate, respectively. The share: $g_i = 0$ is measured as proportion of all 122,493 firms.

Table 1 summarizes the sample composition and the average firm growth rate (measured in terms of employment), average European industry value added growth rate and average country specific total manufacturing value added growth rate. The growth rates are calculated using the first difference of levels of the respective variables. The average firm growth rate tend to be higher compared to the European industry growth rate and the total manufacturing growth rate. Worth noting is the recession year 2003 where both the European industry growth rate and the average firm growth rate is negative, while the country specific total manufacturing growth rate is positive on average. Additionally, the country specific total manufacturing growth rates are higher in comparison to the European industry growth rates. Here the only exception is the year 2001 where the increase in European industry value added is slightly higher than the average total manufacturing industry growth rate.

Most interestingly, Table 1 depicts the number of firms which show non-zero growth rates, zero growth rates and the share of the firms with zero growth rates. The share of firms with exactly the same number of employees in two subsequent years amounts to more than 36 percent of all observed firms, indicating that a non-negligible fraction of firms does not react to any type of business fluctuations.

Tables 2 and 3 show descriptive statistics for the relationship between firm growth, European industry growth and country specific total manufacturing growth at a more disaggregated level, while in Table 4 a simple analysis of variance (ANOVA) is reported. The ANOVA allows to split

Table 2: Average firm specific employment growth rates in terms and European NACE 2-digit industry value added growth rates

Industry	Obs.	2000		2001		2002		2003	
		Firm-i	Industry	Firm-i	Industry	Firm-i	Industry	Firm-i	Industry
Manufacture of food products and beverages	14,163	0.068	−0.002	0.036	0.088	0.021	0.006	0.004	0.019
Manufacture of tobacco products	57	0.113	0.048	0.033	0.119	0.046	−0.045	−0.032	0.017
Manufacture of textiles	5,217	0.067	0.013	0.020	0.003	−0.005	−0.052	−0.023	−0.058
Manufacture of wearing apparel; dressing and dyeing of fur	3,303	0.068	0.001	0.009	0.029	−0.004	−0.053	−0.027	−0.075
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	2,624	0.110	−0.010	0.034	0.052	0.004	−0.046	−0.027	−0.061
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	6,157	0.069	−0.004	0.014	0.057	0.004	−0.017	−0.006	−0.004
Manufacture of pulp, paper and paper products	2,554	0.085	0.089	0.039	0.002	0.010	0.005	−0.012	−0.047
Publishing, printing and reproduction of recorded media	11,783	0.059	0.014	0.026	0.001	0.000	−0.022	−0.017	−0.051
Manufacture of chemicals and chemical products	5,045	0.079	0.061	0.058	0.001	0.014	0.043	0.004	−0.005
Manufacture of rubber and plastic products	5,763	0.095	0.024	0.035	0.034	0.009	0.013	0.001	−0.005
Manufacture of other non-metallic mineral products	6,671	0.099	−0.007	0.048	0.026	0.011	0.001	−0.003	0.000
Manufacture of basic metals	2,371	0.073	0.125	0.045	−0.030	−0.002	−0.051	−0.005	−0.003
Manufacture of fabricated metal products, except machinery and equipment	22,693	0.082	0.010	0.048	0.013	0.005	0.012	−0.004	0.021
Manufacture of machinery and equipment n.e.c.	12,161	0.098	0.045	0.074	0.045	0.013	−0.024	−0.005	−0.008
Manufacture of office machinery and computers	617	0.117	−0.061	0.069	−0.117	−0.008	−0.079	−0.017	−0.026
Manufacture of electrical machinery and apparatus n.e.c.	4,163	0.102	0.081	0.053	−0.027	0.002	−0.006	−0.010	0.003
Manufacture of radio, television and communication equipment and apparatus	1,590	0.119	0.201	0.048	−0.250	−0.011	−0.042	−0.019	0.012
Manufacture of medical, precision and optical instruments, watches and clocks	3,982	0.065	0.054	0.051	0.017	0.012	0.025	−0.002	0.023
Manufacture of motor vehicles, trailers and semi-trailers	2,182	0.097	0.025	0.034	0.049	0.005	−0.004	−0.001	0.043
Manufacture of other transport equipment	1,520	0.087	−0.041	0.049	0.095	0.005	−0.023	−0.012	0.024
Manufacture of furniture; manufacturing n.e.c.	7,877	0.078	0.008	0.021	0.035	−0.002	−0.020	−0.015	−0.031
Correlation		0.300		-0.113		0.584		0.816	

