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Mickey Folkeringa
EIM Business and Policy Research

Joris Meijaard
EIM Business and Policy Research and Erasmus University Rotterdam

André van Stel
Erasmus University Rotterdam, EIM Business and Policy Research and Max Planck Institute of Economics

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Max Planck Institute of Economics
Group Entrepreneurship, Growth and Public Policy
Kahlaische Str. 10
07745 Jena, Germany
Fax: ++49-3641-686710

Innovation, strategic renewal and its effect on small firm performance

Mickey Folkeringa [A], Joris Meijaard [A, B], André van Stel [C, A, D]

[A] EIM Business and Policy Research, Zoetermeer, the Netherlands

[B] Department of Innovation Management, Rotterdam School of Management, Erasmus University Rotterdam, the Netherlands

[C] Centre for Advanced Small Business Economics (CASBEC), Erasmus University Rotterdam, the Netherlands

[D] Max Planck Institute of Economics, Jena, Germany

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Abstract:
In this paper, we investigate the relationship between strategic renewal and the performance of smaller firms (less than 100 employees). We use a panel of micro data on about 1000 Dutch firms. The dataset contains information on aspects of strategic renewal, including process innovation and knowledge management. In our regression analyses we explain the variation in firm performance and we explicitly control for reversed causality, business cycle effects, sector effects, and firm age. We find that market research, an active external network for knowledge acquisition and strategic efforts into the improvement of internal processes are positively related to *turnover growth*. Furthermore, codification of knowledge, cooperation with partner firms and the provision of training to employees directly relates to *employment growth*. The results emphasize the importance of both knowledge absorption and knowledge creation to the success of innovative efforts in small firms. We find that the impact of the various measures varies with firm size. One further notable finding is that the ownership of patents negatively impacts small firm performance, particularly for the smallest firms in our sample.

Keywords: strategic renewal, growth of small firms, entrepreneurship, innovation

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1. Introduction

It is frequently argued that in the last quart of the 20th century the competitive advantage has moved from large, established enterprises to smaller, younger firms (e.g. Audretsch and Thurik, 2000, Baumol, 2003). In many sectors, new technologies have reduced the necessity of scale economies to arrive at competitive advantages (Meijaard, 2001). Developments like the IT-revolution and the increased role of knowledge in the production process have led to increased dynamics and uncertainty, and, in turn, these developments have created room for (groups of) small firms to act as agents of change (Audretsch and Thurik, 2000). The role of small firms in economic growth has become increasingly obvious, part-taking and frequently even dominating the evolutionary dynamics of the business sectors (in line with Nelson and Winter, 1982, Utterback, 1994).

Most academic scholars and policy makers would agree that the strategic renewal and innovation efforts by private firms positively affect overall economic growth (e.g. Romer, 1990, Aghion and Howitt, 1998, Baumol, 2003). There is relatively little empirical evidence, though, on the actual consequences of strategic renewal and innovation at the level of the individual firm, particularly for various types of firms, and, particularly for firms of different ages and sizes. The positive relationship between strategic renewal and innovation by incumbent, existing firms and the performance of these firms, both in the short and long run, is only a rather weak stylized fact. Furthermore, it is not at all clear *which aspects* are in fact most important for achieving firm growth (e.g. Klomp and Van Leeuwen, 2001, Janz et al, 2003). The latter insight is of course needed to arrive at practical and policy relevant insights. Policy-makers and entrepreneurs are on relatively thin ice in trusting that strategic renewal and innovation pay off, although the picture is somewhat clearer for select groups of technological, young and knowledge-intensive firms (e.g. Oakey, 1995, Mairesse and Mohnen, 2001, Klette and Kortum, 2002, Lööf and Heshmati, 2004).

Previous studies do not consistently show the positive effect of efforts in strategic renewal and innovation on firm performance (e.g. turnover and employment growth). One reason for this lies in the relatively long period that is typically needed for strategic renewal and innovation activities to contribute to performance. In addition, a reversed causality problem arises (a direct effect of firm performance on further renewal and innovation efforts). Kleinknecht and Mohnen (2002) provide an excellent survey on these topics. Tackling these reversed causality problems requires at least the use of panel data (see also, for instance, Cainelli et al, 2003). Numerous studies have pointed out that longitudinal research is essential to explore the exact relationship between innovation output and firm performance (Kleinknecht and Mohnen, 2002; Kemp et al., 2003). Such datasets are relatively scarce though. Most studies either use cross-sectional data, or use panel data with only a few years in it (Kleinknecht and Mohnen, 2002, current paper).

In this paper, we investigate the relationship between firm performance and a variety of measures of strategic renewal and innovation.

The goal of the paper is twofold. Firstly, we want to find out which aspects of strategic renewal are most important (in terms of employment and turnover growth). Secondly, we want to understand the specificity of the relationship relative to the size of the firms. Given the differences in organization, structure and behavior of firms of various sizes, we anticipate different effects of particular strategic renewal and innovation efforts (both in timing and strength of the effects). We will therefore explicitly test whether or not the impact of strategic renewal activities varies with firm size.

We investigate a large sample of micro data on Dutch firms with less than 100 employees. We have data on several aspects of strategic renewal and innovation, such as the in-

troduction of new products or services, the codification of renewal activities, the occurrence of firm-provided training, and the use of an external network to exchange knowledge. We control for reversed causality, and, for independent business cycle effects, sector effects and firm age effects.

