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Firm growth, European industry dynamics and domestic business cycles

Harald Oberhofer*

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JEL : F15, F23, L11, L16, L25

Keywords: Firm growth, industry dynamics, domestic business cycle, European integration, multinational enterprises, two-part model

The author

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

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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), faced a severe downturn in the recent recession. From May 2008 onwards until the end of 2009 data of EU 27 total manufacturing industry production showed negative annual growth rates with a maximum (in absolute terms) of about minus 19.4 percent in April 2009 (Eurostat 2010). At the same time, the harmonized unemployment rate increased from 6.8 percent in May 2008 to 9.6 percent in January 2010 (Eurostat 2010). However, countries within the EU 27 are asymmetrically affected by the recession. For instance, in July 2009 Ireland reported an annual total manufacturing industry production growth rate of 4.7 percent while in Germany annual total manufacturing industry production declined by 17 percent (Eurostat 2010).

Additionally, some sectors within the European manufacturing industries seem to be more affected by the general downturn. For example, in the autumn of 2008 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* struggled for their survival. In contrast other manufacturing industries seemed 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 potentially 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). However, given the observed variation in

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

the cyclical behavior it might of special interest to what extent firms within the boundaries of the European Union react to fluctuations in Europe-wide industry production and domestic business cycles.

For this reason, this paper empirically analysis the effects of fluctuations in European industry production and domestic total manufacturing production on firm growth.[2] In particular, this paper contributes to the understanding of the influence of business cycles on firm growth in three ways: (i) It disentangles the impacts of (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 domestically orientated firms and subsidiaries of multinational enterprises (MNEs). In addition, this paper combines the empirical firm growth literature and heterogeneous (microeconomic) adjustment models and tests for heterogeneous reaction to business cycle movements. The theoretical considerations and the structure of the European firm level data at hand (provided by AMADEUS database) supports the use of a two-part model. Thereby, the first part of the model allows to investigate the probability of a reaction to business cycle fluctuations whereas the second part examines the magnitude of the observed reaction.

Our econometric results suggest that domestic business cycles more accurately predict the probability of a 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 across different firm cohorts. Finally, compared to larger and older firms as well as subsidiaries of MNEs the firm growth performance of small and young firms is more sensitive to recessions and recoveries.

In terms of policy implications, the results of this paper suggest that the majority of European firms are still much more affected by domestic business cycles than by Europe-wide trends in industry production. Consequentially,

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

the stabilization of business cycles in each individual member state still seems to be an important task for national governments and their fiscal policies.

The remainder of the paper is organized as follows. Section 2 reviews the related literature, while Section 3 describes the data and presents some descriptive statistics. Section 4 specifies the two-part model and outlines the estimation strategy. Section 5 presents the estimation results and, finally, Section 6 concludes.

2 Related Literature

Since approximately 80 years the empirical firm growth literature analysis the relationship between a firms annual average growth rate and its initial firm size. Gibrat (1931) hypothesized that firm growth is independent of firm size (*Gibrat's Law* of proportionate growth). The majority of empirical contributions in the subsequent literature rejects the hypothesis of independence of firm growth and firm size.[3] In particular, a robust finding indicates that initially small firms exhibit higher growth rates in comparison to initially large firms. This, in turn, leads to convergence in firm size within a given industry. Another stylized fact lends support to the importance of firm age as driving force of the variation in the firm growth rates. Put differently, young firms tend to grow more rapidly.

In line with these 'stylized facts', economists started to formulate theories which explain why, within cross-sections of firms, small and young firms show the highest growth rates.[4] With regard to the specification of a typical empirical firm growth equation these theories commonly point to the importance of initial firm size and firm age as determinants of a firm's growth performance (see for example Geroski and Gugler 2004, Geroski 2005). To sum up, in a survey on previous findings Hart (2000) concludes that the tendency of young and small firms to grow more quickly is the main reason why firm

[3]Surveys on the empirical firm growth literature are available in Evans (1987a), Sutton (1997), Audretsch, Klomp, Santarelli and Thurik (2004), Bellak (2004) and Cabral (2007).