Notes: Firm-i refers to the average employment growth rate of firms within the sample in a given NACE 2-digit industry in the respective year. Industry refers to the European value added growth rate in a given NACE 2-digit industry based on 24 countries in in the respective year and is calculated as an average of the value added growth rates of all NACE 3-digit industries within a given NACE 2-digit industry.

the variation in the individual firm growth rates into country and industry specific parts. Table 2 reports the average firm growth rate within a given NACE 2-digit industry (firm-i), the corresponding average European industry value added growth rate and the correlation between both for each observed year. The European NACE 2-digit industry value added growth rate is calculated by averaging all NACE 3-digit industry growth rates within each NACE 2-digit industry. Focusing only on the average firm growth rate, one observes positive growth rates in all European NACE 2-digit industries in the years 2000 and 2001 and negative growth rates in 6 (18) out of 21 industries in 2002 (2003). Concerning European industry growth, it turns out that even in booming years (2000, 2001) some industries exhibit negative growth rates. Comparing firm level average growth rates and industry average growth rates we observe the same growth pattern for the majority for firm-industry pairs. More specifically, in 56 out of 84 firm-industry pairs both show the same sign, indicating that either average firm and industry growth rates are positive or both are negative. However, most of the firm-industry pairs show a substantial deviation between the average firm growth rate and the corresponding NACE 2-digit industry growth rate. Therefore, the European industry cycle only partially explains the growth performance of the average firm within its corresponding manufacturing industry. Additionally, the correlation between the firm level and the industry level average growth rates fluctuates in a very broad range from -0.113 in 2001 and 0.816 in 2003 indicating that the European industry value added growth rates might exert different effects on firm performance at different points of the business cycle.

Table 3 reports the average firm growth rate (firm-c) and the total manufacturing value added growth rate for each country and year. The reported figures support the view that in general the years 2000 and 2001 were booming years while we observe a recession in 2002 and 2003. Only two countries (i.e. Austria and Slovakia) show slightly negative growth rates in 2000 according to the average firm performance. Additionally, Table 3 shows that some countries deviate dramatically from the European business cycle. For example, in 2000 the majority of countries in the sample (i.e. 8 out of 14 countries) show total manufacturing growth rates in a range from 6 to 10 percent while in Germany (Slovakia) manufacturing industry production de-

Table 3: Average firm specific employment growth rates and countries total manufacturing value added growth rates

Country	Obs.	2000		2001		2002		2003	
		Firm-c	Country	Firm-c	Country	Firm-c	Country	Firm-c	Country
Austria	128	−0.011	0.061	0.009	0.001	0.014	0.045	0.003	0.008
Belgium	9,840	0.052	0.034	0.031	0.035	0.000	−0.005	−0.020	−0.002
Finland	2,633	0.051	0.133	0.024	0.036	0.002	−0.026	−0.013	−0.044
France	19,284	0.040	0.025	0.023	0.029	0.000	0.002	−0.011	−0.015
Germany	10,287	0.037	−0.089	0.014	0.008	−0.001	−0.032	−0.013	0.010
Great Britain	9,082	0.024	0.079	0.002	−0.045	−0.019	−0.012	−0.031	−0.094
Greece	4,285	0.013	0.082	0.001	0.126	0.000	0.141	0.001	0.158
Italy	18,356	0.193	0.085	0.154	0.023	0.042	0.008	0.011	0.004
Netherlands	648	0.019	0.082	0.017	−0.029	−0.016	0.024	−0.007	−0.002
Poland	2,163	0.668	0.101	−0.010	0.452	−0.006	−0.327	−0.013	−0.070
Portugal	71	0.000	−0.008	0.008	−0.017	−0.020	0.024	−0.029	−0.008
Slovakia	131	−0.005	0.207	0.000	0.326	0.000	0.012	0.005	0.131
Spain	30,440	0.075	0.085	0.032	0.056	0.009	0.048	0.000	0.041
Sweden	15,145	0.037	0.099	0.017	−0.103	−0.003	0.019	−0.013	0.042
Correlation		0.246		-0.006		0.151		0.541	