The paper is structured as follows. In the next section we briefly discuss the theory behind strategic renewal and innovation and we present a review of empirical research on the topic. The third section describes our data sources. In the fourth section we describe our regression model and we discuss some methodological problems that have to be tackled. In section five, the results of the empirical analysis are presented. The paper is concluded with a brief discussion of the implications of the results.

2. Theory and earlier empirical findings

Starting Nelson (1959) and Arrow (1962), a key topic in economic literature has been to understand the economics of knowledge generation through corporate investment. The firm has usually been treated as a 'black box', often focusing on the issues of inefficiency due to the (non-) appropriability of returns. Some additional firm and industry attributes have received attention, e.g. technology-push vs. market-pull, Schmookler (1966). A range of authors provide excellent overviews (particularly Kamien and Schwartz, 1975, Mowery and Rosenberg, 1979, Dosi, 1988, Cohen and Levin, 1989, Cohen, 1995, and Freel, 2000).

We agree with Mowery and Rosenberg (1989) that the potential contribution of economics to the development of better public and private innovation policies has been seriously hampered by the limitations of the theoretical frameworks used and the topics chosen. Authors like David (1985), Cohen and Levinthal (1989), Geroski (1995), Cohen and Klepper (1996), Freeman and Soete (1997) have gradually extended the playing field, which resulted in initiatives like the European CIS waves, to get behind the more detailed picture on innovation and its link with firm performance.

Recent studies by scholars like Malerba and Orsenigo (1995), Artz and Norman (2001), Mohnen and Therrien (2001), Mairesse and Mohnen (2001, 2002), Klette and Kortum (2002), Lööf and Heshmati (2004) are increasingly successful in providing consistent answers and in improving the understanding of the link between innovation and firm performance. We will try to build on this.

As stated earlier, a recurring problem is the lack of longitudinal data to tackle causality issues, and, at the same time, the inability to incorporate sufficiently detailed measures of innovation as a process. Our study obviously does not end the desire for additional research. We do, however, bring together earlier insights and extend the knowledge base in getting behind the complex link between innovation and firm performance. Particularly, we have aimed to top the strand of empirical studies in the area of small business economics (Geroski and Machin, 1992, Brouwer et al, 1993, Storey, 1994, Freeman, 1994, Audretsch, 1995, Roper, 1997, Heunks, 1998, Freel, 2000).

We perform an intertemporal analysis of the relationship between strategic renewal, innovation efforts and economic performance. One would expect positive relationships with firm performance of variables such as the introduction of new products or services, the ownership of patents, the codification of renewal activities, the occurrence of firm-provided training, and the use of an external network to exchange knowledge. Also, one would expect these variables to be increasingly important, the larger the firm. It is both the intertemporal analysis of the link and the analysis of the size-effects that our study aims to add to the literature.

In Table 1, the variables on strategic renewal and key references for the relation between each variable and firm performance are summarized. The literature on each of these variables is growing, almost by the day.

Table 1 Some recent empirical studies on aspects of strategic renewal and innovation

	Variable	Examples of empirical studies focusing on the respective variable and link with business performance
1	New products or new services	Özçelik and Taymaz (2004), Stock et al (2002), De Bretani (2001), Heunks (1998), Souder et al. (1997)
2	Patents	Hall et al (2004), Hall and Bagchi-Sen (2002), Ernst (2001), Arundel (2001)
3	Improvement of internal processes	Rabinvich et al (2004), Mellor and Hyland (2004), Alvarez (2004)
4	Constant renewal part of strategy	Brown and Maylor (2004), Caloghirou et al (2004)
5	Codification of knowledge	Choi and Lee (2003), Nahm et al (2003), Koberg et al (1995)
6	External network for knowledge exchange	Caloghirou et al (2004), Sher and Yang (2004)
7	Market research	Hult et al (2004), Tuominen et al (2004), Calantone et al (1995)
8	Cooperation with other firms for renewal	Tuominen et al (2004), Quintana-García and Benavides-Velasco (2004), Soh (2003)
9	Workers involved in renewal activities	Sher and Yang (2004), Caloghirou et al (2004), Choi and Lee (2003)
10	Firm-provided training	Storey (2002), Ballot and Taymaz (2002), Ballot et al (2001)
11	Quality certificate	Prajogo and Sohal (2004a, 2004b), Mellor and Hyland (2004)

3. Data sources: MKB-panel and Innovation Barometer

We use data from the so-called MKB-panel, which is operated by EIM. In this trimesterly survey of firms with less than 100 employees, information on many aspects of running a business is gathered. We have a broad panel of small firms in the Netherlands. By interviewing the same set of firms for several years, a dataset has grown containing information on more than 3000 variables for 3000 firms from 1998 onwards[1].

We broadly use two types of data in this study: firm performance measures and strategic renewal measures. Our dataset covers the period 1999-2003. We use the annual growth in turnover and the annual growth in employment as firm performance measures. We use these measures both because they are common indicators of firm performance and because they are easily available[2]. Both variables are expressed in percentage changes. A specific set of questions concerning several aspects of strategic renewal and innovation is included yearly in the survey. This set of questions is called the Innovation Barometer and the information from the barometer forms the second main data source of this study (on strategic renewal efforts). The questions asked in the Innovation Barometer are listed in table 2. The table also includes the labels that we use throughout the paper for the corresponding variables. All of the resulting variables from the Innovation Barometer are binary.

