Temporal Structure of Firm Growth and the Impact of R&D

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Abstract

This paper examines the time structure of the effect of R&D activities on firm growth. The main question is whether R&D activities come together with firms' growth in the subsequent periods and how this relationship depends on other characteristics of the firms, such as size. We use firm level data of 1000 European companies with details on R&D investments in 2003 to 2006. A regression approach is applied with a linear model taking into account R&D activities at points in time and autocorrelation dynamics of firm growth. We find that R&D has, on average, a positive effect on firm growth, but the effect and its temporal structure depend on the firm size.

Keywords: Firm growth, R&D activities, firm size, time gap, temporal structure

1 Introduction

The growth of firms has positive macro- and micro-economic effects. Therefore, firm growth, the related factors and its explanation is a well studied field of research in the economic literature. There exists a wide range of factors that are found to affect firm performance.

Usually the impacts of firm characteristics on firm growth are studied without considering time explicitly. Firm characteristics and firm growth are usually measured and examined at the same point in time. Therefore, our study will focus on the temporal structure of the influence of firm characteristics on firm growth, especially the impact of R&D activities.

R&D activities are repeatedly found to have a positive impact on growth (e.g. Banbury & Mitchell 1995, Schreyer 2000, Autio et.al 2007, Adamou & Sasidharan 2007, Yang & Lin 2007, Coad & Rao 2008). In the context of the time structure of firm growth, R&D activities have three characteristics that make them especially interesting. First, it takes time for R&D activities to become economically effective and influence growth. Investments in R&D can be expected to lead to innovations in the following years, and as a consequence, to higher sales. However, this takes some time. Therefore, we do not expect that R&D investments lead to firm growth in the same year. However, the size of the time lag is unclear. Second, most firms show quite stable R&D activities. This means that research-intensive firms usually remain research-intensive, whereas firms that do not invest in R&D usually remain R&D-inactive. Third, the temporal structure of the impact of R&D activities might be influenced by the firms' characteristics – primarily the firm size. As a consequence, the temporal structure of the effect of R&D activities on firm growth is difficult to disentangle, but it is important to understand these interrelationships.

Besides focusing on the time structure of the R&D impacts, we also examine the time structure of growth, because it is impossible to study the first kind of time structure without knowing the latter. The autocorrelation of firm growth has been repeatedly studied in the literature (e.g. Almus & Nerlinger 2000, Bottazzi & Secchi 2003, Coad 2006, Coad & Hölzl 2008). The findings vary. We repeat this analysis in order to benchmark our results.

The study is based on a sample of 1000 firms operating in Europe. The data are recorded in the European Innovation Scoreboard, in the period from 2003 to 2006. The collected data provide firm names as well as information on R&D activities, sector affiliation and size. However, the data are limited to firms with high R&D investments. We set up regression analysis to identify firm growth related factors that also come together with the subsequent periods of firms' growth performance. Especially, we study the impact of R&D expenditure and R&D capital expenditure on firm growth and its corresponding time lags.

The structure of this paper is as follows. Section 2 provides an overview of the literature on firm growth related factors and autocorrelation dynamics in regard to firm growth. Several empirical findings are used to deduce expectations for the analysis. Section 3 focuses on the methodology and data source. In Section 4, we present, discuss and interpret the results and answer our research questions. Section 5 concludes.

2 Background and hypotheses

A wide range of empirical studies exist dealing with firm growth and firm growth related factors. Research issues are the identification of firm growth stages and firms' development paths (e.g., Delmar, Davidsson, and Gartner, 2003), Gibrat's Law (meaning that firm growth follows a random walk) (e.g., Bottazzi and Secchi, 2006) as well as the

examination of firm- and industry related growth factors on different geographical scale (e.g., Harhoff, Stahl and Woywode, 1998). Previous studies have already dealt with the identification of (innovation) factors contributing to firm growth (e.g. Hölzl 2009). A few studies examine these factors and their role in time (e.g. Kafouros and Wang, 2008). Hence, some issues examined here, have already been addressed in previous research and can thus be used to feed up our expectations.

2.1 R&D activities and firm growth

A magnitude of studies maintains that firms with a strong commitment to *R&D* and technology-based innovations tend to have a higher growth rate than firms with a weaker commitment. In previous research dealing with innovation and firm growth, it is discussed that innovation activity has a positive impact on firm growth. Banbury and Mitchell (1995) conclude, for instance, that incremental product innovation is an important competitive factor in growing companies. The German panel results by Schreyer (2000) show that the share of firms that are qualified as 'growers' increases with the intensity of R&D activities. Del Monte and Papagni (2003) prove growth rates to be positively correlated with the research intensity. They show that sales growth of firms performing R&D is higher than the growth of firms without performing R&D. In line with this, Adamou and Sasidharan (2007) study the impact of R&D by using panel data on Indian manufacturing firms. They argue that R&D is an essential determinant of firm growth and find that an increase in current R&D induces higher growth irrespective of the industry. Hence, they identified the absence of innovation activities and learning-effects to be the main difference between fast growing firms and average ones. Likewise, Yang and Lin (2007) examined the effects of innovation on firm growth in terms of employment growth in Taiwan. Their empirical results are that innovations, measured by R&D investments and patent counts, have a positive impact on firm growth. Analysing the impacts of R&D investments in time, a few studies find these impacts to be time lagged. For example, Ravenscraft and Scherer (1982) study the lag between R&D activities and their impact on profit. They find R&D activities impact profits with a time gap of four years. Other studies explore that the impact of R&D is highest in the year of investment and that R&D-capital starts to depreciate immediately (e.g. Kafouros and Wang, 2008).

Additionally, it has been recognized that the impact of R&D activities described above are influenced by *firm size* (e.g. Lichtenberg and Siegel, 1991; Cohen and Klepper, 1996). For example, larger firms are better able to exploit the outcomes of R&D activities.

2.2 Autocorrelation dynamics in firm growth

The *autocorrelation* of growth rates provides crucial information about the firms' growth processes (see Coad and Hölzl, 2008). Autocorrelation patterns have been examined in various studies with different results. Positive autocorrelation is found by Bottazzi and Secchi (2003). They find that firms growing in any one year of observation are more likely to repeat this performance in the following year. Other studies find no significant autocorrelation in firms' growth rates (e.g., Almus and Nerlinger, 2000). Coad (2006) considers how serial correlation changes with two firm aspects, its size and its growth. He concludes that small firms typically are subject to negative correlation of growth rates, whereas larger firms display positive correlation. Hence, small firms growing in one year are unlikely to repeat this performance in the following year.

A study by Kafouros and Wang (2008) investigates the impact of R&D activities by estimating different lagged measures. They conclude that R&D activities have direct impact on firm performance. In contrast, Bottazzi and Secchi (2003) also examine time lags in their

analysis of autocorrelation. They find that only one lag is significant whereas Geroski et.al (1997) find significant autocorrelation at the 3rd lag. Obviously, autocorrelation dynamics of firm growth is not only dependent on time patterns, but might be also influenced by firm characteristics such as their size. Furthermore, positive autocorrelation of growth rates might be caused by firm characteristics that stay constant in time and have an impact on growth rates.

2.3 Hypotheses for the impact of R&D activities on firm growth

The autocorrelation of firm growth has been repeatedly studied in the literature (e.g. Almus & Nerlinger 2000, Bottazzi & Secchi 2003, Coad 2006, and Coad & Hölzl 2008). The findings vary. We repeat this analysis for two reasons: First, we examine which results from the literature are confirmed for our data. Second, the results provide a comparison case for the interpretation of the results for the R&D activities' impact. A study by Coad (2006), based on 10000 French manufacturing firms, deals with the serial correlation changes of firms in relation to their firm size and their growth rate. Coad (2006) observes negative correlation of growth and size in case of small firms and positive correlation of these factors in case of larger firms. Additionally, he finds that small firms exhibiting extreme positive growth in any one year are unlikely to repeat this performance in the following year. Having in mind the research studies mentioned above, we assume:

H1: The autocorrelation dynamics of firm growth vary with the size of firms.

In a next step, we focus on the temporal structure of R&D impacts on firm growth. Investments in R&D can be expected to lead to firm growth in the following years, and as a consequence, to higher sales. The literature review concludes that R&D activities are an important growth factor. However, R&D activities do not necessarily have impact immediately, i.e. in the same period. The findings in the literature differ. Nevertheless, we claim that the impact of R&D activities, measured by R&D expenditure and R&D capital expenditure is time-lagged. Thus, we formulate the following expectation:

H2: The impact of R&D activities on firm growth tends to be time-lagged.