Notes: Firm-c refers to the average employment growth rate of all firms within a given country in the respective year. Country refers to (total) value added growth rate within a given country in the respective year.

clined (increased) by about 9 (21) percent. However, similar to Table 2, the country specific average firm growth rates and corresponding total manufacturing value added growth rates indicate a recession in the years 2002 and 2003. The correlation between both measures is again negative in the year 2001 and in its magnitude comparable to the correlation shown in Table 2.

The ANOVA, displayed in Table 4, allows to split the variation in the annual firm growth rates into two parts, one which can be explained by the model and the second which is unexplained. More specifically, the model contains country dummies, industry dummies (main effects) as well as interaction terms between the main effects. The country dummies capture the variation in domestic demand while industry dummies examine European industry fluctuations. In general, Table 4 shows that this dummy variable design explains only a relatively small fraction of the variation in the firm growth rates and the explanatory power becomes even worse for the recession years 2002 and 2003. The goodness of fit measured via R^2 is highest in the first year of the sample, while in 2003 the model is only able to explain 1.6 percent of the variation in the dependent variable.

Only the country dummies significantly explain some parts of the variation in the firm growth rate throughout the whole sample period. This, in turn, indicates the relevance of country specific effects (within the European Union) for the growth performance of the observed firms. Surprisingly, the industry effects are (statistically) insignificant throughout, suggesting minor variations in the firm growth rates across the 98 industries. The interaction effects which allow for deviations from the main effects are only significant in the years 2000 and 2001 and only explain a small fraction of the variation in the dependent variable given the huge number of interaction terms (i.e. 1056). In other words, the variation in the growth rates of firms within a particular country is poorly explained by the fact that the firms operate in different industries.

Taking the descriptive evidence together, the data surprisingly deliver a first indication of the limited importance of European industry fluctuations for the performance of firms in this sample. The country of origin tends to be still important for differences in firm performance across Europe. However, neither European industry effects nor country specific effects seem to reasonably predict firm performance. However, a more systematic analysis of the data is needed to draw final conclusions. Therefore, econometrically we set up a two-part model in the next section.

3 Empirical specification and estimation strategy

We estimate the impact of business type fluctuations on firm performance at each point within one European business cycle. Subsequently, each annual cross-section of firms is separately investigated. In contrast to econometric panel data methods, this approach allows to identify different effects at several stages of the business cycles. Additionally, the very short time span in the data set renders dynamic panel estimation impossible. Unfortunately, this approach is unable to control for unobserved heterogeneity across firms. However, the majority of contributions in the empirical firm growth literature uses cross-sectional data, which permits a direct comparison with the obtained results.

The structure of the data (see Table 1) requires a careful consideration of the non-reacting firms. Accordingly we consider a two-part model. The first part describes the binary choice between reaction and non-reaction to business cycle fluctuations for a particular firm i in period t:

$$y_{it}^* = \begin{cases} 0 \text{ for } g_{it} = 0 \\ 1 \text{ for } g_{it} \neq 0. \end{cases} \tag{1}$$

Based on equation (1) we parameterize the probability of $y_{it}^* = 1$ such that:

$$P(y_{it}^* = 1|\mathbf{x}_{it}) = P(g_{it} \neq 0|\mathbf{x}_{it}) = F(\mathbf{x}_{it}\beta), \tag{2}$$

where $F(.)$ is the cumulative logistic function, β is a vector of estimation coefficients and $\mathbf{x}_{it}$ contains the explanatory variables of firm i at time t.