[1] The panel is unbalanced. For many firms some of the waves are missing. We only study the firms that have participated in all rounds. We have tested for selection biases. We did not find a reason to suspect the representativeness of the sample.

[2] Data restrictions prevented us from also using another commonly used indicator, *viz.* profits.

The data from the Innovation Barometer have been gathered yearly since 1999. In the course of years, on an incidental basis, some additional questions on innovation have been asked as well. We are also using some of the information from these additional questions, since they provide rather specific accounts of inputs and outputs related to strategic renewal. This includes the percentage of employees in the firm involved in renewal activities, the percentage in turnover obtained from new products or services and the degree to which actual R&D investments have been made. The first two variables are available for 1999. The R&D variable is included as a dummy for 1998.

Finally, we use firm age and several dummy variables as additional control variables.

Table 2 Sample questions and variable labels Innovation Barometer

	Label	Question
1	New products or services	Did your company put new products or services on the market over the past three years?
2	Patents	Is your company in the possession of patents?
3	Improvement of internal processes	Did your company introduce improvements or renewal in internal company processes over the past three years?
4	Constant renewal part of strategy	Does constant renewal form part of your company strategy?
5	Codification of knowledge	If yes (on question 4), are these renewal efforts written down on paper?
6	External network for knowledge exchange [3]	Does your company use an external network for the exchange of knowledge, for instance through universities, competitors, suppliers or advisers?
7	Market research	Did your company perform (or outsource) market research over the past three years?
8	Cooperation with other firms for renewal	Does your company cooperate with other companies or institutions to carry out renewal projects?
9	Workers involved in renewal activities	Are your employees (including unpaid family workers and owner/managers) involved in renewal activities?
10	Firm-provided training	Did your company in the past year finance any additional training of employees (including unpaid family workers and owner/managers)?
11	Quality certificate	Is your company in the possession of a formal quality certificate (for instance, ISO)?

4. Hypotheses, methods and model

4.1 Hypotheses

In order to measure the impact of innovation on firm performance, we carry out a multiple regression analysis with firm performance (turnover growth or employment growth) as the dependent variable, and the strategic renewal measures discussed earlier (*i.e.*, the 11 binary variables corresponding to the questions in Table 2, and the three additional, continuous variables mentioned in Section 3) as independent variables. All of the variables have been the

[3] We avoid using the word 'cluster' in our label, as that would imply a geographical concentration not referred to in the question. Wever and Stam (1999) show that for Dutch high technology SMEs (some 8% of all SMEs), 'regional clusters, characterized by innovation linkages with other firms and knowledge centres, hardly exist'. Instead, they find that most of the customers and suppliers which the interviewed high technology SMEs consider relevant for their innovative development are located outside their own (COROP or NUTS3 level) region.

subject of earlier research and we refer to Sections 1 and 2 for a general overview of relevant theory. As regards model hypotheses, it is clear that all strategic renewal measures have expected positive relations with firm performance.

We explicitly investigate size class differences in the relationships. Therefore both the intercepts and the estimates are allowed to vary by size class. As explained in section 2, a range of earlier studies point at the size dependence of determinants of firm performance, particularly in relation to strategic renewal and innovation efforts (e.g. Kemp et al, 2003 and Cohen and Levin, 1989). Table 3 summarizes the set of hypotheses to be investigated. In the extant literature on this topic, some contradictory results are found for several hypothesized effects. In particular, some of the size effects may only start to work at larger sizes than we study. Previous studies have also shown non-linear size effects (e.g. Cohn and Levin, 1989, Lööf and Heshmati, 2004).

Table 3 Hypotheses

	Variable	Expected effect on business performance	Effect expected to be stronger, similar or weaker the larger the firm?
1	New products or services	+	+
2	Patents	+	+
3	Improvement of internal processes	+	+
4	Constant renewal part of strategy	+	+
5	Codification of knowledge	+	+
6	External network for knowledge exchange	+	-
7	Market research	+	+
8	Cooperation with other firms for renewal	+	-
9	Workers involved in renewal activities	+	-
10	Firm-provided training	+	+
11	Quality certificate	+	+

4.2 Methods

Before the impact of the various measures on performance can be established, a number of methodological problems have to be dealt with. This involves the choice of control variables, the choice of lags for the independent variables, the estimation of missing data, the construction of the estimation sample and the selection of the final model specification. Each of these topics will be elaborated upon below.

Control variables

To obtain unbiased estimators for the effects of the strategic renewal variables, it is important to include a sufficient number of control variables in the model. We include six (groups of) control variables: (i) a lagged dependent variable, (ii) dummy variables for years, (iii) dummy variables for sectors, (iv) dummy variables for size classes, (v) firm age and (vi) lagged turnover growth[4]. The rationale behind each of these controls is as follows.

(i)

The lagged dependent variable (turnover growth or employment growth in year t-1) helps to control for reversed causality, *i.e.*, it controls for the effects of firm performance actually inducing innovation, since strong firm performance creates resources to invest in innovation.

[4] Concerns only the employment growth equation.

This reverse effect is not our primary interest and therefore we need to correct for it. The use of lagged dependent variables to correct for reversed causality is named after Clive Granger, who was awarded the 2003 Nobel Memorial Prize in Economic Sciences. The concept is known in the econometric literature as Granger-causality[5]. In our model: if firm growth influences innovation (the 'reverse' effect) and firm growth also influences future firm growth (growth autocorrelation or path dependency), then the omission of the lagged dependent variable in analyses causes a bias. The estimation of the effect of innovation on firm performance would then be biased due to the reverse effect, *i.e.* the positive correlation between past growth and innovation creates a 'spurious' effect if not corrected for.