Third, previous research claims that the impact of R&D activities is influenced by firms' characteristics – primarily its size (e.g. Shefer and Frenkel, 2005). Among others, Kafouros and Wang (2008) found that firm size is an important factor influencing the impact of R&D activities. To gain a more detailed insight into the R&D activity impacts we analyse the impact of R&D activities in relation to different firm size classes. Hence, the research topic guiding hypothesis 3 is:

H3: The temporal structure of the impact of R&D activities on firm growth varies with firm size.

In the next chapter, we describe the analysis framework, before we test these three hypotheses with regression analysis. The regression results and their interpretation are presented in section 4.

3 Methodology and Data

3.1 Data source and studied firms

We use the European Innovation Scoreboard 2007 as data source. This data source includes 1000 European companies (see Table 1) with information on employees, turnover, sector affiliation as well as details on R&D activities, e.g. R&D capital expenditure and R&D expenditure. These data are available for the time frame from 2003 to 2006. Hence, we are able to generate the growth rates for three time periods.

It is important to mention that we exclude extreme values (outliers) in terms of turnover growth. Additionally, we cannot distinguish organic from acquired growth. Hence, we study total growth.

Finally, the sample consists of 978 firms. Table 1 shows the firm sample differentiated by country. The highest number of observation can be found in the UK with 310 observations which is about 31.8 percent of the firm sample. Table 2 displays our sample within firm size classes. These size classes were derived from Europeans SME definition (see European Commission (2003)).

Table 1: Firms distribution at the country level

Country	Code	Frequency	Percent [%]
Germany	1	162	16.6
UK	2	310	31.8
France	3	113	11.6
Finland	4	68	7.0
Sweden	5	74	7.6
The Netherlands	6	51	5.2
Italy	7	47	4.8
Denmark	8	37	3.8
Belgium	9	33	3.4
Spain	10	21	2.2
Ireland	11	11	1.1
Luxembourg	12	5	0.5
Austria	13	30	3.1
Hungary	14	3	0.3
Slovenia	15	2	0.2
Czech Republic	16	4	0.4
Greece	17	3	0.3
Portugal	18	1	0.1
Latvia	19	1	0.1
		978	**100.0**

Table 2: Firm size in terms of employment (SIZE)

Size*	Frequency	Percent [%] of Firms
small	20	3.0
medium	124	13.1
large	182	18.6
very large	652	66.6
Total	978	100

*SME definition of European Commission (2003)

3.2 Operationalisation of firm growth

Before starting with our analysis, an operationalisation of the term firm growth is necessary. In the empirical literature, there exists a wide range of definitions of firm growth. Some definitions are based on the number of employees (e.g. Kirchhoff & Greene, 1998; Schreyer, 2000; Garnsey, Stam, & Heffernan 2006; Hoelzl & Friesenbichler, 2008) whereas others are based on turnover (Daunfeldt, Elert, & Johansson, 2010). For example, Garnsey, Stam, and Heffernan (2006) claim that a firm's growth can be measured in terms of inputs (e.g. employees), in terms of value (e.g. asset) or outputs (e.g. turnover, profit). In our analysis, we use turnover data which is one of the most commonly used measures for growth. In the regression model we apply the relative turnover growth indicator.

3.3 Dependent variable

The dependent variable is a continuous variable. For the linear model, we define our dependent variable by measuring turnover growth *(TURNGROWTH)* as the ratio of the turnover of year t (respectively 2006) to turnover to year t-1 (respectively 2005):

3.4 Independent variables

In regard to the hypotheses, we employ five independent variables. These variables are the relative turnover growth in the periods 2003 to 2004 and 2004 to 2005, firm size, the R&D activities measured by R&D expenditure and R&D capital expenditure. In addition we use industry affiliation as a control variable because some empirical studies claim that firms' growth is related to industry and sector affiliation. However, it is beyond the scope of this study to explore the differences between industries. Therefore, the results of industry affiliation are not discussed. The independent variables are described as follows:

Relative turnover growth (TURNGROWTH_03_04; TURNGROWTH_04_05)
We use the relative growth indicator in terms of turnover to measure the firm growth from 2003 to 2004 and from 2004 to 2005. These independent variables testify whether firms that experience growth in any one year repeat this performance in the following year.

Size of firms (SIZE)
We classify the firms into four size classes: small-sized enterprises (less than 50 employees), medium-sized enterprises (51 to 250 employees), large-sized enterprises (251 to 1000 employees) and very large-sized enterprises (more than 1000 employees). The independent variable SIZE takes the value 1 for small-sized enterprise, the value 2 for medium-sized enterprises, the value 3 for large-sized enterprises and the value 4 for very large-sized enterprises. For this classification, we use the average employment number reported during the time period from 2003 and 2006. The frequency of the different size classes is presented in Table 2.

R&D expenditure (R&Dexp)
In the European Scoreboard, firms report the R&D expenditure for each year. We measure the ratio between their R&D expenditure and their total turnover. First, we use the average R&D expenditure value for the observed years (2003-2006). Second, we use the R&D expenditure value for each year *(R&Dexp03, R&Dexp04 and R&Dexp05).*

R&D capital expenditure (R&Dcapex)
Furthermore, the European Scoreboard database provides data on capital expenditure in R&D related fields for each firm. Capital expenditures are funds used by a company to acquire or upgrade physical assets such as property, industrial buildings or equipment.[1] Again, we measure the average R&D capital expenditure as the ratio of R&D capital expenditure to total turnover (2003-2006). Additionally, we use the R&D capital expenditure value for each year *(R&Dcapex03, R&Dcapex04 and R&Dcapex05).*

Industry classes (SECTOR)
As mentioned above we use industry affiliation as a control variable. For this purpose we aggregated the NACE-2-digit industries classification. We use 11 different types of industry which are presented in Table 3. For each sector a dummy is included in the multiple regression analysis.

Table 3: Type of industry (SECTOR)

Description*	**Code**	**Frequency**	**Percent [%]**
Agriculture, Forestry	1	8	0.8
Mining and Quarrying	2	24	2.5
Manufacturing	3	550	56.2
Electricity, gas, steam, hot water supply	4	31	3.2
Construction	5	8	0.8
Wholesale, retail trade	6	25	2.6
Transport, storage, communication	7	30	3.1
Financial intermediation	8	50	5.1
Real estate, renting, business activities	9	218	22.3
Public administration, defense	10	9	0.9
Other community, social/personal service activities	11	25	2.6
Total		**978**	**100.0**

* NACE Codes Description

3.5 Regression approach

We set up a regression approach with a linear model. The dependent variable is a continuous variable. It measures the relative growth of firms in terms of turnover in the period from 2005 to 2006. As independent variables all the above described variables are used. In the course of the regression analysis we find that the variables R&Dexp and R&Dcapex are highly correlated. Furthermore, the variables R&Dexp03, R&Dexp04 and R&Dexp05 are highly correlated with each other. The same holds for the variables R&Dcapex03, R&Dcapex04 and R&Dcapex05. To avoid multicollinearity between these explanatory variables, we set up different regression models. In each model only one of these eight variables is included.

Hence, we conduct for each kind of analysis in total eight regressions, each containing one of the variables R&Dexp, R&Dexp03, R&Dexp04 and R&Dexp05, R&Dcapex, R&Dcapex03, R&Dcapex04 and R&Dcapex05. The comparison of the results provides information about whether R&Dexp or R&Dcapex is the more important variable and about the time structure of the impact of R&D on firm growth.

This time structure might interfere with the time structure of the growth process itself. If growth in one year depends on growth in previous years and growth in previous years

[1] See http://www.investopedia.com/terms/c/capitalexpenditure.asp [29/06/2010]

depends on R&D activities in previous years or R&D activities further in the past, a relationship between current growth and previous R&D activities might be a direct effect or an indirect effect. To disentangle this structure we conduct each regression one time without any measure of R&D activity as independent variable, one time with including growth in the past and one time with past growth rates and R&D activities as independent variables at the same time.

Furthermore, we conduct one regression set for all firms together and then four regression sets for each firm size separately. Through this, we are able to analyse whether our findings depend on the size of the firms.

In total we conduct 85 regressions. The structure is presented in Table 4.

Table 4: Structure of the conducted regressions: Combinations of characteristics of the regression settings that are used.

		All firms	Small firms	Medium sized firms	Large firms	Very large firms
Past growth included	**No R&D var. incl.**	**x**	**x**	**x**	**x**	**x**
	R&Dexp incl.	**x**	**x**	**x**	**x**	**x**
	R&Dexp03 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dexp04 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dexp05 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex03 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex04 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex05 incl.	**x**	**x**	**x**	**x**	**x**
Past growth not included	**No R&D var. incl.**	**x**	**x**	**x**	**x**	**x**
	R&Dexp incl.	**x**	**x**	**x**	**x**	**x**
	R&Dexp03 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dexp04 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dexp05 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex03 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex04 incl.	**x**	**x**	**x**	**x**	**x**
	R&Dcapex05 incl.	**x**	**x**	**x**	**x**	**x**

4 Results and Interpretation

4.1 Regression Results

The complete regression results are reported in Tables A.1 – A.11 (in the appendix). In the next subsections, we discuss the results according to our hypotheses that have been set up in Section 2 and present for each discussion only the relevant parts of the results.