In contrast to standard formulations of two-part models the dependent variable in our model is not restricted in any way.[7] Accordingly, the second part of the model which only governs the non-zero outcomes of the dependent variable (i.e. the current annual firm growth rate g_{it}) is modeled under the

[7] Typically, two-part models are used in health economics (see, e.g., Duan, Manning, Morris and Newhouse 1983; Pohlmeier and Ulrich 1995) or for fractional response variables (see, e.g., Oberhofer and Pfaffermayr 2009; Ramalho and Vigidal da Silva 2009) where the dependent variable is either restricted to $\mathbb{R}^+$ (e.g. demand for health care) or confined to the [0,1] interval (e.g. financial leverage).

Table 4: Analysis of variance of the firm growth rate

	Growth 2000			Growth 2001			Growth 2002			Growth 2003		
Source	Abs.	in %	P-value	Abs.	in %	P-value	Abs.	in %	P-value	Abs.	in %	P-value
Country effects	339.72	2.6	0.000	51.60	0.9	0.000	7.26	0.2	0.000	3.56	0.1	0.000
Industry effects	9.43	0.1	0.404	2.77	0.0	0.998	2.43	0.0	0.942	3.78	0.1	0.369
Country * Industry effects	220.46	1.7	0.000	118.83	2.0	0.000	34.48	0.9	0.287	41.45	0.9	0.130
Constant (Overall mean)	808.04	6.3	-	277.93	4.7	-	39.75	1.0	-	25.03	0.5	-
Model	1,377.65	10.7	0.000	451.13	7.6	0.000	83.92	2.1	0.000	73.82	1.6	0.000
Residual	11,474.32	89.3	-	5,507.45	92.4	-	3,871.83	97.9	-	4,541.94	98.4	-
Total	12,851.97	100.0	-	5,958.58	100.0	-	3,955.75	100.0	-	4,615.76	100.0	-

Notes: 122,493 observations for each year. P-values are based on F-tests according to 13 d.f. (degrees of freedom) for Country Effects, 97 d.f. for Industry Effects and 1055 d.f. for Country * Industry Effects.

linearity assumption:

$$E(y_{it}|\mathbf{x}_{it}, y^*_{it} = 1) = \mathbf{x}_{it}\gamma, \tag{3}$$

where γ is another vector of parameters to be estimated with ordinary least squares (OLS) and $\mathbf{x}_{it}$ is defined as above. Note that, in principle, the firm specific vector of explanatory variables ($\mathbf{x}_{it}$) does not need to be the same in the first and second part of the model. Since the two-part model allows the explanatory variables to affect the probability of an outcome and the magnitude of the non-zero outcome in a different way, in this application the same explanatory variables are included in both parts of the model.

Furthermore, the conditional mean of the two-part model is given by:

$$E(y_{it}|\mathbf{x}_{it}) = P(y^*_{it} = 1|\mathbf{x}_{it})E(y_{it}|\mathbf{x}_{it}, y^*_{it} = 1). \tag{4}$$

Since $E(y^*_{it} = 0|\mathbf{x}_{it}) = 0$, the conditional mean function simply reduces to the conditional mean of non-zero outcomes multiplied with the probability of a non-zero outcome. In addition, equation (4) provides an easy way to calculate conditional means for different firm cohorts.

The empirical model contains firm specific characteristics (i.e. firm size, firm age and information concerning the current MNE subsidiary status) as explanatory variables. Moreover, European NACE 3-digit industry value added growth rates a country's total value added growth rates and interactions between all firm characteristics and the (European and total manufacturing) value added growth rates are included in $\mathbf{x}_{it}$.

Firm size and firm age are captured by dummy variables based on the quartiles of the respective distributions in the previous year. Technically, each distribution is split into its quartiles and four dummy variables are constructed indicating whether a firm is located within the respective quartile of each distribution. This approach enables us to construct different cohorts of firms which share similar characteristics. Consequently, this approach delivers a straight-forward testing procedure for the hypothesis of heterogeneous adjustment to business type fluctuations. The interaction terms of several firm characteristics with European industry value added growth rates and domestic total manufacturing growth rates capture potential heterogeneity with respect to the adjustment to business type fluctuations. In contrast to heterogeneous adjustment models, reaction to the business cycles is only modeled to be heterogeneous across firm cohorts, while within each cohort the reaction is assumed to be homogeneous.