(ii)
We include year dummies to allow for (economy-wide) business cycle effects. We use the years 2001 until 2003 in our sample.

(iii)
We include sector dummies to allow for sector-specific effects, in particular sectors being in different stages of the business cycle in the period under investigation. The dummies may also reflect differences in wage levels between sectors, possibly affecting employment growth. We use dummies for eight sectors, as listed in table 2.

(iv)
We include size-class dummies to allow for structural growth differences between firms of different size classes. It is generally considered a 'stylized fact' that Gibrat's 'law of proportional effect' does not hold (Klomp et al, 2003)[6]. Small firms grow at systematically higher rates than their larger counterparts. Even though we remove observations with exceptionally high growth rates from the sample (which are mostly smaller firms), it is not unlikely that Gibrat's Law is still violated in our estimation sample. Therefore we include size-class dummies in our model, see table 4.

(v)
We would also like to control for firm age. Literature on the effect of firm age on firm performance indicates that young firms grow faster than old firms (Verhoeven, 2004). Therefore, we also control for age. However, as there is a significant correlation between firm age and firm size, for which we also control, we will use firm age only to test the robustness of the model.

(vi)
In our employment growth regressions we include (lagged) turnover growth as an additional control variable. In labour market economics it is common practice that employment is determined by production, instead of the other way around (e.g. Lever, 1996, and Van Stel, 1999). Therefore, following Kemp et al. (2003), we do not use (lagged) employment growth as a determinant of turnover growth, but we do use (lagged) turnover growth as a determinant of employment growth.

[5] The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant (Audretsch et al., 2001).

[6] This 'Law' states that all firms grow at the same rate, independent of size.

*Table 4 Distribution of sample observations over sectors and size-classes**

Sector	Observations
Manufacturing	75
Construction	98
Trade	99
Hotels and restaurants	56
Transport and communication	47
Business services	50
Financial services	43
Personal services	29
Total	497

Size-class	Observations
Micro firms (0-9 employees)	203
Small firms (10-49 employees)	177
Medium-sized firms (50-99 employees)	117
Total	497

* Estimation sample for turnover growth regression.

Lags

For the explanatory variables in our model that vary over time (the strategic renewal variables and the lagged dependents), autocorrelation exists. In order to avoid multicollinearity problems, we include only one lag of each explanatory variable.

Ideally, we would like to experiment with different lag lengths in the model to establish the exact lag structure of the impact of strategic renewal activities on firm performance (*i.e.* how long does it take before implementation of some activities actually influences performance?). The time period of our data panel is too short (1999-2003) to actually make inferences on the lag structure. Therefore we choose a rather pragmatic approach. Based on the relationship with the dependent variable in auxiliary regressions (regarding significance), and considering the limited availability of data over time, we choose a lag length of either one year or two years for each of our strategic renewal variables[7].

Missing data

For 2001 the strategic renewal data are missing. In such cases, we have estimated the data for 2001 as the average of 2000 and 2002. As the variables are all of the binary type, the variables for 2001 thus get the value 0 or 1 (if the occurrence of a certain innovation measure has not changed between 2000 and 2002), or 0.5. In the latter case a certain renewal activity took place in 2000 but no longer in 2002, or vice versa[8].

We think that in such cases interpolation is a plausible estimation method. It implies that the change takes place gradually. For instance, if a firm does not have a formal quality certificate in 2000, but it does have one two years later, then it is likely that the firm already made preparations to qualify for such a certificate in the year in between. So, in a way, in that year the firm already had obtained 'half' of the certificate. One might even argue that a value

[7] Choosing longer lags would result in a loss of years in the estimation sample. This would leave too much information unused.

[8] On average for all 11 innovation measures, such a change occurs for about half of the firms in our estimation sample.

of 0.5 is more appropriate in such cases, even if the 'true' value would be 1 (if the firm actually received the certificate in the intermediate year). The change in work processes underlying the acquisition of a quality certificate is more incremental in nature than the radical change involving the moment of acquisition suggests. Similar arguments apply for the other innovation variables.

Estimation sample

When using micro data, there is always a danger of outlier observations disturbing the estimation. Individual firms may deviate heavily from the 'average' firm in terms of strategic renewal activities or firm performance. Incidentally, typing errors may also be involved. Such outlier cases fall outside the scope of our model and should be removed from the estimation sample.

The construction of our estimation sample is as follows. We start with the firms in the SME Panel that participated in all three surveys of the Innovation Barometer (1999, 2000 and 2002), these are 606 firms in total. Next, we remove observations with extreme values for turnover or employment growth (or past growth).[9] We define annual growth rates of more than 100% or less than -50% as extreme[10]. Using the remaining sample of observations, we ran a regression with all 11 strategic renewal variables (either with a one- or a two-year lag) and the control variables. As it turns out, the residuals of this regression are skewed, as appears from the large value of the Jarque-Bera test statistic. Apparently, outlier observations disturb the estimation, creating a bias in the parameter estimates. Therefore we have removed the observations in the tails of the residuals. In particular we remove those observations with an (absolute) standardized residual exceeding 2. This results in unbiased parameter estimates, as the Jarque-Bera test statistic then falls below the critical value (10% significance level)[11]. Applying this procedure results in 497 observations for the turnover growth regressions and 717 observations for the employment growth regressions (we have one extra year for employment growth, hence the higher number of observations).