[4]Among them are learning theories (Jovanovic 1982), Penrose Effects (Penrose 1959), adjustment cost theories (Hamermesh and Pfann 1996), financial constraints (Cabral and Mata 2003) and organizational capabilities (Slater 1980)

growth rates are not entirely stochastic. Consequentially, our econometric firm growth model contains initial firm size and firm age as key determinants of a firm's annual growth rate.

In recent years MNEs attracted increasing attention in the theoretical and empirical IO-literature. In particular, one strand within the empirical firm growth literature argues that firm growth dynamics differ between purely domestically orientated 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 2010). Furthermore, MNEs as a whole are exposed to different domestic and non-domestic business type of fluctuations. Consequentially, this paper tests whether subsidiaries of MNEs react differently to the respective business cycles.

With regard to the second strand of related 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 a 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.[5]

Following Caballero, Engel and Haltiwanger (1997), the presence of adjustment costs leads to non-continuous adjustment of employment. In particular, current employment decisions depend on past employment decisions and expectations concerning the future market conditions. Caballero et al. (1997) call the difference between the desired and actual level of employment 'employment shortage'. Put formally, employment shortage is given by: $z_{it} = e^{*}_{it} - e_{i,t-1}$, where e_{it} denotes the firm level employment for each firm i at time t. Additionally, the probability of employment adjustment is assumed to

[5]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 e.g., Caplin and Leahy (1997); Caballero and Engel (1999); Cooper, Haltiwanger and Power (1999) and Adda and Cooper (2000). 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).

be increasing in the absolute value of z and the cross-sectional distribution of employment shortages is given by $f(z,t)$. Given this assumptions a common shock (e.g. decline in demand for all goods) translates into heterogeneous reaction. Some firms for which $|z_i|$ is low will not adjust their firm size, and consequently exhibit a zero employment growth rate. Other firms with a high $|z_i|$ will decide to adjust firm size and will close some part of the employment shortage given by an *adjustment function* $A(z,t)$. Consequentially, at each point in time a firm's employment shortage, firstly, determines the probability of employment adjustment and, secondly, in case of adjustment the magnitude of the respective change in employment. Econometrically, heterogeneous (microeconomic) adjustment models support the use of a two-part model, where its first part examines the probability of adjustment and the second part focuses on the extent of the (non-zero) adjustment.

In comparison to the 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. The study of Hart and Oulton (2001) uses a comparable methodology and analyzes a large sample of firms over 10 years. However, building on Hart and Oulton (2001) this paper additionally utilizes explicit business cycle information and addresses the problem of non-reaction of firms.

3 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 (revision 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 onwards 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 to factor costs growth rates.

Firm level data is provided by the AMADEUS database.[6] Balance sheet data and profit and loss accounts are 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 to factor costs and two years (2002, 2003) with negative Europe-wide industry growth rates. In order to isolate the effects of one single business cycle The analysis is based on the years 2000 to 2003 . 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 104,595 firms within 14 European countries which are observed in all four years.[7]

[6]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.

[7]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.

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).

Table 1 summarizes the sample composition and the average firm growth rate (measured in terms of employment), average European industry value added to factor costs growth rate and average country specific total manufacturing industries value added to factor costs growth rate. The growth rates are calculated using the first difference of levels of the respective variables. With only one exception the average firm growth rate exceeds both – the European industry value added to factor costs growth rate and the countries average total manufacturing value added to factor costs growth rate. Worth noting is the recession year 2003 where the European industry growth rate and the average firm growth rate are slightly negative, while the country specific total manufacturing growth rate is positive on average. Additionally, the country specific total manufacturing growth rates in the majority of cases exceed the Europe-wide industry specific growth rates. Here the year 2001 represents the only exception.

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 no change in the 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 rates, European industry growth rates and country specific total manufacturing growth rates at a more disaggregated level, while in Table 4 a simple analysis of variance (ANOVA) is reported. By regressing firm growth on a full set of country and 3-digit industry dummy variables and

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	104,595	66,369	38,226	0.365	0.083	0.023	0.063
2001	104,595	65,153	39,442	0.377	0.044	0.024	0.018
2002	104,595	63,194	41,401	0.396	0.009	−0.008	0.017
2003	104,595	63,865	40,730	0.389	−0.004	−0.007	0.015