One strand of the the empirical firm growth literature argues that firm growth dynamics differ between purely national companies and subsidiaries of MNEs (see, Buckley, Dunning and Pearce 1984; Cantwell and Sanna-Randaccio 1993; Bloningen and Tomlin 2001; Belderbos and Zou 2007; Oberhofer and Pfaffermayr 2008). Accordingly, we hypothesize that subsidiaries of MNEs react differently to business cycle fluctuations. As mentioned above, information on the organizational structure of firms is only reported for one point in time in each AMADEUS version. Therefore, we use several different versions of the database to construct a dummy variable which for each firm in each year takes on the value 1 if the firm is a subsidiary of a MNE and 0 otherwise.[8]

4 Estimation results

Table 5 summarizes the results of the two-part model, where the logit model (first part) is reported in the first column of each year. The second column shows the OLS results concerning the firms with $g_{it} \neq 0$. In accordance with Moulton (1990), we calculate robust standard errors clustered by industry-country which take correlation in the error terms within the industry and total manufacturing growth rate aggregates into account. The smallest, youngest, non-MNE subsidiary firms build the reference group. The effects of their firm characteristics are captured by the constant.

The OLS results concerning the main effects of the firm characteristics are in line with standard results put forward by the empirical firm growth literature. The smallest, youngest, non-MNE subsidiary firms show the highest growth rates throughout the whole sample period. This, in turn, indicates conditional convergence in firm size. The age effects also indicate convergence in firm sizes, which implies that young firms show higher growth rates than their older counterparts. Both results are well-known from *Gibrat's*

[8] On average, subsidiaries of MNEs make up approximately 1 percent of all firms in the sample with the exception of the year 2001, where only half a percent belongs to a MNE network. This feature of the data is well in line with observations concerning more aggregated FDI data (see, e.g., Figure 1 in Mody 2004). However, the firm level information shows an increase in the number of MNE subsidiaries already in 2002.

Law type of regressions (see, e.g., Evans 1987b; Variyam and Kraybill 1992; Cabral 2007). The logit models indicate that large firms are more likely to exhibit non-zero growth rates compared to the reference group. This result indicates that convergence in firm size might be driven by the fact that small, young, non-MNE subsidiary firms are more likely to show a constant firm size (i.e. $g_{it} = 0$), than large firms which tend to have negative growth rates.

The main effects concerning the European business cycle indicate a procyclical influence on individual firm growth rates for the years 2000 and 2002. Otherwise, European industry fluctuations do not seem to influence the probability of an adjustment captured by the main effect. Additionally, the interaction effects are insignificant throughout. The only remarkable exception is the year 2002, where the European business cycle tend to negatively affect older firms. Overall, the explanatory power of the European business cycle seems to be very limited.

Concerning the impact of domestic business type fluctuations on firm performance, we detect more systematic relationships. The main effect of domestic business cycles is positive and significant in both parts of the model, indicating that an increase in domestic demand increases the probability of non-zero growth rates for the smallest, youngest, non-MNE subsidiary firms and positively influences the growth rates of the respective firms. The interaction effects support the hypothesis of heterogeneity in the adjustment. Compared to the reference group, large firms tend to more likely adjust their firm size in the year 2000, while for the other years an adjustment is less likely. Furthermore, larger firms exhibit lower growth rates at all points of the domestic business cycle. Consequently, the stylized fact of convergence in firm sizes (i.e. faster growing small firms) is robust with regard to domestic cyclical fluctuations.

Finally, the MNE subsidiary main effect indicates a higher probability of non-zero growth rates compared to the smallest, youngest, non-MNE subsidiary firms in the sample. Nevertheless, the estimated growth rate of MNE subsidiaries is statistically not different from the growth rate of the reference group. Here the only exception is the year 2000 where MNE subsidiaries show moderately higher growth rates. The interaction effects of the MNE dummy with the European industry growth rate are insignificant

Table 5: Estimation results: Probability of reaction (LOGIT) and non-zero growth rates (OLS)