The estimation sample is cleaned of outliers, both in terms of variable values, and in terms of regression residuals. The use of individual firm data justifies the steps described above (although alternatively, similar methods might have been used).

To obtain an impression of the resulting sample, we present the distribution of the observations over sectors and size classes in table 4. Except for the primary sectors, firms from all sectors of economy are included in the dataset. Outliers also occurred quite evenly across sectors. In regard to size, three size-classes are distinguished: micro (0-9 employees), small (10-49 employees), and medium-sized (50-99 employees). Our data set does not include larger medium-sized firms (100 or more employees). From table 4 we learn that the observations are quite evenly spread over the different sectors and size-classes[12].

4.3 Final model specification

[9] We make a distinction between the number of *firms* and the number of *observations*. The latter number is higher as each firm is in the data set for three years.

[10] Such data may be correct (for instance, for microfirms, an increase from 1 to 3 workers corresponds to a change of 200%), but we feel that our model would not be appropriate to explain such extreme growth percentages. In this way we basically remove those firms that grow from one to two or three persons in a certain year. We want to emphasize that we do not remove so-called 'fast-growing firms' or 'gazelles' (for instance defined as growing by 60% in five years starting from a nonzero level of employees onwards), as these are still within our plausible range of growth rates.

[11] In this way, some 15% of the observations from the original regression are removed.

[12] As the (turnover growth) estimation sample is a panel for two years (2001 and 2002), the actual number of firms in the sample is 346, not 497. For the employment growth regressions we have a panel for three years (2001-2003) and the sample of 717 observations corresponds to 390 firms.

Basically, we want to run regressions explaining turnover growth or employment growth from the strategic renewal variables of the Innovation Barometer. We want to take account of control variables and possible size class differences in the effects of the explanatory variables. In order to allow for different effects per size-class, all innovation variables are multiplied by the three sizeclass dummies (micro, small, and medium-sized)[13].

In our data set there is quite some correlation between independent variables, potentially causing problems of multicollinearity. In interpreting regression results we are not interested in estimates that are inefficient because some non-significant variables (which possibly correlate with other independent variables) are still included in the model. However, the correlation matrix (not in the paper) shows relatively high correlations for many pairs of independent variables.[14] This makes it difficult to establish beforehand which variables should be removed in order to avoid multicollinearity. Therefore we let the data speak for themselves by applying a selection procedure that leaves us exclusively with the significant variables, enabling interpretation of regression results. In order to avoid throwing away the baby with the bathwater, we should use rather liberal criteria for inclusion of variables. That is, we want to minimize the chance of removing variables that might have a certain impact after all.

Our selection procedure is as follows. Using the 'cleaned' estimation samples, we start by running the regression explaining turnover (employment) growth from the 33 innovation variables (11 innovation measures times 3 size-classes) and the mentioned control variables. In a second step, we include only the innovation variables, for which at least one size-class coefficient is significant at 10% level. Next, if in this second regression all (remaining) innovation variables still have at least one significant size class coefficient, we use this as our final specification. Otherwise, the non-significant variables are once more removed, until all variable coefficients are significant (at 10%, for at least one size-class). In this way the 'dominating' variables remain in the final model specification, and the extent of overestimation of standard errors due to multicollinearity is kept to a minimum.

5. Results

In this section we present the results of our empirical analysis. Firstly, we present descriptive statistics for the variables in our data set. In particular, we present means and standard deviations for the estimation sample. Subsequently, the results of the multiple regressions for both turnover growth and employment growth are presented. We pay special attention to firm-size effects. Finally, the outcomes of various robustness tests are outlined. These tests include the use of the additional variables (other than the strategic renewal variables from the Innovation Barometer) and the inclusion of firm age.

Descriptive statistics

Means and standard deviations of the variables in our data set are reported in tables 5, 6 and 7[15]. In reading these tables it is important to realize that we excluded outlier observations. As mentioned, firms with an implied turnover growth or employment growth of more than 100% or a loss of more than 50% in one year are defined as outlier observations. In the tables we also exclude observations that are inconsistent like %-shares in excess of 100.

[13] Formally, the number of variables thus gets three times as high. However, for each firm two of the three variables corresponding to a certain innovation measure get value 0, because the firm is not in the corresponding size-class.

[14] For the 497 observations sample, mutual correlations between the 11 Innovation Barometer variables vary between 0 and 0.5, with many pairs of variables correlating by 0.2 to 0.3.

[15] Except for employment growth, the statistics refer to the estimation sample for the turnover growth regressions. Statistics for the employment growth regression samples are approximately the same though.

Table 5 Descriptive statistics for firm performance measures

		Total	Micro (0-9)	Small (10-49)	Medium-sized (50-99)
Turnover growth (%) *	Mean	4.6	5.9	4.5	2.4
	(Std. dev.)	(14.0)	(15.7)	(13.4)	(11.4)
	Observations	497	203	177	117
Employment growth (%) **	Mean	-0.4	-0.1	-0.7	-0.5
	(Std. dev.)	(10.2)	(10.2)	(11.0)	(8.7)
	Observations	717	268	265	184

* Estimation sample of turnover regression is used (see table 8).

** Estimation sample of employment regression is used (see table 9).

From table 5 we see that, on average for our sample period, the firms in our data set have achieved a small positive turnover growth, but employment has not increased. Smaller firms seem to have performed somewhat better than their larger counterparts, particularly in terms of turnover growth. The differences between size-classes are not significant though: the large standard deviations point at a large amount of variation in growth levels among the firms in the panel.