Notes: g_i, g_j, g_c denote firm growth rate, European NACE 2-digit industry value added to factor costs growth rate and average country specific total manufacturing value added to factor costs growth rate, respectively. The share of $g_i = 0$ is measured as proportion of all 104,595 firms.

its interaction terms this type of ANOVA allows to split the variation in the individual firm growth rates into country and industry specific parts.[8]

Table 2 reports for each observed year the average firm growth rate within a given NACE 2-digit industry (firm-i), the corresponding average European industry value added to factor costs growth rate and its correlation. The Europe-wide NACE 2-digit industry value added to factor costs growth rates are calculated by averaging all 3-digit industry growth rates within each 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 year 2000 and negative growth rates in one, six and 18 out of 21 industries in the subsequent years. Concerning European industry growth, it turns out that even in booming years (2000, 2001) some industries exhibit negative growth rates. Comparing the firm level average growth rates with the Europe-wide industry average growth rates we observe the same growth pattern for the majority of firm-industry pairs. More specifically, in 54 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, the deviation between the actual average firm growth rates and the corresponding Euro-

[8]Using Amadeus database Goodard, Tavakoli and Wilson (2009) provide a more comprehensive variance decomposition analysis with regard to profitability and growth of manufacturing firms located in eleven European countries.

Table 2: Average firm level employment growth rates 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	11,697	0.071	−0.002	0.038	0.088	0.024	0.006	0.006	0.018
Manufacture of tobacco products	39	0.140	0.048	−0.001	0.119	0.017	−0.045	−0.012	0.017
Manufacture of textiles	4,411	0.070	0.012	0.022	0.003	−0.003	−0.052	−0.020	−0.058
Manufacture of wearing apparel; dressing and dyeing of fur	2,702	0.076	0.001	0.012	0.029	0.001	−0.053	−0.016	−0.075
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	2,376	0.107	−0.011	0.036	0.052	0.006	−0.047	−0.018	−0.062
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	5,317	0.071	−0.004	0.017	0.057	0.005	−0.016	−0.005	−0.003
Manufacture of pulp, paper and paper products	2,167	0.090	0.090	0.043	0.002	0.015	0.004	−0.010	−0.048
Publishing, printing and reproduction of recorded media	9,863	0.059	0.014	0.028	0.001	0.000	−0.022	−0.013	−0.050
Manufacture of chemicals and chemical products	4,439	0.077	0.061	0.062	0.002	0.016	0.043	0.005	−0.005
Manufacture of rubber and plastic products	4,950	0.097	0.024	0.037	0.034	0.008	0.013	0.003	−0.005
Manufacture of other non-metallic mineral products	5,757	0.103	−0.006	0.052	0.026	0.016	0.002	0.000	0.000
Manufacture of basic metals	2,031	0.079	0.124	0.049	−0.028	0.003	−0.052	0.000	−0.006
Manufacture of fabricated metal products, except machinery and equipment	19,585	0.084	0.011	0.051	0.012	0.007	0.012	−0.001	0.021
Manufacture of machinery and equipment n.e.c.	10,760	0.098	0.045	0.079	0.045	0.015	−0.024	−0.003	−0.008
1Manufacture of office machinery and computers	550	0.124	−0.061	0.075	−0.117	−0.008	−0.079	−0.007	−0.026
Manufacture of electrical machinery and apparatus n.e.c.	3,606	0.107	0.081	0.056	−0.026	0.004	−0.006	−0.006	0.003
Manufacture of radio, television and communication equipment and apparatus	1,400	0.120	0.201	0.049	−0.253	−0.009	−0.042	−0.013	0.012
Manufacture of medical, precision and optical instruments, watches and clocks	3,352	0.069	0.056	0.054	0.016	0.014	0.024	−0.002	0.023
Manufacture of motor vehicles, trailers and semi-trailers	1,881	0.101	0.026	0.034	0.049	0.009	−0.004	0.001	0.043
Manufacture of other transport equipment	1,320	0.089	−0.042	0.055	0.096	0.006	−0.022	−0.006	0.025
Manufacture of furniture; manufacturing n.e.c.	6,392	0.084	0.008	0.023	0.036	−0.001	−0.020	−0.012	−0.032
Correlation		0.282		-0.101		0.549		0.829	

Notes: Firm-i refers to the average employment growth rate of firms within 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 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.

pean 2-digit industry growths rate are substantial for most of the observed firm-industry pairs. Therefore, Table 2 descriptively indicates that the European industry business cycle is only able to partially explain the growth performance of the average firm operating in the respective 2-digit manufacturing industry. Moreover, the correlation between the firm level and the industry level average growth rates fluctuates in a very broad range from -0.101 in 2001 to 0.829 in 2003 indicating that the European industry value added to factor costs growth rates might exert different effects on firm growth at different stages of the business cycle.