	2000		2001		2002		2003	
Variable	LOGIT	OLS	LOGIT	OLS	LOGIT	OLS	LOGIT	OLS
Constant	−0.430***	0.360***	−0.521***	0.156***	−0.729***	0.052***	−0.567***	0.001
	(0.038)	(0.025)	(0.030)	(0.006)	(0.046)	(0.006)	(0.040)	(0.006)
Size 2	0.495***	−0.252***	0.988***	−0.059***	1.038***	−0.024***	1.127***	−0.004
	(0.033)	(0.023)	(0.042)	(0.008)	(0.048)	(0.006)	(0.035)	(0.006)
Size 3	0.987***	−0.270***	1.745***	−0.075***	1.736***	−0.020***	1.864***	0.007
	(0.042)	(0.025)	(0.050)	(0.007)	(0.059)	(0.006)	(0.043)	(0.006)
Size 4	1.802***	−0.283***	2.556***	−0.116***	2.499***	−0.032***	2.460***	0.009
	(0.060)	(0.026)	(0.061)	(0.008)	(0.078)	(0.006)	(0.070)	(0.006)
Age 2	−0.118***	−0.055***	−0.103***	−0.017***	−0.063**	−0.015***	−0.136***	−0.013***
	(0.030)	(0.010)	(0.028)	(0.005)	(0.030)	(0.003)	(0.032)	(0.003)
Age 3	−0.288***	−0.060***	−0.046	−0.013*	0.000	−0.019***	−0.103***	−0.018***
	(0.036)	(0.011)	(0.041)	(0.007)	(0.041)	(0.003)	(0.041)	(0.003)
Age 4	−0.321***	−0.084***	−0.286***	−0.030***	−0.217***	−0.038***	−0.414***	−0.032***
	(0.042)	(0.009)	(0.044)	(0.007)	(0.042)	(0.003)	(0.050)	(0.003)
MNE	0.848***	0.026*	0.495***	0.012	0.470***	−0.007	0.489***	−0.008
	(0.143)	(0.012)	(0.157)	(0.008)	(0.099)	(0.005)	(0.095)	(0.006)
European industry growth	−0.064	0.605*	0.274	−0.088	−0.590	0.298***	−0.298	0.181
	(0.726)	(0.361)	(0.386)	(0.078)	(0.914)	(0.100)	(0.862)	(0.158)
Total manufacturing growth	1.886***	1.101***	3.371***	0.515***	2.723**	0.520***	−3.653***	0.688***
	(0.673)	(0.365)	(0.402)	(0.079)	(1.115)	(0.188)	(0.916)	(0.212)
Size 2 * European industry growth	0.326	−0.372	−0.390	0.012	−0.387	−0.088	−0.377	−0.034
	(0.619)	(0.392)	(0.399)	(0.089)	(0.716)	(0.101)	(0.762)	(0.148)
Size 3 * European industry growth	0.989	−0.401	−0.661	−0.024	−0.203	−0.090	−0.000	−0.016
	(0.825)	(0.422)	(0.547)	(0.085)	(0.861)	(0.101)	(0.893)	(0.150)
Size 4 * European industry growth	1.780	−0.535	−1.118	0.096	0.153	−0.105	0.186	−0.076
	(1.121)	(0.429)	(0.778)	(0.098)	(1.067)	(0.104)	(1.141)	(0.155)
Age 2 * European industry growth	0.248	0.026	0.143	−0.010	0.482	−0.150**	−0.452	0.068
	(0.524)	(0.100)	(0.382)	(0.063)	(0.631)	(0.060)	(0.504)	(0.073)
Age 3 * European industry growth	0.360	−0.007	−0.023	−0.012	0.226	−0.113**	−0.043	0.081
	(0.651)	(0.131)	(0.461)	(0.074)	(0.774)	(0.055)	(0.675)	(0.069)
Age 4 * European industry growth	0.108	−0.039	−0.220	0.079	0.456	−0.091*	−0.191	0.079
	(0.737)	(0.122)	(0.649)	(0.087)	(0.976)	(0.055)	(0.882)	(0.067)
MNE * European industry growth	−1.137	−0.138	0.199	−0.071	2.915	−0.073	2.038	0.012
	(1.590)	(0.124)	(1.638)	(0.113)	(1.906)	(0.111)	(1.779)	(0.108)
Size 2 * total manufacturing growth	3.870***	−1.164***	−5.743***	−0.549***	−3.984***	−0.591***	−5.234***	−0.469**
	(0.611)	(0.367)	(0.625)	(0.097)	(0.740)	(0.181)	(0.789)	(0.205)
Size 3 * total manufacturing growth	6.372***	−1.075***	−8.576***	−0.723***	−7.523***	−0.615***	−10.268***	−0.547***
	(0.737)	(0.402)	(0.830)	(0.083)	(1.196)	(0.188)	(0.971)	(0.209)
Size 4 * total manufacturing growth	8.158***	−0.723*	−7.154***	−0.637***	−4.516***	−0.529***	−10.762***	−0.405***
	(1.032)	(0.417)	(0.510)	(0.083)	(1.347)	(0.189)	(1.502)	(0.216)
Age 2 * total manufacturing growth	0.065	0.333**	1.302***	0.110***	0.661	0.037	1.321**	−0.098
	(0.458)	(0.138)	(0.234)	(0.035)	(0.488)	(0.036)	(0.515)	(0.078)
Age 3 * total manufacturing growth	2.214***	0.341**	−0.701	0.147**	−2.467**	−0.044	−0.322	−0.136*
	(0.503)	(0.157)	(0.434)	(0.058)	(1.027)	(0.059)	(0.813)	(0.070)
Age 4 * total manufacturing growth	2.638***	0.583***	1.750***	0.115**	4.606***	0.201***	4.170***	−0.045
	(0.643)	(0.145)	(0.367)	(0.045)	(1.290)	(0.044)	(1.101)	(0.071)
MNE * total manufacturing growth	−4.370***	−0.766***	−7.285**	0.268*	3.127	0.080	2.328	0.001
	(1.779)	(0.178)	(3.519)	(0.159)	(2.468)	(0.089)	(2.480)	(0.134)
R^2-Measures[a]	0.129	0.116	0.124	0.029	0.122	0.010	0.150	0.006
N	122,493	77,704	122,493	75,983	122,493	73,725	122,493	74,289