From table 6 we see that about half of the firms claim to have introduced new products or services in the past three years. The percentage of firms with patents is small: only eight percent of all firms smaller than 100 employees. Some further interesting information from the table is that about half of the firms use an external network to exchange knowledge and three out of four firms provide some form of training to employees. Most innovation measures score higher in the subsample of small and medium-sized firms.

In table 7 we notice several interesting things. The percentage of employees involved in renewal activities is higher for smaller firms, while (see table 6) the total number of firms with any employee involved in renewal activities is higher among larger firms[16]. Apparently, once strategic renewal is embraced by a microfirm, more employees within the firm are involved. To the contrary, for medium-sized firms, although strategic renewal activities by employees occur more often, only a small part of personnel is involved in these activities. This scale effect could imply that larger firms class their strategic renewal activities under a small number of qualified employees (specialization). More micro firms tend to specialize in being innovative altogether. The high share of innovative personnel among small firms partly results from a denominator-effect as well[17]. For the percentage of new products or services in turnover, we see something similar. While the occurrence of new product introductions is somewhat higher for small and medium-sized firms (roughly 50%, versus 40% for micro

[16] This is not due to the different sample in table 7 (caused by missing values). For the 407 observations the pattern for the occurrence of innovative workers is similar to that in table 6 for the 497 observations: means are 0.58, 0.74 and 0.76 for micro, small and medium-sized firms, respectively.

[17] The denominator effect implies that for smaller firms the occurrence of one extra innovative employee results in a higher increase of the share of innovative personnel than for larger firms.

firms), the percentage in turnover of new products is higher for micro firms: 28% versus 13% for medium-sized firms[18].

The lower occurrence among micro firms of the above two forms of activities may be explained by the existence of the financial risks associated with investing in strategic renewal. These investments can be relatively expensive, while returns on these investments are uncertain. Larger firms have more resources to deal with or spread these financial risks. Furthermore, even as a small firm may be willing to make investments in these renewal efforts, it is possible that financial institutions are not willing to supply the capital needed. Finally, table 7 shows that investments in actual R&D occur more often in larger firms (no significant difference with microfirms though). We also see that larger firms are, on average, older.

*Table 6 Descriptive statistics for variables from Innovation Barometer **

		Total	Micro (0-9)	Small (10-49)	Medium-sized (50-99)
New products or services	Mean	.47	.42	.52	.51
	(Std. dev.)	(.48)	(.47)	(.48)	(.48)
Patents	Mean	.08	.05	.07	.16
	(Std. dev.)	(.26)	(.21)	(.24)	(.35)
Improvement of internal processes	Mean	.82	.74	.88	.88
	(Std. dev.)	(.38)	(.44)	(.32)	(.33)
Constant renewal part of strategy	Mean	.70	.59	.75	.81
	(Std. dev.)	(.43)	(.49)	(.41)	(.36)
Codification of knowledge**	Mean	.41	.29	.46	.56
	(Std. dev.)	(.49)	(.45)	(.50)	(.50)
External network for knowledge exchange	Mean	.45	.35	.51	.55
	(Std. dev.)	(.46)	(.44)	(.46)	(.46)
Market research	Mean	.38	.27	.44	.50
	(Std. dev.)	(.49)	(.44)	(.50)	(.50)
Cooperation with other firms for renewal	Mean	.45	.36	.40	.68
	(Std. dev.)	(.50)	(.48)	(.49)	(.47)
Workers involved in renewal activities	Mean	.64	.51	.71	.75
	(Std. dev.)	(.45)	(.47)	(.42)	(.40)
Firm-provided training	Mean	.75	.53	.88	.93
	(Std. dev.)	(.43)	(.50)	(.33)	(.25)

[18] Again, this is not due to the different sample in table 7.

Quality certificate	Mean	.36	.20	.37	.61
	(Std. dev.)	(.46)	(.38)	(.46)	(.48)
Observations		497	203	177	117

* Estimation sample, and lag lengths (one or two years), of turnover regression are used (see table 3).
** Percentage refers to whole sample (i.e., including those firms answering 'no' on question 4 of Innovation Barometer).

Table 7 Descriptive statistics for remaining innovation measures, and firm age

		Total	Micro (0-9)	Small (10-49)	Medium-sized (50-99)
% employees involved in renewal activities, 1999	Mean	29	45	27	12
	(Std. dev.)	(34)	(39)	(30)	(18)
	Observations	407	142	154	111
% new products or services in turnover, 1999	Mean	22	28	22	13
	(Std. dev.)	(18)	(21)	(15)	(11)
	Observations	314	118	116	80
dummy R&D investments, 1998	Mean	.36	.28	.42	.38
	(Std. dev.)	(.48)	(.45)	(.50)	(.49)
	Observations	317	109	117	91
Age of firm (in years)	Mean	26.1	17.4	28.5	37.5
	(Std. dev.)	(26.0)	(17.8)	(25.5)	(33.1)
	Observations	497	203	177	117

Multiple regressions for turnover growth

The regression results for turnover growth are depicted in table 8. In the first column, all 11 strategic renewal variables are included, with separate impacts for each size-class (through multiplication by the size class dummies). In the second column the insignificant variables are removed. This second regression serves as a 'benchmark' for the regressions in columns 3 to 5, which adds the variables from table 7 to the model. Below we discuss the results of the 'benchmark' regression.