Table 3 reports for each country and year the average firm growth rate (firm-c) and the total manufacturing value added to factor costs growth rate. The reported figures support the view that overall the years 2000 and 2001 are recovery years while we observe a recession tendency in 2002 and 2003. Moreover, 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 11 percent while in Germany (Slovakia) manufacturing industry production declined (increased) by about 9 (22) percent. However, similar to Table 2, the country specific average firm growth rates and the corresponding total manufacturing value added to factor costs growth rates indicate a recession in the years 2002 and 2003. In comparison to Table 2 the correlation between the firm growth rate and the country-wide total manufacturing value added to factor costs growth rate is lower in each year. However, over time the correlation of these measures evolve in a similar vein.

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 and 3-digit industry dummy variables (main effects) and interaction terms between the main effects. The former (latter) capture country specific (industry specific) variation in the observed firm growth rates. In general, Table 4 shows that the chosen dummy variable design explains only a relatively small fraction of the variation in the firm growth rates and the

Table 3: Average firm level employment growth rates and country level 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	75	−0.010	0.067	0.013	0.000	0.020	0.057	0.053	0.035
Belgium	3,618	0.044	0.048	0.029	0.019	−0.004	0.001	−0.023	0.004
Finland	2,529	0.052	0.133	0.023	0.035	0.002	−0.025	−0.011	−0.044
France	18,338	0.041	0.026	0.023	0.029	0.001	0.002	−0.011	−0.015
Germany	8,280	0.037	−0.087	0.015	0.009	0.001	−0.032	−0.012	0.010
Great Britain	6,062	0.025	0.078	0.001	−0.043	−0.020	−0.008	−0.028	−0.095
Greece	4,133	0.014	0.081	0.001	0.126	0.000	0.141	0.001	0.157
Italy	17,542	0.194	0.085	0.154	0.024	0.043	0.008	0.014	0.005
Netherlands	209	0.019	0.104	0.015	−0.051	−0.014	0.051	−0.028	0.009
Poland	804	1.404	0.106	−0.022	0.437	−0.017	−0.315	−0.024	−0.059
Portugal	69	0.000	−0.007	0.008	−0.020	−0.020	0.028	−0.029	−0.008
Slovakia	114	−0.006	0.215	0.000	0.319	0.000	0.011	0.011	0.128
Spain	27,891	0.075	0.086	0.033	0.056	0.011	0.048	0.003	0.041
Sweden	14,931	0.037	0.099	0.017	−0.103	−0.002	0.019	−0.012	0.042
Correlation		0.184		0.054		0.126		0.436	

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.

Table 4: Analysis of variance of the firm growth rate

	Growth 2000			Growth 2001			Growth 2002			Growth 2003		
Source	Abs.	%	P-val.	Abs.	%	P-val.	Abs.	%	P-val.	Abs.	%	P-val.
Country effects	569.71	5.1	0.000	47.66	0.9	0.000	7.72	0.2	0.000	4.06	0.1	0.000
Industry effects	8.69	0.1	0.449	2.31	0.0	1.000	2.49	0.1	0.867	4.03	0.1	0.108
Country * Industry effects	109.69	1.0	0.000	110.05	2.2	0.000	30.26	0.9	0.701	35.02	1.0	0.677
Constant (Overall mean)	1207.16	10.9	-	260.27	5.1	-	35.77	1.1	-	18.58	0.5	-
Model	1,895.25	17.1	0.000	420.29	8.3	0.000	76.24	2.4	0.000	61.69	1.7	0.000
Residual	9,165.47	82.9	-	4,656.97	91.7	-	3,153.57	97.6	-	3,638.56	98.3	-
Total	11,060.72	100.0	-	5,077.26	100.0	-	3,229.81	100.0	-	3,700.26	100.0	-

Notes: 104,595 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 1017 d.f. for Country * Industry Effects.

explanatory power becomes even worse for the recession years 2002 and 2003. The goodness of fit in terms of the standard R^2 is highest in the first year of the sample (17.1 percent), while in 2003 the model is only able to explain 1.7 percent of the variation in the firm growth rate.