4.2 Autocorrelation dynamics (Hypothesis 1)

The autocorrelation of firm's growth has been repeatedly studied in the literature, but the results vary. The autocorrelation dynamics of firm growth are found to depend on firm characteristics such as their size. We repeat this analysis. Hypothesis 1 states that *the autocorrelation dynamics of firm growth varies with the size of firm.*

Hypothesis 1 is confirmed by our empirical examination. If autocorrelations is used as independent variable in the regression analyses, we find different results within the four firm size classes. The results do not change if we exclude or include the variables related to R&D activities. Hence, we do only present the results for the model with no R&D variable included and do only present the findings for the independent variables Turngrowth_03-04 and Turngrowth_04-05 (the complete results can be found in the appendix).

Table 5: Estimates of the coefficients for the independent variables Turngrowth_03-04 and Turngrowth_04-05 from the regressions with no R&D variable included (standard errors in parentheses).

Variable	All firms	Small firms	Medium sized firms	Large firms	Very large firms
Turngrowth_04-05	**0.1219*** (0.023)**	**0.6527** (0.285)**	0.0262 (0.041)	**0.3613*** (0.119)**	**0.3697** (0.032)**
Turngrowth_03-04	**0.09997*** (0.021)**	-0.1375 (0.284)	0.0567 (0.044)	0.09171 (0.086)	**0.1156*** (0.022)**

Looking at the results of all firms, we find positive autocorrelation dynamics. The results go in line with the results by Bottazzi and Secchi (2003) who examine serial correlation for US manufacturing companies. They explore positive autocorrelation dynamics in their sample. Bottazzi et.al. (2001) found positive autocorrelation for every year up to and including the seventh lag, although only the first lag is statistically significant. We also find positive autocorrelation for both lags that we are able to consider.

However, this finding only holds for the analysis of all firms and the analysis of the very large firms. For the other firm subgroups the time lag of two years does not lead to significant results. Hence, the positive autocorrelation for several (two) lags is confirmed here only for the very large firms, which dominate our sample.

Hence, we obtain the result that autocorrelation of firm growth varies with firm size. In our analysis, we find confirmation from the literature that especially large firms show autocorrelation in their growth. Likewise, Coad (2006) concludes that larger firms experience positive feedback in year-to-year growth rates. For medium sized we do not find any autocorrelation. However, small firms show an autocorrelation in growth with a time lag of one year. This result especially contradicts the findings in the literature that smaller firms experience significant negative correlation (Coad, 2006). We find that smaller firms that experience growth in any one year are likely to repeat this performance with a time lag of one year. However, our findings for small firms have to be interpreted with care because our sample only contains 16 small firms. These 16 firms might fail to be representative for all small firms.

4.3 R&D activities (Hypothesis 2)

The literature review concludes that the growth of firms is driven by innovation activities such as R&D activities (e.g. R&D expenditure). Furthermore, it has been recognized that the impact of R&D may be time lagged. Previous studies examine the lag of R&D activities and their impact on the firm performance (e.g. Ravenscraft and Scherer, 1982). Other studies show that the impact if R&D is highest in the year that it is undertaken, and that R&D-capital starts to depreciate immediately (e.g. Kafouros and Wang, 2008). Hypothesis 2 states that *the impact of R&D activities on firm growth tends to be time-lagged.* To gain a deeper insight into this issue, we set up several regressions, each time using one of the R&D-related variables as independent variable. Each regression is conducted for all firms and is run twice, one time including growth in the past and one time without considering growth rates in

the past. The results for the independent R&D-related variables are presented in Table 6 (the complete results for these regressions can be found in Tables A.2 and A.3).

Table 6: Estimates of the coefficients for the independent R&D-related variables, which are used in separate regressions together with the same other independent variables (complete results in Tables A.2 and A.3; standard errors in parentheses).

Variable	Past growth included	Past growth not included
R&Dexp	-0.00009 (0.00008)	**-0.0006*** (0.0001)**
R&Dexp05	0.0000006 (0.00006)	**0.0002* (0.0001)**
R&Dexp04	**-0.00009* (0.00005)**	0.00006 (0.00005)
R&Dexp03	-0.00007 (0.00007)	0.00005 (0.00007)
R&Dcapex	**0.00000003** (0.00000001)**	**-0.00000008*** (0.00000002)**
R&Dcapex05	**0.0026*** (0.0005)**	**0.0022** (0.0009)**
R&Dcapex04	-0.0006 (0.0008)	0.0011 (0.0007)
R&Dcapex03	-0.0002 (0.0003)	-0.00002 (0.0004)

While the variables R&Dexp and R&Dcapex represent the average investments over four years, the other variables in Table 6 represent the investments in one year. Hence, we might assume that the variables R&Dexp and R&Dcapex represent the overall attitude of a firm, while the other variables represent singular events. Therefore, if the growth rate of firms depends on their long-run average investment in R&D we should see this effect in the variables R&Dexp and R&Dcapex. However, such a long-run relationship might also show up in a strong autocorrelation of the growth development, meaning that a firm with an R&D attitude that leads to growth will continuously grow. Therefore, we have to compare the findings for the regressions considering temporal autocorrelation and for the regressions that do not consider temporal autocorrelation.

For the variables R&Dexp and R&Dcapex we find varying results. The relationship of R&Dexp with firm growth is always negative, although this relationship is only significant if past growth is not included in the analysis. This can be interpreted as follows. A long-run high R&D activity relates to lower growth rates. However, this might be an indirect effect caused by other long-run characteristics of the firm that influence growth. Such an indirect effect is also captured by a dependence on past growth, so that the significant relationship between R&D expenditures and growth disappears as found in Table 6. Nevertheless, we find no evidence for higher permanent R&D expenditures relating to higher growth rates.

The results for R&D-related capital expenditures are slightly different. Again we find a negative relationship with growth for the regression that does not include past growth. Again, the above interpretation might apply. In the case of R&D capital expenditure is even more likely because the relationship between R&Dcapex and growth turns into a significant positive relationship if past growth is included. Hence, the negative relationship seems to be caused by some related characteristics of the firm, which is also represented by a dependence on past growth. Permanent high R&D-related capital expenditures seem to increase growth.

In contrast, a clear picture is obtained for the one-time R&D capital expenditures. We find significant coefficient with a positive sign for the R&D capital expenditure variable in 2005. We do not find any significant results for earlier R&D capital expenditures. These results do not depend on the inclusion of past growth. Hence, R&D capital expenditures are positively related to firm growth in the time step from the year of the expenditure to the following year. Earlier years do not matter.

In line with this, Adamou and Sasidharan (2007) study the impact of R&D by using panel data on Indian manufacturing firms. They argue that R&D is an essential determinant of firm growth performance and find that an increase in current R&D induces higher growth

irrespective of the industry. Furthermore, the analysis shows that the impact of R&D tends to be time lagged. That means it takes time for R&D activities to influence firm growth. Likewise, Ravenscraft and Scherer (1982) have studied the lag between R&D activities and their impact on profit. They have found that that there is a time gap of about 4 years. We do not find any evidence for such a time gap in our study.

The results for one-time R&D expenditures are again mixed. If past growth is not included in the analysis we find, as in the case of R&Dcapex05, a positive relationship between growth and the R&D expenditures just before. This finding disappears if past growth is included. The significant relation that is found for R&Dexp04 is just significant, so that we do not want to over-interpret this result here.

To sum up, on average, we find that R&D activities are positively related to firm growth. Our expectation (hypothesis 2) is confirmed by our results. However, the details of the results show interesting aspects. The results for R&D expenditures are very mixed. A significant positive relationship is only found for the one-time expenditures in the year just before growth is measured if autocorrelation dynamics are not considered. Permanent R&D expenditures are rather negatively correlated to growth, although this finding is also not stable if autocorrelation dynamics are considered. In contrast, R&D-related capital expenditures are clearly positively related to firm growth. This holds for permanent R&D capital expenditures (if autocorrelation dynamics are included) as well as for one-time expenditures just before growth measurement. No evidence is found for a time gap.

4.4 Firm size (Hypothesis 3)

We also have claimed based the findings in the literature, that the importance of R&D activities is influenced by a firm's characteristics – primarily its size (e.g. Shefer and Frenkel, 2005). We formulated the hypothesis *that the temporal structure of the impact of R&D activities on firm growth varies with firm size* (Hypothesis 3).