According to table 8, the possession of patents has a negative effect on turnover growth. This may reflect the process that firms shift their activities towards investing in product development and market introduction once a patent is obtained. The estimation results indicate that this effect is smaller for larger firms. Artz and Norman (2001) found a similar negative effect of holding patents on sales growth (while not differentiating between size classes). They state that patents give firms a unique position on the market and, as a re-

sult of this, they may price their product at a premium[19]. This premium increases the profit margin, but as the selling price is higher, consumers may turn to substitute products. This in turn has a negative impact on sales growth. On average, positive returns on patents are expected to be visible over a longer period than the one considered in our analysis. Possibly the effect remains for the smallest firms if they fail to grow. The result should be interpreted with caution however, as the percentage of firms with patents in our data set is very low, especially for microfirms (see table 6). The estimates are based on small numbers of observations and therefore less reliable on the population level.

Attention to the improvement of internal processes leads to a higher turnover growth for small firms. Examples of such internal processes are reorganizations, routing schemes of products or the human-research policy towards the selection of innovative personnel. Improvements of internal processes are associated with a more efficient innovation process, that is the transition from innovation input into innovation output. This improved efficiency has a significant positive effect on turnover growth. It may also be that the positive effect concerns firms that are entirely devoted to process innovation as a form of innovation output (as opposed to product innovation).

The coefficient of constant renewal as part of the strategy is significantly negative for micro firms. Similar arguments as for the effect of patents hold: positive returns of this variable may only be expected in the long run, and possibly the small innovative firm has to grow at some point to actually survive. Firms that incorporate constant renewal in their strategy are engaged in innovation on a structural basis. This is likely to involve gradual improvements in products or production processes (incremental innovation), which has a negative effect on sales in the short run. This may reflect the fact that micro firms are often dependent on the turnover of a small number of products or product categories. If these are still in development, total sales will be lower in the short and medium run.

The use of an external network has a significant positive effect on turnover growth for small firms. This network may include universities, competitors, partners, suppliers and advisors. Firms that make use of such networks are able to exchange knowledge on the product level, but also information on market structure, trends and developments could be shared. This raises the level of innovation input (information being one of the inputs). Furthermore, the knowledge diffusion may accelerate the transition process of strategic inputs into actual output.

The effect of conducting market research is positive (insignificantly for the middle group). Market research is an important tool for SMEs to explore consumer wants and to take these into account in product development. First, from a consumer perspective, market research can be used to collect consumer preferences with respect to products and services. (Lifestyle) trends may be identified. From this perspective, market research is used as a means to give direction to both the shape of the innovation output (new or improved products), as well as the type and level of inputs (what is needed to accomplish the desired output). Second, from a producer perspective, a firm can use market research to investigate the possible demand for a newly or improved product or service. This gives direction to the market introduction and/or promotion and distribution strategy towards the relevant targeted groups. The variable does not distinguish between these different perspectives, but altogether market research contributes to a higher turnover growth.

We see that the coefficient of turnover growth in the previous period (the lagged dependent) is highly significant, with a negative sign. Apparently, some kind of 'error-correction' occurs: if firm performance is very good in a certain year, it may be a bit less

[19] Firms may also raise price levels to account for development and introduction costs.

good in the next year, for instance because the exceptional year was caused by some incidental revenues. Note though that this alternating, error-correcting effect is only about 10%.

Regarding the non-reported dummy variables, the most notable results are as follows. We do not find significant economy-wide business cycle effects for 2002 (reference year 2001). As regards to sectoral effects, we find no significant differences between sectors except for transport and communication, which has grown structurally faster than the other sectors in 2001 and 2002[20]. As regards size-class effects, we find that the small and medium-sized firms grow at a structurally slower pace than the micro firms. This confirms the stylized fact of violation of Gibrat's Law, found in many empirical studies, although there may be a limited selection bias. There is no significant difference between small and medium-sized firms, though.

Finally, as regards the adjusted R^2 values, we see that this varies between 0.10 and 0.16. This is not too low, given that we use micro data, and given that we include only one specific type of variables in the model, *i.e.*, variables related to strategic renewal. Of course other variables such as the quality of human and physical capital within the firm, market circumstances, etcetera, impact performance as well. These phenomena are only captured by the model to an unknown extent through the lagged dependent variable. The level of explained variance may therefore be seen as plausible.

Firm-size effects

From the above regression results, systematic firm-size effects may be deduced. We define a firm-size effect to exist if the impact of an explanatory variable monotonically increases or decreases with firm size, both in terms of magnitude and in terms of significance.

Using this definition we find firm-size effects for the possession of patents and for the variable constant renewal part of strategy. As regards patents, the negative effects are clearest in the smallest class of firms, the micro firms. Considering that the moment when the patent is obtained is not known, this might be interpreted in two ways. Firstly, if the patent is just obtained, the negative coefficient reflects the relatively high cost of investment in innovation for micro firms, given their turnover levels. Secondly, if the patent was obtained longer ago, the negative effect may reflect a failure of successful commercialization of the patent. This implies that the costs of innovation cannot be earned back. This, in turn, may indicate that small innovative firms actually have to grow in order to survive. Our data set does not allow us to distinguish between these possibilities. For both cases, though, it is likely that larger firms have more financial resources through diversification, hence the smaller negative effect on turnover growth.