Moreover, only the country dummy variables statistically 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) with regard to the firm growth performance of the observed firms. Surprisingly, the industry effects are statistically insignificant throughout, suggesting minor variations in the firm growth rates across all 98 observed 3-digit 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 very small fraction of the variation in the firm growth rate given the huge number of interaction terms (i.e. 1018). Put differently, 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, with regard to the growth performance of firms in our sample the data surprisingly deliver a first indication of the limited importance of European industry fluctuations. The country of origin tends to be still more important for differences in firm growth rates across Europe. However, neither European industry effects nor country specific effects seem to reasonably explain the variation in firm growth rates. Consequently, 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.

4 Empirical specification and estimation strategy

We estimate the impact of business type fluctuations on firm growth at each point within the observed European business cycle. Subsequently, each annual cross-section of firms is separately investigated. This is in line with Hart and Oulton (1998, 2001), who split the business cycle into several cross sections. 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, with regard to previous findings the inclusion of initial firm size and firm age controls for the important systematic determinants of differences in firm growth rates (Hart 2000).

Moreover, following the previous theoretical considerations and the structure of the data (see Table 1) a careful treatment of non-reacting firms is required. The above mentioned heterogeneous adjustment literature suggest that firms, based on their actual and desired size, firstly decide whether the are willing to adjust their firm size and secondly choose the magnitude of adjustment. Econometrically, this lends support to the usage of a two-part model. Thereby, the first part describes the binary choice of reaction versus 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:

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

where $F(.)$ is the cumulative logistic function, γ is a vector of estimation coefficients and $\mathbf{z}_{it}$ contains 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.[9] Accordingly, the second part of the model which only governs non-zero outcomes of the actual annual

[9]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 Vidigal da Silva 2009; Ramalho, Ramalho and Murteira 2010) 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).

firm growth rate g_{it} is modeled under the linearity assumption:

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

where β is another vector of parameters to be estimated with ordinary least squares (OLS) and $\mathbf{x}_{it}$ represents a different set of covariates. Finally, the conditional mean of a two-part model is given by:

$$\begin{aligned} E(y_{it}|\mathbf{x}_{it}) = {} & P(y^*_{it} = 1|\mathbf{z}_{it})E(y_{it}|\mathbf{x}_{it}, y^*_{it} = 1) \\ & + P(y^*_{it} = 0|\mathbf{z}_{it})E(y_{it}|\mathbf{x}_{it}, y^*_{it} = 0). \end{aligned} \tag{4}$$

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

As just mentioned, the empirical specification of the two-part model contains two different sets of explanatory variables. More precisely, following related studies on determinants of job creation and job destruction the first part of the model includes previous years firm size and firm age (Varejao and Portugal 2007, Hölzl and Huber 2009) and a firm's level of sales per employee in the previous year (Nilsen, Salvanes and Schiantarelli 2007). Additionally, the inclusion of the ratio of a firm's previous years sales to industry minimum efficient scale (denoted as relative size) proxies the difference between a firm's actual and desired size. Thereby, the minimum efficient scale (MES) is defined as the third quartile of the within 3-digit (Europe-wide) industry distribution of sales in the previous year. Thereby, we also use firms which are not part of our final (balanced) sample. More concretely, the number of firms used for the calculation of the MES ranches from more than 360,000 in the year 1999 to approximately 530,000 firms in 2002.

Following the above mentioned discussion on MNEs, we hypothesize that subsidiaries of MNEs react differently to business cycle fluctuations. We use several different versions of AMADEUS 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.[10] Finally, we include contemporaneous European 3-digit industry value added to factor growth rates and a country's contemporaneous total manufacturing value added to factor costs growth rates to examine whether European firms more likely react to the European business cycle or to domestic fluctuations.