For the small-sized companies we do not find any significant relationship between R&D activities and firm growth (see Tables A.4 and A.5). Hence, the above findings do not apply to small firms. Again, one reason might be the small number of such firms in our sample. Another reason might be the fact that small firm have not the potential to invest in R&D as much as larger firms do (for such an argument see Coad 2006).

For the other firm size classes we find significant relations. These relations do not differ between the regressions including past growth and the regressions not including past growth, except for one result. Hence we discuss here mainly the results for the regressions including past growth (all results are presented in Tables A.6 to A.11). The relevant part of the results is presented in Table 7.

Table 7: Estimates of the coefficients for the independent R&D-related variables, which are used in separate regressions together with the same other independent variables for the different firm size groups (complete results in Tables A.7, A.9 and A.11; standard errors in parentheses).

Variable	Medium-sized firms	Large-sized firms	Very large-sized firms
R&Dexp	0.00007 (0.0002)	**0.0108*** (0.0036)**	-0.0028 (0.0017)
R&Dexp05	0.0001 (0.0001)	**0.0176*** (0.0027)**	-0.0020 (0.0017)
R&Dexp04	0.000004 (0.0002)	**0.0100*** (0.0032)**	-0.0025 (0.0017)
R&Dexp03	0.0002 (0.0002)	**0.0061*** (0.0013)**	-0.0021 (0.0013)
R&Dcapex	**-0.0000002** (0.0000001)**	0.0003 (0.0003)	-0.000002 (0.00001)
R&Dcapex05	**0.0029** (0.0014)**	0.0021 (0.0024)	**0.0031* (0.0017)**
R&Dcapex04	0.0017 (0.0018)	0.0016 (0.0041)	0.0011 (0.0018)
R&Dcapex03	0.0001 (0.0006)	**0.0116* (0.0063)**	0.0012 (0.0013)

Table 7 clearly confirms Hypothesis 3: the relationship between R&D activities and firm growth varies strongly with the size of firms. Coad (2006) finds that small firms and large firms appear to operate on different 'frequencies'. The R&D activities of smaller firms are characterized by an unstable, 'stop and go' dynamics, whilst larger firms operate more constantly and sustainable. We find similar dependency, but also some different details.

First, let us consider the R&D expenditures. For this variable we find only significant relations to firm growth for the large-sized firms. For all other sizes of firms, even for the very large ones, no relationship is found. Hence, R&D expenditures are especially relevant for large firms. This result is stable independent of how we include R&D expenditures, meaning independent of whether we take the average R&D expenditures or the one-time values and whether we use a time lag or not. Hence, large firms with permanently high R&D expenditures show a permanently higher growth rate.

In this context, we want to highlight the fact that this result is quite different from the findings for all firms. There we found only evidence for a relationship of growth with the R&D expenditures just before and definitely no positive relationship between firm growth and permanent R&D expenditures. This is caused by the fact that the other firm size groups, which show no significant relation themselves, seem to blur the relationship for the large firms. This might very well also be the reason for the sensitive results in the regressions that contained all firms together.

Let us now look at the results for the R&D-related capital expenditures. For this variable we find significant results for medium-sized, large and very large firms. There is also one feature common for these firm groups, although it is not significant for large firms: the R&D capital expenditure in 2005 is positively related to firm growth. This confirms the findings for the whole sample: firm growth is related to the R&D capital expenditure that is spend in the year before the growth is measured. This is significantly confirmed for medium-sized and very large firms.

For large firms we find a positive significant coefficient for R&D capital expenditure variable with a time lag of three years. Hence, the one-time R&D capital expenditure of firms is positively related to firm growth, but in the case of medium-sized and very large firms this growth occurs immediately while in the case of large firms this growth occurs two years later.

In addition, we find a negative relationship between average R&D capital expenditures and firm growth for the medium-sized firms. This means that high permanent R&D capital expenditures come together with small growth in the case of medium-sized firms. Maybe medium-sized firms that grow well do not focus on R&D but expand their production capacities first.

To sum up, Hypothesis 3 is clearly confirmed by our results: the relation between R&D activities and firm growth varies with firm size. Whilst large firms show high growth if they invest in R&D constantly, the investments in R&D of medium-sized and very large firms seem to have a more short-run relation to firm growth.

5 Conclusions

In this paper we analyse the time structure of the relationship between R&D activity and firm growth. The literature usually states that R&D activities are related to firm growth. These usual approaches detect the general effects of R&D activities on firm growth. We deviate from this usual approach by focusing on the time structure of the relationship between R&D efforts and firm growth. In addition, we differentiate between different firm sizes. This leads to a more detailed picture.

We find that the autocorrelation of growth rates varies with firm size. We find confirmation for the finding from the literature that especially larger firms show autocorrelation in their year-to-year growth rates. For medium-sized firms we do not find any

autocorrelation. However, small firms show a very strong autocorrelation in growth with a time lag of one year.

Furthermore, we explore that R&D capital expenditures have a positive relationship with the firm growth from this to the following year. This holds especially for medium-sized and very large firms, while for large firms a time lag of two years is found. No such relationship is found for the case of small firms.

Additionally, we find evidence for the expectation that the temporal structure of the effect of R&D expenditures on firm growth vary with firm size. A positive relationship between R&D expenditures and firm growth is only found for large firms. For all other firm sizes no such relation is confirmed by our study.

To sum up our findings, we conclude that R&D activities can be expected to lead to innovation and growth. Nevertheless, the temporal structure of the impact of R&D activity is important to consider and this temporal structure as well as the overall impact depends strongly on the size of the firm. So far, studies on the temporal structure of firm growth are rare; hence, it is interesting to examine this topic further. More studies are required to get deeper and more detailed insights into the temporal structure of firm growth.

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Appendix

Table A.1: Regression results for different firm size (excluding R&D activity variables)

	Relative turnover growth				
	(I) absolut	(II) very large	(III) large	(IV) medium	(V) small
Turngrowth_04-05	0.1219*** (0.0226)	0.3697*** (0.03161)	0.3613*** (0.1192)	0.0262 (0.0409)	0.6527** (0.2853)
Turngrowth_03-04	0.0997*** (0.0207)	0.1156*** (0.02208)	0.09171 (0.08598)	0.0567 (0.0437)	-0.1375 (0.2835)
size_small	0.2674*** (0.0976)	-	-	-	-
size_medium	0.1234*** (0.0409)	-	-	-	-
size_large	0.0483 (0.0336)	-	-	-	-
Dummy_sector1	-0.0528 (0.1559)	0.01899 (0.09909)	0.1197 (0.5965)	(dropped)	(dropped)
Dummy_sector2	0.0616 (0.1101)	0.03714 (0.07492)	-0.01261 (0.5942)	-0.4683 (0.6531)	(dropped)
Dummy_sector3	-0.1175 (0.0786)	-0.05278 (0.05962)	-0.0108 (0.2102)	-0.5331* (0.3024)	0.0383 (0.3225)
Dummy_sector4	-0.0622 (0.1034)	-0.1267* (0.07172)	0.18457 (0.3806)	1.2546* (0.6538)	(dropped)
Dummy_sector5	-0.0622 (0.1561)	-0.0255 (0.09505)	(dropped)	(dropped)	(dropped)
Dummy_sector6	-0.2072* (0.1088)	-0.1252* (0.07397)	-0.3835 (0.3811)	(dropped)	(dropped)
Dummy_sector7	-0.1385 (0.1044)	-0.06626 (0.07137)	-0.02291 (0.4447)	(dropped)	-0.3290 (0.6523)
Dummy_sector8	-0.0454 (0.0942)	-0.008457 (0.06722)	0.00733 (0.3032)	-0.3940 (0.5075)	(dropped)
Dummy_sector9	-0.0638 (0.0812)	-0.07413 (0.06327)	0.1723 (0.2143)	-0.4194 (0.3017)	(dropped)
Dummy_sector10	-0.1411 (0.1494)	-0.09559 (0.091738)	(dropped)	(dropped)	(dropped)
Constant	0.9767*** (0.0848)	0.6380*** (0.067224)	0.60474** (0.2640)	1.6537*** (0.3042)	0.8138 (0.5180)
R-squared	0.1	0.3	0.1	0.11	0.44
Number_of_obs	972	652	182	122	16

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.2: Regression results for all firms (excluding the previous turnover growth rates)