Notes: Robust standard errors clustered by industry-country in parentheses. [a]For the LOGIT (OLS) models the Pseudo R^2 (usual R^2) is reported.

throughout. This in turn, indicates similar adjustment to European industry fluctuations in comparison to the reference group. Additionally, domestic business cycles decrease the probability of non-zero growth rates for MNEs in the years 2000 and 2001, while in recession years MNEs adjust their firm size with equal probability compared to the smallest, youngest, non-MNE subsidiary firms. Only in the year 2000 MNE subsidiaries show a significantly negative growth reaction in consequence of domestic business type fluctuations, again compared to the reference cohort.

Table 6 reports for each year the conditional means for several firm cohorts. Columns (1) and (2) report conditional probabilities for non-zero growth rates, and the conditional mean growth rates for the firms with non-zero growth rates. Finally, columns (3) show the conditional mean growth rates for the entire sample. All calculations are based on the conditional mean equation (4). More specifically, columns (3) in the first row show the conditional means for the smallest, youngest, non-MNE subsidiary firms in the sample, which is given by the combined effect of *Constant + European industry growth + Total manufacturing growth* from the OLS regression multiplied with the probability of a non-zero outcome which is again based on the combined effect of *Constant + European industry growth + Total manufacturing* from the logit model. Additional main effects and interaction terms enter the calculation of the conditional probabilities, conditional mean growth rates for the firms with non-zero growth rates, and the (overall) conditional mean for all other reported cohorts.

The conditional means in Table 6 indicate that, on average, the smallest, youngest, non-MNE subsidiary firms exhibit the highest growth rates in all years. However, the relative difference in the conditional average growth rate between boom and recession years is largest for this cohort suggesting a relatively pronounced sensitivity of small, young, non-MNE firms to business cycle movements. Subsidiaries of MNEs show slightly negative growth rates in the recession years, but the MNE cohort is estimated to be the most stable group of firms. This result is in line with previous findings by Oberhofer and Pfaffermayr (2008). Their findings suggest that MNE corporate groups (as a whole) are more stable than lone standing firms.