Drawing from Gibrat's Law type of regressions, the second part of the model analysis the extent of a firm's annual employment growth rate for all firms with non-zero growth rates. Moreover, we are interested whether the magnitude of reaction to business cycles is heterogeneous across different types of firms. For this reason in addition to initial firm size, firm age, Europe-wide 3-digit industry growth, total manufacturing growth and the MNE dummy variable x_{it} contains interaction terms of all firm specific variables (firm size, firm age, MNE status) with both types of contemporaneous business cycles. In order to construct different types of firms, firm size and firm age are captured by dummy variables based on the quartiles of the respective distributions in the previous year. Technically, the firm size and firm age distributions are split into their 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 to factor costs growth rates and domestic total manufacturing growth rates capture potential heterogeneity with respect to the magnitude of adjustment to business type fluctuations. In contrast to heterogeneous (microeconomic) 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.

[10] 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.

5 Estimation results

Tables 5 and 6 summarize the results of the two-part model, where Table 5, for each year, reports average marginal effects for the first part obtained from a standard logit model. Table 6 shows the OLS results only considering 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. For the second part, the smallest, youngest, non-MNE subsidiary firms build the reference group. The effects of their firm characteristics are captured by the constant.

Interestingly, in terms goodness-of-fit the standard R^2 is considerably decreasing over the business cycle for the second part while for the first part the Pseudo R^2 is relatively stable. This, in turn, indicates that in each year the first part of the model is continuously able to explain which firms adjust their firm size, while a Gibrat's Law type of regression is better able to explain the variation in firm growth in recovery years.

Since in non-linear models marginal effects of covariates are individual (firm) specific we calculate average marginal effects using the approach suggested by Bartus (2005). Based on the respective estimates in Table 5, firms which (ceteris paribus) are initially larger and younger more probably change their firm size in each of the four years. Additionally, firms with a higher level of per employee turnover and firms below the industry specific MES more likely adjust firm size. This, in turn, indicates that firms are more (less) likely to adjust firm size if their actual size is below (above) their desired size. Finally, subsidiaries of MNEs do not tend to exhibit systematic differences in their adjustment probabilities. Generally, our first part estimation results are well in line with previous research on job creation and job destruction. For example, Hölzl and Huber (2009) report higher adjustment probabilities for larger and younger firms while Nilsen et al. (2007) provide evidence for a positive impact of previous year's sales per employee on the probability of size adjustment.

With regard to the European industry cycle and domestic business fluctuations it turns out that European firms do no tend to react to the European industry cycle. The respective average marginal effects are rather small and insignificant for all four reported years. In contrast, over the business cycle, the country specific total manufacturing value added to factor costs growth rates exhibit a significant and non-constant impact on the probability of size adjustment. More precisely, firms in countries with high total manufacturing growth rates are more likely to adjust their firm size in 2000 while in the remaining years higher total manufacturing growth rates reduce the probability of size adjustment. This result supports the heterogeneous adjustment models, which assume that the difference between the actual and desired firm size has to exceed a certain threshold to induce a size adjustment. Put differently, in recovery years firms in countries with the highest growth rates more probably adjust (increase) their firm size while in recession years firms in countries with the most severe decrease in manufacturing production most likely adjust (decrease) their firm size.

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. Table 6 shows that the smallest, youngest, non-MNE subsidiary firms show the highest growth rates throughout the whole sample period with the exception of the year 2003, where the differences in growth rates across all different size classes are statistically insignificant. The age effects also indicate convergence in firm size, which implies that young firms show higher growth rates than their older counterparts. Both results are well-known from *Gibrat's Law* type of regressions (see, e.g., Evans 1987b; Variyam and Kraybill 1992; Hart 2000; Hart and Oulton 2001; Cabral 2007). With regard to subsidiaries of MNEs no general result can be obtained. In comparison to the reference group multinationally orientated firms exhibit a higher main effect in the year 2000 and lower growth rates in 2002 and 2003. However, taking the interaction effects with Europe-wide industry growth rates and countries total manufacturing growth rates into account the differences in growth rates between MNEs and domestically orientated firms disappear.