	Relative turnover growth (all firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	-0.0006*** (0.0001)	-	-	-	-	-	-	-
R&Dexp05	-	0.0002* (0.0001)	-	-	-	-	-	-
R&Dexp04	-	-	0.00006 (0.00005)	-	-	-	-	-
R&Dexp03	-	-	-	0.00005 (0.00007)	-	-	-	-
R&Dcapex	-	-	-	-	-7.91e-08*** (2.39e-08)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0022** (0.0009)	-	-
R&Dcapex04	-	-	-	-	-	-	0.0011 (0.0007)	-
R&Dcapex03	-	-	-	-	-	-	-	-0.00002 (0.0004)
size_small	1.8894*** (0.2166)	0.9275*** (0.2208)	0.1642 (0.1105)	0.2092* (0.1164)	1.4822*** (0.1803)	1.0582*** (0.1949)	0.1575 (0.1184)	0.2776** (0.1097)
size_medium	0.2730*** (0.0734)	0.1717** (0.0744)	0.1789*** (0.0418)	0.1801*** (0.0423)	0.2095*** (0.0734)	0.1698** (0.0743)	0.1744*** (0.0424)	0.1891*** (0.0415)
size_large	0.0946 (0.0610)	0.0843 (0.0616)	0.0740** (0.0344)	0.0723** (0.0345)	0.0868 (0.0619)	0.0805 (0.0618)	0.0741** (0.0346)	0.0742** (0.0346)
Dummy_sector1	-0.0703 (0.2843)	-0.0876 (0.2871)	-0.0889 (0.1606)	-0.0890 (0.1606)	-0.0815 (0.2870	-0.0901 (0.2870)	-0.0897 (0.1608)	-0.0872 (0.1609)
Dummy_sector2	0.1149 (0.2006)	0.1028 (0.2026)	0.1001 (0.1133)	0.0998 (0.1123)	0.1195 (0.2048)	0.0887 (0.2027)	0.0934 (0.1136)	0.1013 (0.1136)
Dummy_sector3	-0.1031 (0.1433)	-0.1171 (0.1447)	-0.1330 (0.0809)	-0.1345* (0.0810)	-0.1159 (0.1447)	-0.1216 (0.1447)	-0.1346* (0.0811)	-0.1324 (0.0811)
Dummy_sector4	-0.0591 (0.1886)	-0.0742 (0.1905)	-0.0751 (0.1065)	-0.0754 (0.1065)	-0.0680 (0.1918)	-0.1547 (0.1939)	-0.0947 (0.1076)	-0.0736 (0.1069)
Dummy_sector5	-0.0564 (0.2848)	-0.0722 (0.2876)	-0.0753 (0.1608)	-0.0756 (0.1609)	-0.0665 (0.2876)	-0.0778 (0.2875)	-0.0764 (0.1611)	-0.0739 (0.1612)
Dummy_sector6	-0.2007 (0.1984)	-0.2161 (0.2004)	-0.2178* (0.1121)	-0.2180* (0.1121)	-0.2097 (0.2024)	-0.2171 (0.2003)	-0.2187* (0.1123)	-0.2163* (0.1123)
Dummy_sector7	-0.1038 (0.1912)	-0.2230 (0.1928)	-0.1739 (0.1077)	-0.1740 (0.1080)	-0.1484 (0.1937)	-0.1711 (0.1939)	-0.1642 (0.1087)	-0.1547 (0.1086)
Dummy_sector8	-0.0446 (0.1719)	-0.0562 (0.1736)	-0.0581 (0.0971)	-0.0583 (0.0971)	-0.0450 (0.1748)	-0.0576 (0.1741)	-0.0594 (0.0976)	-0.0561 (0.0976)
Dummy_sector9	-0.1197 (0.1479)	-0.1372 (0.1494)	-0.0935 (0.0835)	-0.0879 (0.0836)	-0.1233 (0.1494)	-0.1300 (0.1493)	-0.0943 (0.0837)	-0.0878 (0.0837)
Dummy_sector10	-0.1224 (0.2726)	-0.1450 (0.2753)	-0.1471 (0.1540)	-0.1478 (0.1540)	-0.1378 (0.2753)	-0.1433 (0.2752)	-0.1463 (0.1542)	-0.1452 (0.1543)
Constant	1.2192*** (0.1419)	1.235*** (0.1433)	1.2378*** (0.0802)	1.2381*** (0.0802)	1.2290*** (0.1433)	1.2279*** (0.1433)	1.2346*** (0.0803)	1.2364*** (0.0803)
R-squared	0.1	0.07	0.05	0.05	0.1	0.06	0.05	0.05
Number_of_obs	977	977	974	973	965	972	969	968

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.3: Regression results for all firms (including previous turnover growth rates and R&D investment variables)

	Relative turnover growth (all firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	-0.00009 (0.00008)	-	-	-	-	-	-	-
R&Dexp05	-	5.90e-07 (0.00006)	-	-	-	-	-	-
R&Dexp04	-	-	-0.00009* (0.00005)	-	-	-	-	-
R&Dexp03	-	-	-	-0.00007 (0.00007)	-	-	-	-
R&Dcapex	-	-	-	-	2.97e-08** (1.35e-08)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0026*** (0.0005)	-	-
R&Dcapex04	-	-	-	-	-	-	-0.0006 (0.0008)	-
R&Dcapex03	-	-	-	-	-	-	-	-0.0002 (0.0003)
Turngrowth_04-05	0.1256*** (0.0227)	0.1219*** (0.0226)	0.1481*** (0.0274)	0.1271*** (0.0230)	0.1262*** (0.0227)	0.1234*** (0.0223)	0.1321*** (0.0265)	0.1223*** (0.0226)
Turngrowth_03-04	0.0991*** (0.0207)	0.0997*** (0.0207)	0.0939*** (0.0210)	0.1025*** (0.2089)	0.0990*** (0.0208)	0.1009*** (0.0205)	0.0972*** (0.0211)	0.1003*** (0.0208)
size_small	0.3620*** (0.1253)	0.2667** (0.1245)	0.3757*** (0.1168)	0.3331*** (0.1141)	0.3572*** (0.1055)	0.0421 (0.1104)	0.3421*** (0.1231)	0.3088*** (0.1065)
size_medium	0.1328*** (0.0417)	0.1233*** (0.0417)	0.1334*** (0.0413)	0.1327*** (0.0418)	0.1232*** (0.0411)	0.0830** (0.0412)	0.1303*** (0.0419)	0.1271*** (0.0414)
size_large	0.0494 (0.0336)	0.0483 (0.0336)	0.0483 (0.0336)	0.0488 (0.0336)	0.0488 (0.0338)	0.0393 (0.0334)	0.0497 (0.0338)	0.0492 (0.0338)
Dummy_sector1	-0.0505 (0.1558)	-0.0528 (0.1560)	-0.0472 (0.1558)	-0.0495 (0.1559)	-0.0520 (0.1562)	-0.0617 (0.1541)	-0.0499 (0.1562)	-0.0520 (0.1562)
Dummy_sector2	0.0620 (0.1101)	0.0616 (0.1102)	0.0577 (0.1100)	0.0616 (0.1101)	0.0743 (0.1116)	0.0394 (0.1089)	0.0643 (0.1104)	0.0631 (0.1104)
Dummy_sector3	-0.1156 (0.0785)	-0.1175 (0.0786)	-0.1139 (0.0785)	-0.1148 (0.0786)	-0.1176 (0.0788)	-0.1254 (0.0777)	-0.1143 (0.0788)	-0.1164 (0.0787)
Dummy_sector4	-0.0610 (0.1034)	-0.0622 (0.1035)	-0.0621 (0.1033)	-0.0602 (0.1034)	-0.0628 (0.1044)	-0.1660 (0.1042)	-0.0508 (0.1047)	-0.0593 (0.1038)
Dummy_sector5	-0.0606 (0.1561)	-0.0622 (0.1562)	-0.0602 (0.1560)	-0.0599 (0.1561)	-0.0619 (0.1565)	-0.0748 (0.1543)	-0.0603 (0.1564)	-0.0616 (0.1564)
Dummy_sector6	-0.2056 (0.1087)	-0.2072* (0.1088)	-0.2047* (0.1087)	-0.2050* (0.1088)	-0.2073* (0.1101)	-0.2139** (0.1075)	-0.2054* (0.1090)	-0.2060* (0.1090)
Dummy_sector7	-0.1253 (0.1050)	-0.1386 (0.1048)	-0.1240 (0.1047)	-0.1264 (0.1050)	-0.1267 (0.1054)	-0.1534 (0.1041)	-0.1210 (0.1057)	-0.1251 (0.1055)
Dummy_sector8	-0.0443 (0.0942)	-0.0455 (0.0943)	-0.0446 (0.1047)	-0.0437 (0.0942)	-0.0383 (0.0952)	-0.0501 (0.0935)	-0.0414 (0.0948)	-0.0424 (0.0948)
Dummy_sector9	-0.0627 (0.0811)	-0.0638 (0.0812)	-0.0609 (0.0811)	-0.0617 (0.0812)	-0.0616 (0.0814)	-0.0628 (0.0802)	-0.0637 (0.0813)	-0.0645 (0.0813)
Dummy_sector10	-0.1384 (0.1494)	-0.1411 (0.1495)	-0.1363 (0.1493)	-0.1377 (0.1494)	-0.1405 (0.1498)	-0.1466 (0.1477)	-0.1392 (0.1497)	-0.1405 (0.1497)
Constant	0.9714*** (0.0849)	0.9767*** (0.0848)	0.9507*** (0.0861)	0.9652*** (0.0854)	0.9722*** (0.0850)	0.9710*** (0.0838)	0.9681*** (0.0857)	0.9756*** (0.0850)
R-squared	0.12	0.1	0.11	0.11	0.12	0.13	0.11	0.11
Number_of_obs	972	972	972	972	961	967	967	967
standard errors in parentheses ***p<0.01 **p<0.05 *p<0.1								