Interestingly, the conditional probability of a non-zero outcome monotonically increases with firm size and firm age. While only less than 43

Table 6: Conditional means for several firm cohorts and each year

	2000			2001			2002			2003		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Size 1-Age 1 Firms (non-MNE)	0.423	0.440	0.188	0.387	0.160	0.064	0.340	0.062	0.021	0.344	0.015	0.004
Size 2-Age 2 Firms (non-MNE)	0.574	0.073	0.043	0.584	0.079	0.046	0.559	0.012	0.007	0.565	−0.015	−0.009
Size 3-Age 3 Firms (non-MNE)	0.716	0.056	0.043	0.728	0.063	0.046	0.702	0.009	0.007	0.717	−0.012	−0.009
Size 4-Age 4 Firms (non-MNE)	0.842	0.049	0.047	0.840	0.011	0.009	0.819	−0.021	−0.016	0.825	−0.028	−0.024
MNEs	0.910	0.039	0.035	0.862	0.045	0.037	0.856	−0.006	−0.005	0.859	−0.021	−0.018

Notes: Columns (1) report the conditional probabilities for non-zero growth rates ($P(y_{it}^* = 1|\mathbf{x}_{it})$) while columns (2) present the conditional mean growth rates of non-zero outcomes ($E(y_{it}|\mathbf{x}_{it}, y_{it}^* = 1)$) for the mentioned firm cohorts, respectively. In Columns (3) the (overall) conditional mean growth rates are reported.

percent of the smallest, youngest non-MNE subsidiary firms are expected to show non-zero growth rates more than 80 percent of the largest and oldest non-MNE subsidiaries are intended to change their firm size in each year. However, the probability of non-zero growth rates is highest for the MNE subsidiary cohort throughout the whole sample period. Therefore columns (2) show that the sensitivity with respect to the growth performance of small, young, non-MNE subsidiary firms with non-zero employment growth is even more pronounced.

5 Conclusions

Based on the empirical firm growth literature and on heterogeneous (microeconomic) adjustment models, this paper empirically investigates the impact of European industry fluctuations and domestic business cycles on the growth performance of European firms. The structure of the firm level data at hand (i.e. relative high share of zero growth rates) requires a careful econometric treatment. In particular, a two-part model is proposed. In its first part this model examines the probability of a non-zero reaction to business type fluctuations while the second part analyzes the extent of the adjustment.

In general, our results suggest that European industry fluctuations are not able to sufficiently explain variation in firm growth rates of European firms. Instead, domestic cyclical production movements tend to better predict the probability of reaction and the extent of the (non-zero) adjustment. Additionally, domestic demand fluctuations create detectable heterogeneity in the reaction among several cohorts of firms, while the adjustment to European industry booms and recessions tends to be homogeneous.

Concerning the different firm cohorts and in line with standard results from the empirical firm growth literature, the smallest, youngest non-MNE subsidiary firms show the highest growth rates indicating convergence in firm size (measured in terms of employment) within European industries. However, in relative terms the cohort of the smallest, youngest MNE subsidiaries are most intensely affected by cyclical movements. In contrast, the firm size of MNE subsidiaries tend to be relatively stable during a business cycle.

Since this empirical investigation uses data from a time period (2000-2003) of relatively moderate macroeconomic development, more pronounced results might be obtained using more severe cyclical movements. For this reason, the proposed model should be reconsidered using firm and industry level data including the currently observed recession.

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Harald Oberhofer

Firm growth, European industry dynamics and domestic business cycles

Abstract

Based on the empirical firm growth literature and on heterogeneous (microeconomic) adjustment models, this paper empirically investigates the impact of European industry fluctuations and domestic business cycles on the growth performance of European firms. Since the implementation of the Single market program (SMP) the EU 27 member states share a common market. Accordingly, the European industry business cycle is expected to become a more influential predictor of European firms' behavior at the expense of domestic fluctuations. Empirically, the results of a two-part model for a sample of European manufacturing firms reject this hypothesis. Additionally, subsidiaries of Multinational Enterprises (MNEs) constitute the most stable firm cohort throughout the observed business cycle.

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