Table 5: Estimation results: First part (logit model)

	2000	2001	2002	2003
Size	0.134***	0.150***	0.146***	0.138***
	(0.004)	(0.003)	(0.003)	(0.003)
Age	−0.036***	−0.046***	−0.040***	−0.061***
	(0.005)	(0.005)	(0.004)	(0.005)
Sales per employee	0.0002***	0.0001***	0.0001***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Relative size	0.0001	−0.0001***	−0.0001***	−0.0001***
	(0.0003)	(0.0000)	(0.0000)	(0.0000)
MNE	−0.016	0.014	0.024	0.031
	(0.022)	(0.029)	(0.022)	(0.019)
European industry growth	0.091	−0.037	−0.091	−0.073
	(0.097)	(0.122)	(0.160)	(0.151)
Total manufacturing growth	1.471***	−0.611***	−0.610*	−2.154***
	(0.084)	(0.111)	(0.370)	(0.186)
Pseudo R^2	0.137	0.130	0.135	0.168
N	104,595	104,595	104,595	104,595

Notes: Robust standard errors clustered by industry-country in parentheses. The table reports average marginal effects following (Bartus 2005). *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Similar to the results obtained in the first part, the impact of the European industry business cycle seems to be limited. With the exception of the year 2002, the 3-digit industry growth rate has no impact on the magnitude of the average growth rate of European firms. Additionally, virtually all interaction effects of the European business cycle with different firm characteristic are insignificant. Most interestingly, not even very large firms tend to be effected by the European industry business cycle.

Focusing, on the impact of fluctuations in domestic total manufacturing value added on firm growth, we detect more systematic relationships. The main effect of domestic business cycles is positive and significant in all four years indicating a positive impact on the growth rates of the reference group. Moreover, the interaction effects support the hypothesis of heterogeneity in the adjustment. Compared to the reference group, larger firms exhibit significantly lower growth rates, especially in the years from 2000 to 2002. Conversely, the results with regard to firm age are inconclusive. In comparison to

Table 6: Estimation results: Second part (OLS)

	2000	2001	2002	2003
Constant	0.335***	0.162***	0.055***	0.014**
	(0.026)	(0.006)	(0.007)	(0.007)
Size 2	−0.236***	−0.064***	−0.020***	−0.010
	(0.024)	(0.009)	(0.007)	(0.006)
Size 3	−0.257***	−0.082***	−0.016**	−0.002
	(0.027)	(0.008)	(0.007)	(0.006)
Size 4	−0.278***	−0.124***	−0.032***	−0.002
	(0.028)	(0.009)	(0.007)	(0.006)
Age 2	−0.044***	−0.015***	−0.018***	−0.014***
	(0.010)	(0.006)	(0.003)	(0.003)
Age 3	−0.034***	−0.005	−0.019***	−0.020***
	(0.010)	(0.007)	(0.003)	(0.003)
Age 4	−0.067***	−0.024***	−0.038***	−0.033***
	(0.009)	(0.007)	(0.003)	(0.003)
MNE	0.030**	0.007	−0.011**	−0.010*
	(0.013)	(0.009)	(0.005)	(0.006)
European industry growth	0.551	−0.058	0.285***	0.041
	(0.338)	(0.087)	(0.097)	(0.147)
Total manufacturing growth	0.886***	0.536***	0.491***	0.491**
	(0.339)	(0.081)	(0.177)	(0.191)
Size 2 * European industry growth	−0.381	0.010	−0.074	0.093
	(0.381)	(0.097)	(0.098)	(0.137)
Size 3 * European industry growth	−0.331	−0.058	−0.104	0.085
	(0.409)	(0.095)	(0.100)	(0.145)
Size 4 * European industry growth	−0.473	0.072	−0.106	0.047
	(0.421)	(0.110)	(0.107)	(0.148)
Age 2 * European industry growth	0.005	−0.046	−0.127**	0.049
	(0.107)	(0.066)	(0.060)	(0.076)
Age 3 * European industry growth	−0.014	0.002	−0.083	0.113)
	(0.146)	(0.080)	(0.055)	(0.071)
Age 4 * European industry growth	−0.055	0.060	−0.063	0.094
	(0.135)	(0.091)	(0.055)	(0.070)
MNE * European industry growth	−0.148	−0.090	−0.085	0.059
	(0.137)	(0.124)	(0.115)	(0.113)
Size 2 * total manufacturing growth	−0.954***	−0.628***	−0.756***	−0.278
	(0.344)	(0.108)	(0.184)	(0.190)
Size 3 * total manufacturing growth	−0.821**	−0.815***	−0.826***	−0.360*
	(0.375)	(0.097)	(0.179)	(0.193)
Size 4 * total manufacturing growth	−0.241	−0.776***	−0.506***	−0.187
	(0.403)	(0.091)	(0.178)	(0.196)
Age 2 * total manufacturing growth	0.173	0.237***	0.063	−0.115
	(0.138)	(0.055)	(0.065)	(0.082)
Age 3 * total manufacturing growth	0.153	0.286***	−0.024	−0.182**
	(0.155)	(0.078)	(0.082)	(0.082)
Age 4 * total manufacturing growth	0.473***	0.315***	0.233***	−0.108
	(0.150)	(0.064)	(0.057)	(0.080)
MNE * total manufacturing growth	−0.860***	0.203	0.038	0.039
	(0.202)	(0.163)	(0.100)	(0.133)
R^2	0.107	0.031	0.012	0.006
N	66,369	65,153	63,194	63,865