Table A.4: Regression results for small-sized firms (excluding previous turnover growth rates)

	Relative turnover growth (small-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	-0.0021 (0.0017)	-	-	-	-	-	-	-
R&Dexp05	-	0.0018 (0.0016)	-	-	-	-	-	-
R&Dexp04	-	-	0.0002 (0.0002)	-	-	-	-	-
R&Dexp03	-	-	-	-0.0004 (0.0004)	-	-	-	-
R&Dcapex	-	-	-	-	-2.98e-08 (0.861)	-	-	-
R&Dcapex05	-	-	-	-	-	-0.0048 (0.0166)	-	-
R&Dcapex04	-	-	-	-	-	-	0.00006 (0.0034)	-
R&Dcapex03	-	-	-	-	-	-	-	-0.0014 (0.0013)
Dummy_sector1	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector2	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector3	-5.5122 (7.8330)	9.0325 (7.6387)	1.1069 (0.9438)	-0.9211 (1.6357)	1.9153 (2.3068)	2.1615 (2.2090)	0.2472 (0.3974)	0.3779 (0.4045)
Dummy_sector4	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector5	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector6	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector7	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector8	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector9	-7.7528 (7.9889)	6.3170 (7.2049)	0.9983 (1.0314)	-1.2647 (1.7549)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector10	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Constant	10.6802 (8.9988)	-7.3402 (8.7235)	0.1593 (1.0650)	2.7170 (1.8874)	1.4014 (1.8340)	1.6923 (2.2318)	1.2457*** (0.3534)	1.3441*** (0.2793)
R-squared	0.15	0.13	0.13	0.12	0.06	0.06	0.04	0.11
Number_of_obs	19	19	17	16	18	18	16	15

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.5: Regression results for small-sized firms (including previous turnover growth rates and R&D investment variables)

	Relative turnover growth (small-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	0.0001 (0.0003)	-	-	-	-	-	-	-
R&Dexp05	-	0.0002 (0.0003)	-	-	-	-	-	-
R&Dexp04	-	-	0.0002 (0.0002)	-	-	-	-	-
R&Dexp03	-	-	-	0.00003 (0.0004)	-	-	-	-
R&Dcapex	-	-	-	-	-1.46e-08 (2.34e-	-	-	-
R&Dcapex05	-	-	-	-	-	0.0004 (0.0030)	-	-
R&Dcapex04	-	-	-	-	-	-	-0.0008 (0.0030)	-
R&Dcapex03	-	-	-	-	-	-	-	-0.0009 (0.0012)
Turngrowth_04-	0.6996* (0.3170)	0.7825** (0.3354)	0.7757** (0.2788)	0.6595* (0.3133)	0.6558** (0.2935)	0.6448* (0.3055)	0.6625* (0.3003)	0.6220* (0.2941)
Turngrowth_03-	-0.1375 (0.2948)	-0.1097 (0.2910)	0.0304 (0.2866)	-0.1440 (0.3102)	-0.1359 (0.2917)	-0.1551 (0.3288)	-0.1378 (0.2963)	-0.1202 (0.2904)
Dummy_sector1	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector2	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector3	0.9017 (1.4416)	(dropped)	-0.1569 (0.3269)	0.0264 (0.3751)	-0.0199 (0.3447)	0.0353 (0.3388)	0.0759 (0.3646)	0.1461 (0.3595)
Dummy_sector4	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector5	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector6	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector7	(dropped)	-1.2081 (1.2697)	-1.3287 (0.8765)	-0.4453 (1.7241)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector8	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector9	0.9168 (1.5570)	-0.0895 (0.3350)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector10	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Constant	-0.2368 (1.8995)	0.4921 (0.7274)	0.3976 (0.5531)	0.8015 (0.5682)	0.8736 (0.5415)	0.8049 (0.5476)	0.8588 (0.5664)	0.8603 (0.5324)
R-squared	0.45	0.47	0.55	0.44	0.45	0.42	0.43	0.45
Number_of_obs	16	16	16	16	15	15	15	15

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.6: Regression results for medium-sized firms (excluding previous turnover growth rates)

	Relative turnover growth (medium-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	0.00006 (0.0002)	-	-	-	-	-	-	-
R&Dexp05	-	0.0001 (0.0001)	-	-	-	-	-	-
R&Dexp04	-	-	0.00004 (0.00009)	-	-	-	-	-
R&Dexp03	-	-	-	0.0002 (0.0001)	-	-	-	-
R&Dcapex	-	-	-	-	-1.68e-07* (9.72e-0.8)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0028** (0.0014)	-	-
R&Dcapex04	-	-	-	-	-	-	0.0010 (0.0013)	-
R&Dcapex03	-	-	-	-	-	-	-	0.0002 (0.0006)
Dummy_sector1	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector2	-0.5125 (0.6581)	-0.5115 (0.6567)	-0.5129 (0.6572)	-0.5105 (0.6507)	-0.51313 (0.6494)	-0.5031 (0.6468)	-0.5103 (0.6558)	-0.5119 (0.6557)
Dummy_sector3	-0.5428* (0.3056)	-0.5463* (0.3044)	-0.5302* (0.3048)	-0.5682* (0.3023)	-0.5242* (0.3010)	-0.5738* (0.3001)	-0.5406* (0.3045)	-0.5401* (0.3038)
Dummy_sector4	1.2213* (0.6582)	1.2060* (0.6572)	1.2236* (0.6572)	1.2127* (0.6508)	1.2250* (0.6494)	-0.1702 (0.9402)	1.1912* (0.6571)	1.2229* (0.6557)
Dummy_sector5	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector6	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector7	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector8	-0.4641 (0.5098)	-0.4626 (0.5087)	-0.4645 (0.5091)	-0.4617 (0.5041)	-0.4650 (0.5030)	-0.4638 (0.5010)	-0.4722 (0.5081)	-0.4638 (0.5079)
Dummy_sector9	-0.4511 (0.3047)	-0.4613 (0.3039)	-0.4534 (0.3041)	-0.4608 (0.3013)	-0.4277 (0.3000)	-0.4632 (0.2987)	-0.4593 (0.3032)	-0.4359 (0.3031)
Dummy_sector10	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Constant	1.7740*** (0.2943)	1.7724*** (0.2937)	1.7745*** (0.2939)	1.7717*** (0.2910)	1.7750*** (0.2904)	1.7624*** (0.2893)	1.7698*** (0.2933)	1.7734*** (0.2933)
R-squared	0.1	0.1	0.1	0.11	0.11	0.12	0.1	0.1
Number_of_obs	124	124	123	123	123	124	123	123

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.7: Regression results for medium-sized firms (including previous turnover growth rates and R&D investment variables)