Notes: Robust standard errors clustered by industry-country in parentheses. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

the reference group in the year 2001 older firms exhibit higher growth rates while in 2002 no systematic difference in the adjustment behavior between young and old firms can be detected.

In order to examine the sensitivity to business cycle fluctuations we calculate conditional mean growth rates for five different firm cohorts over the entire observational period. The results are presented in Table 7. 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. Columns (3) show the conditional mean growth rates for all firms in the respective firm cohorts. 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 average probability of a non-zero outcome for the reference group from the logit model. Additional main effects and interaction terms enter the calculation of the conditional mean growth rates for the firms with non-zero growth rates for all other reported cohorts.

The conditional means in Table 7 indicate that, on average, the smallest, youngest, non-MNE subsidiary firms exhibit the highest growth rates in all years. However, the relative volatility in the conditional average growth rate between recovery 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 well in line with previous findings by Oberhofer and Pfaffermayr (2010). Their findings suggest that, in terms of firm size, 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 45 percent of the smallest, youngest non-MNE subsidiary firms are expected to show non-zero growth rates more than 8o percent of the largest and oldest domes-

Table 7: 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)	0.442	0.406	0.182	0.398	0.166	0.065	0.382	0.065	0.025	0.390	0.026	0.009
Size 2-Age 2 Firms (non-MNE)	0.587	0.065	0.039	0.563	0.084	0.047	0.550	0.012	0.007	0.554	−0.009	−0.006
Size 3-Age 3 Firms (non-MNE)	0.704	0.063	0.045	0.688	0.073	0.050	0.675	0.011	0.008	0.683	−0.011	−0.007
Size 4-Age 4 Firms (non-MNE)	0.839	0.054	0.049	0.856	0.018	0.015	0.848	−0.016	−0.014	0.859	−0.025	−0.022
MNEs	0.911	0.041	0.038	0.871	0.043	0.035	0.860	−0.007	−0.007	0.863	−0.021	−0.019

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 for 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.

tically orientated firms are intended to change their firm size in each year. However, in each year the probability of adjustment in firm size is largest for the MNE subsidiary cohort throughout the whole sample period. Additionally, 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. Put differently, in the year 2000 firm size adjusting firms within the reference group are expected to exhibit a growth rate of about 40 percent while in 2002 the conditional mean growth rate for the same firms is estimated to be only 2.6 percent.

6 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. Following heterogeneous (microeconomic) adjustment models and given the structure of the data at hand (i.e. relative high share of zero growth rates) a careful treatment of non-reacting firms is required. In particular, a two-part model is proposed. In its first part this model examines the probability of a non-zero growth rate while the second part analyzes the magnitude of the firm size adjustment.

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

With regard to 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 growth rates of the smallest, youngest only domestically orientated firms are most intensely affected by cyclical movements. In contrast, during the business cycle the firm size of MNE subsidiaries tends to be relatively stable.

In terms of policy implications, the results of this paper suggest that the majority of European firms are still much more affected by domestic business cycles than by Europe-wide trends in industry production. Consequentially, the stabilization of business cycles in each individual member state still seems to be an important task for national governments and their fiscal policies. However, 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, as an outline for a research agenda this topic should be reconsidered using firm and industry level data including the recent economic crisis.

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