	Relative turnover growth (medium-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	0.00007 (0.0002)	-	-	-	-	-	-	-
R&Dexp05	-	0.0001 (0.0001)	-	-	-	-	-	-
R&Dexp04	-	-	3.64e-06 (0.0002)	-	-	-	-	-
R&Dexp03	-	-	-	0.0002 (0.0002)	-	-	-	-
R&Dcapex	-	-	-	-	-2.38e-07** (1.06e-07)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0029** (0.0014)	-	-
R&Dcapex04	-	-	-	-	-	-	0.0017 (0.0018)	-
R&Dcapex03	-	-	-	-	-	-	-	0.0001 (0.0006)
Turngrowth_04-05	0.0215 (0.0438)	0.0240 (0.0410)	0.0248 (0.0907)	0.0085 (0.0450)	0.0686 (0.0444)	0.0191 (0.0404)	-0.0145 (0.0598)	0.0257 (0.0411)
Turngrowth_03-04	0.0574 (0.0439)	0.0582 (0.0438)	0.0569 (0.0447)	0.0458 (0.0452)	0.0553 (0.0430)	0.0651 (0.0433)	0.0643 (0.0445)	0.0564 (0.0439)
Dummy_sector1	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector2	-0.4685 (0.6557)	-0.4663 (0.6542)	-0.4686 (0.6563)	-0.4789 (0.6535)	-0.4557 (0.6419)	-0.4549 (0.6437)	-0.4717 (0.6535)	-0.4679 (0.6559)
Dummy_sector3	-0.5393* (0.3043)	-0.5420* (0.3031)	-0.5335* (0.3043)	-0.5544* (0.3034)	-0.5356* (0.2972)	-0.5711* (0.2986)	-0.5550* (0.3035)	-0.5349* (0.3038)
Dummy_sector4	1.2450* (0.6571)	1.2327* (0.6555)	1.2530* (0.6630)	1.2259* (0.6547)	1.2990** (0.6429)	-0.1834 (0.9421)	1.1561* (0.6626)	1.2527* (0.6566)
Dummy_sector5	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector6	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector7	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector8	-0.3989 (0.5096)	-0.3963 (0.5084)	-0.4000 (0.5098)	-0.4122 (0.5079)	-0.3938 (0.4988)	-0.3912 (0.5002)	-0.4115 (0.5079)	-0.3997 (0.5097)
Dummy_sector9	-0.4260 (0.3037)	-0.4356 (0.3029)	-0.4199 (0.3042)	-0.4422 (0.3028)	-0.4021 (0.2966)	-0.4345 (0.2974)	-0.4327 (0.3022)	-0.4219 (0.3032)
Dummy_sector10	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Constant	1.6574*** (0.3057)	1.6515*** (0.3048)	1.6553 (0.3184)	1.6909*** (0.3069)	1.6010*** (0.2999)	1.6371*** (0.2999)	1.6862*** (0.3064)	1.6541*** (0.3055)
R-squared	0.11	0.11	0.11	0.11	0.15	0.14	0.11	0.11
Number_of_obs	122	122	122	122	122	122	122	122

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.8: Regression results for large-sized firms (excluding previous turnover growth rates)

	Relative turnover growth (large-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	0.0112*** (0.0037)	-	-	-	-	-	-	-
R&Dexp05	-	0.0171*** (0.0029)	-	-	-	-	-	-
R&Dexp04	-	-	0.0112*** (0.0033)	-	-	-	-	-
R&Dexp03	-	-	-	0.0066*** (0.0013)	-	-	-	-
R&Dcapex	-	-	-	-	0.0003 (0.0003)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0015 (0.0025)	-	-
R&Dcapex04	-	-	-	-	-	-	-0.00003 (0.0042)	-
R&Dcapex03	-	-	-	-	-	-	-	0.0136** (0.0058)
Dummy_sector1	-0.0830 (0.6034)	-0.0793 (0.5633)	-0.0882 (0.5993)	-0.0872 (0.5759)	-0.0978 (0.6192)	-0.0967 (0.6203)	-0.0986 (0.6209)	-0.0323 (0.6116)
Dummy_sector2	-0.0366 (0.6039)	-0.0689 (0.5636)	-0.0438 (0.5999)	-0.0139 (0.5760)	-0.1098 (0.6439)	0.0430 (0.6202)	0.0441 (0.6209)	0.0466 (0.6110)
Dummy_sector3	-0.2597 (0.2124)	-0.3096 (0.1976)	-0.2595 (0.2105)	-0.2250 (0.2008)	-0.1676 (0.2156)	-0.1639 (0.2160)	-0.1616 (0.2164)	-0.1295 (0.2132)
Dummy_sector4	0.0409 (0.3851)	0.0126 (0.3596)	0.0346 (0.3826)	0.0556 (0.3676)	0.0475 (0.3953)	-0.1541 (0.5348)	0.0562 (0.5264)	0.0141 (0.3903)
Dummy_sector5	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector6	-0.3448 (0.3851)	-0.3456 (0.3596)	-0.3520 (0.3825)	-0.3467 (0.3676)	-0.3495 (0.3952)	-0.3484 (0.3959)	-0.3497 (0.3963)	-0.2721 (0.3914)
Dummy_sector7	-0.1786 (0.4497)	-0.1790 (0.4199)	-0.1792 (0.4467)	-0.1702 (0.4292)	-0.1744 (0.4615)	-0.1739 (0.4623)	-0.1741 (0.4628)	-0.1768 (0.4554)
Dummy_sector8	-0.1085 (0.3074)	-0.1352 (0.2870)	-0.1028 (0.3053)	-0.0931 (0.2932)	-0.0356 (0.3328)	-0.0736 (0.3158)	-0.0755 (0.3161)	-0.0670 (0.3111)
Dummy_sector9	-0.1776 (0.2192)	-0.2984 (0.2040)	-0.1916 (0.2174)	-0.1521 (0.2045)	-0.0309 (0.2189)	-0.0162 (0.2184)	-0.0143 (0.2187)	0.0355 (0.2162)
Dummy_sector10	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Constant	1.2715*** (0.2013)	1.2616*** (0.1879)	1.2766*** (0.1999)	1.2802*** (0.1920)	1.2970*** (0.2064)	1.2934*** (0.2069)	1.2981*** (0.2072)	1.1910*** (0.2087)
R-squared	0.07	0.19	0.1	0.15	0.03	0.02	0.02	0.06
Number_of_obs	182	182	182	182	181	181	181	181

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.9: Regression results for large-sized firms (including previous turnover growth rates and R&D investment variables)

	Relative turnover growth (large-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VII)
R&Dexp	0.0108*** (0.0036)	-	-	-	-	-	-	-
R&Dexp05	-	0.0176*** (0.0027)	-	-	-	-	-	-
R&Dexp04	-	-	0.0100*** (0.0032)	-	-	-	-	-
R&Dexp03	-	-	-	0.0061*** (0.0013)	-	-	-	-
R&Dcapex	-	-	-	-	0.0003 (0.0003)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0021 (0.0024)	-	-
R&Dcapex04	-	-	-	-	-	-	0.0016 (0.0041)	-
R&Dcapex03	-	-	-	-	-	-	-	0.0116* (0.0063)
Turngrowth_04-05	0.3750*** (0.1166)	0.4222*** (0.1076)	0.3508*** (0.1163)	0.3525*** (0.1129)	0.3647*** (0.1197)	0.3692*** (0.1201)	0.3642*** (0.1202)	0.3903*** (0.1199)
Turngrowth_03-04	0.0638 (0.0846)	0.0423 (0.0777)	0.0663 (0.0842)	-0.0427 (0.0866)	0.0859 (0.0865)	0.0896 (0.0864)	0.0931 (0.0866)	0.0108 (0.0963)
Dummy_sector1	0.1256 (0.5831)	0.1406 (0.5363)	0.1101 (0.5817)	0.0521 (0.5650)	0.1187 (0.5985)	0.1249 (0.5988)	0.1228 (0.5998)	0.1452 (0.5942)
Dummy_sector2	-0.0859 (0.5813)	-0.1249 (0.5345)	-0.0852 (0.5799)	-0.0375 (0.5626)	-0.1514 (0.6197)	-0.0146 (0.5964)	-0.0158 (0.5974)	0.0034 (0.5918)
Dummy_sector3	-0.1098 (0.2081)	-0.1598 (0.1904)	-0.1104 (0.2075)	-0.1203 (0.2005)	-0.01616 (0.2110)	-0.0115 (0.2111)	-0.0122 (0.2115)	-0.0027 (0.2095)
Dummy_sector4	0.1674 (0.3720)	0.1440 (0.3422)	0.1566 (0.3712)	0.1410 (0.3604)	0.1783 (0.3819)	-0.1109 (0.5146)	0.0556 (0.5063)	0.1332 (0.3800)
Dummy_sector5	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Dummy_sector6	-0.3895 (0.3725)	-0.4044 (0.3426)	-0.3914 (0.3716)	-0.4193 (0.3609)	-0.3857 (0.3824)	-0.3837 (0.3825)	-0.3818 (0.3832)	-0.3462 (0.3800)
Dummy_sector7	-0.0368 (0.4346)	-0.0341 (0.3998)	-0.0430 (0.4337)	-0.0876 (0.4212)	-0.0249 (0.4462)	-0.0212 (0.4463)	-0.0246 (0.4471)	-0.0563 (0.4432)
Dummy_sector8	-0.0292 (0.2966)	-0.0562 (0.2728)	-0.0253 (0.2959)	-0.0438 (0.2873)	0.0469 (0.3210)	0.0107 (0.3044)	0.0079 (0.3049)	-0.0006 (0.3020)
Dummy_sector9	0.0088 (0.2165)	-0.1160 (0.1978)	-0.0020 (0.2163)	-0.0162 (0.2071)	0.1562 (0.2160)	0.1720 (0.2151)	0.1717 (0.2155)	0.1924 (0.2137)
Dummy_sector10	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)
Constant	0.6032** (0.2581)	0.5541** (0.2375)	0.6420** (0.2578)	0.8165*** (0.2543)	0.6080** (0.2650)	0.5894** (0.2656)	0.5939** (0.2670)	0.5988** (0.2630)
R-squared	0.15	0.28	0.15	0.2	0.1	0.1	0.1	0.12
Number_of_obs	182	182	182	182	182	181	181	181

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.10: Regression results for very large-sized firms (excluding previous turnover growth rates)

	Relative turnover growth (very large-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	-0.0011 (0.0020)	-	-	-	-	-	-	-
R&Dexp05	-	-0.0009 (0.0020)	-	-	-	-	-	-
R&Dexp04	-	-	-0.0008 (0.0020)	-	-	-	-	-
R&Dexp03	-	-	-	0.0002 (0.0015)	-	-	-	-
R&Dcapex	-	-	-	-	4.58e-06 (0.00001)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0024 (0.0020)	-	-
R&Dcapex04	-	-	-	-	-	-	0.0020 (0.0021)	-
R&Dcapex03	-	-	-	-	-	-	-	0.0007 (0.0015)
Dummy_sector1	0.0187 (0.1155)	0.0178 (0.1155)	0.0178 (0.1155)	0.0156 (0.1155)	0.0161 (0.1160)	0.0156 (0.1154)	0.0162 (0.1154)	0.0157 (0.1155)
Dummy_sector2	0.2154** (0.0861)	0.2154** (0.0862)	0.2159** (0.0861)	0.2165** (0.0861)	0.2306*** (0.0873)	0.2031** (0.0868)	0.2046** (0.0870)	0.2116** (0.0867)
Dummy_sector3	-0.0160 (0.0696)	-0.0167 (0.0695)	-0.0168 (0.0696)	-0.0193 (0.0695)	-0.0178 (0.0697)	-0.0174 (0.0694)	-0.0191 (0.0694)	-0.0183 (0.0695)
Dummy_sector4	-0.0489 (0.0831)	-0.0488 (0.0831)	-0.0484 (0.0831)	-0.0475 (0.0831)	-0.0500 (0.0840)	-0.0657 (0.0844)	-0.0675 (0.0857)	-0.0565 (0.0852)
Dummy_sector5	0.0247 (0.1107)	0.0249 (0.1107)	0.0252 (0.1107)	0.0264 (0.1107)	0.0260 (0.1111)	0.0245 (0.1106)	0.0265 (0.1106)	0.0267 (0.1107)
Dummy_sector6	-0.0970 (0.0861)	-0.0970 (0.0861)	-0.0968 (0.0861)	-0.0965 (0.0861)	-0.0946 (0.0873)	-0.0943 (0.0861)	-0.0964 (0.0861)	-0.0989 (0.0863)
Dummy_sector7	-0.0532 (0.0831)	-0.0530 (0.0831)	-0.0529 (0.0831)	-0.0524 (0.0831)	-0.0525 (0.0835)	-0.0687 (0.0842)	-0.0658 (0.0843)	-0.0576 (0.0838)
Dummy_sector8	0.0496 (0.0781)	0.0496 (0.0782)	0.0498 (0.0782)	0.0502 (0.0782)	0.0525 (0.0787)	0.0515 (0.0783)	0.0493 (0.0784)	0.0499 (0.0785)
Dummy_sector9	-0.0275 (0.0742)	-0.0287 (0.0742)	-0.0292 (0.0742)	-0.0339 (0.0740)	-0.0346 (0.0741)	-0.0284 (0.0737)	-0.0310 (0.0737)	-0.0320 (0.0737)
Dummy_sector10	-0.0372 (0.1077)	-0.0407 (0.1072)	-0.0395 (0.1078)	-0.0488 (0.1093)	-0.0452 (0.1073)	-0.0404 (0.1068)	-0.0422 (0.1068)	-0.0450 (0.1068)
Constant	1.1383*** (0.0684)	1.1379*** (0.0684)	1.1375*** (0.0684)	1.1360*** (0.0683)	1.1363*** (0.0686)	1.1244*** (0.0690)	1.1279*** (0.0689)	1.1334*** (0.0686)
R-squared	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Number_of_obs	652	652	652	652	643	649	649	649

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1

Table A.11: Regression results for very large-sized firms (including previous turnover growth rates and R&D investment variables)

	Relative turnover growth (very large-sized firms)							
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
R&Dexp	-0.0028 (0.0017)	-	-	-	-	-	-	-
R&Dexp05	-	-0.0020 (0.0017)	-	-	-	-	-	-
R&Dexp04	-	-	-0.0025 (0.0017)	-	-	-	-	-
R&Dexp03	-	-	-	-0.0021 (0.0013)	-	-	-	-
R&Dcapex	-	-	-	-	-1.62e-06 (9.96e-06)	-	-	-
R&Dcapex05	-	-	-	-	-	0.0031* (0.0017)	-	-
R&Dcapex04	-	-	-	-	-	-	0.0011 (0.0018)	-
R&Dcapex03	-	-	-	-	-	-	-	0.0012 (0.0013)
Turngrowth_04-05	0.3725*** (0.0316)	0.3713*** (0.0316)	0.3726*** (0.0316)	0.3713*** (0.0316)	0.3777*** (0.0319)	0.3712*** (0.0316)	0.3691*** (0.0316)	0.3710*** (0.0316)
Turngrowth_03-04	0.1161*** (0.0221)	0.1156*** (0.0221)	0.1157*** (0.0221)	0.1199*** (0.0222)	0.1120*** (0.0222)	0.1162*** (0.0221)	0.1160*** (0.0221)	0.1153*** (0.0221)
Dummy_sector1	0.0255 (0.0990)	0.0228 (0.0991)	0.0244 (0.0991)	0.0233 (0.0990)	0.0191 (0.0993)	0.0182 (0.0989)	0.0190 (0.0991)	0.0183 (0.0991)
Dummy_sector2	0.0335 (0.0749)	0.0344 (0.0749)	0.0344 (0.0749)	0.0342 (0.0749)	0.0561 (0.0756)	0.0190 (0.0754)	0.0308 (0.0756)	0.0295 (0.0755)
Dummy_sector3	-0.0464 (0.0597)	-0.0484 (0.0597)	-0.0470 (0.0597)	-0.0474 (0.0597)	-0.0521 (0.0597)	-0.0518 (0.0595)	-0.0529 (0.0597)	-0.0529 (0.0596)
Dummy_sector4	-0.1303* (0.0717)	-0.1295* (0.0717)	-0.1297* (0.0717)	-0.1284* (0.0716)	-0.1347* (0.0723)	-0.1507** (0.0728)	-0.1376* (0.0739)	-0.1405* (0.0735)
Dummy_sector5	-0.0297 (0.0950)	-0.0285 (0.0951)	-0.0288 (0.0950)	-0.0283 (0.0950)	-0.0263 (0.0952)	-0.0279 (0.0949)	-0.0253 (0.0951)	-0.0248 (0.0951)
Dummy_sector6	-0.1267* (0.0739)	-0.1264* (0.0740)	-0.1263* (0.0739)	-0.1258* (0.0739)	-0.1254* (0.0748)	-0.1224* (0.0738)	-0.1251* (0.0740)	-0.1289* (0.0741)
Dummy_sector7	-0.0680 (0.0713)	-0.0675 (0.0714)	-0.0676 (0.0713)	-0.0672 (0.0713)	-0.0666 (0.0715)	-0.0876 (0.0722)	-0.0736 (0.0724)	-0.0741 (0.0720)
Dummy_sector8	-0.0102 (0.6714)	-0.0100 (0.0672)	-0.0102 (0.0672)	-0.0096 (0.0671)	-0.0078 (0.0675)	-0.0048 (0.0673)	-0.0058 (0.0675)	-0.0072 (0.0675)
Dummy_sector9	-0.0611 (0.0637)	-0.0650 (0.0637)	-0.0628 (0.0637)	-0.0644 (0.0635)	-0.0750 (0.0635)	-0.0685 (0.0632)	-0.0731 (0.0633)	-0.0731 (0.0633)
Dummy_sector10	-0.0758 (0.0924)	-0.0855 (0.0921)	-0.0773 (0.0925)	-0.0651 (0.0937)	-0.0956 (0.0919)	-0.0896 (0.0916)	-0.0940 (0.0918)	-0.0953 (0.0918)
Constant	0.6394*** (0.0671)	0.6399*** (0.0672)	0.6388*** (0.0672)	0.6350*** (0.0672)	0.6336*** (0.0674)	0.6200*** (0.0678)	0.6335*** (0.0676)	0.6324*** (0.0675)
R-squared	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Number_of_obs	652	652	652	652	643	649	649	649

standard errors in parentheses

***p<0.01 ** p<0.05 *p<0.1