The second firm-size effect concerns the systematic negative effect on turnover growth of constant renewal in the firm's strategy. The negative coefficient is significant only for the smallest class of firms. Again, this may be explained by the higher degree of diversification among larger firms, which reduces the relative cost of incorporating constant renewal in the firm's strategy.

[20] Although six dummy variables are thus not significantly different from zero, the magnitude of the effects among these six varies between –4 and +3 (additional %-point growth per year, compared to reference sector manufacturing), demonstrating the relevance of including sectoral dummies in the model.

Table 8 Turnover growth regressions, sample years 2001-2002

		I	II benchmark	III	IV	V
Constant		9.0 ***	8.6 ***	7.5 **	8.1 **	4.5
New products or services, t-1	micro	1.2				
	small	1.1				
	med.	-2.7				
Patents, t-1	micro	-19.1 ***	-17.9 ***	-16.2 ***	-19.5 ***	-17.2 ***
	small	-9.1 **	-8.1 *	-9.7 **	-7.4 *	-9.2 **
	med.	-5.1	-6.9 *	-6.6 *	-5.2	-5.6
Improvement of internal processes, t-2	micro	.7	1.5	2.6	3.2	6.4 *
	small	7.8 **	8.0 **	7.8 *	2.1	9.1 **
	med.	1.0	2.5	1.2	2.3	3.7
Constant renewal part of strategy, t-1	micro	-6.6 **	-5.8 **	-3.4	-4.4	-6.4 *
	small	-4.0	-4.5	-1.0	-3.4	-10.7 **
	med.	-2.5	-3.1	-3.3	-4.5	-8.8 *
Codification of knowledge, t-2	micro	4.0				
	small	-.3				
	med.	.2				
External network for knowledge exchange, t-1	micro	.03	.8	-.3	-1.7	.5
	small	6.1 **	6.9 ***	4.8 *	8.4 ***	7.9 ***
	med.	.1	.3	.2	3.2	1.2
Market research, t-2	micro	5.8 **	6.2 ***	6.8 ***	9.1 ***	7.4 **
	small	-1.6	-2.1	-2.7	-.7	-.4
	med.	7.3 ***	8.0 ***	7.2 ***	8.5 **	8.7 ***
Cooperation with other firms for renewal, t-2	micro	.6				
	small	.04				
	med.	4.4				
Workers involved in renewal activities, t-1	micro	-1.9				
	small	.07				
	med.	-3.3				
Firm-provided training, t-2	micro	1.4				
	small	.9				
	med.	7.2				
Quality certificate, t-1	micro	-1.5				
	small	-3.7				
	med.	-1.1				
% employees involved in renewal activities, 1999	micro			-.04		
	small			-.04		
	med.			.03		
% new products or services in turnover, 1999	micro				.0009	
	small				-.09	
	med.				-.06	
dummy R&D investments, 1998	micro					.5
	small					1.4
	med.					-3.1
Turnover gr., t-1		-.09 ***	-.09 ***	-.05	-.11 ***	-.11 ***
Adjusted R2		.10	.12	.11	.16	.13
Observations		497	497	407	314	317

Coefficients for year, sector, and size-class dummies not reported.

*; **; ***: Significant at 10%, 5% or 1% level, respectively.

Multiple regressions for employment growth

The results for employment growth are depicted in table 9. Compared to turnover growth, there is one sample year extra (2003) in these regressions. This is because employment (a stock variable) is measured in the first half of the calendar year. At the time of this study we already have employment data for 2003, but we do not have turnover data for 2003, as turnover is a flow variable measured over the calendar year[21].

For the middle size-class, firms that have produced new products and/or services have a significant lower employment growth than firms that have not (at the 10% level). When innovation activities have resulted in new products or services, the market introduction follows. Apparently, for small firms introduction costs are relatively high, inhibiting employment growth in the short-run. Resources are allocated for the market introduction, leaving little room for hiring new personnel. Unfortunately, data restrictions do not allow us to determine the long-run effect.

The coefficient for patents is significantly negative and more so the smaller the firms. This indicates that the possession of patents leads to a lower employment growth. As we reported earlier, this variable also has a negative effect on turnover growth. Apparently, patents do not immediately make life easier for small firms. There may be problems in actually making the commercialization of the patented ideas work.

For micro firms there is a direct positive effect of codification of knowledge. Firms that write down their renewal efforts perform better in terms of employment growth than firms that (wittingly or unwittingly) keep relying on using tacit (or implicit) knowledge. In part, this is an indication of the degree of professionalism in the small firm. From table 6 we see that only 29% of micro firms make an effort to codify their renewal activities. The codification process is not easy, and micro firms may have less financial ability (or priority) to invest in knowledge codification processes[22]. Furthermore it clarifies the common goals of the firm, helping employees to focus on what is most important.

Exchanging knowledge by means of external networks has a positive effect on employment growth for the middle class of small firms. As stated earlier, the use of a network can raise the level of innovation input, which in this case results in hiring new personnel. In particular, firms that are part of a network may also directly have easier access to qualified employees to fill vacancies. Similar arguments may apply for firms that cooperate with other firms. This variable also displays a significant positive value.

We also see a direct effect of firm-provided training on employment growth. It is only (significantly) positive for the middle size class of small firms. The effect for small firms is considerably larger than for micro firms. This may be related to the amount of training support. Using panel data on 173 Dutch firms, De Kok (2002) showed that the amount of training support per working day has a positive influence on the benefits of training. He also showed that smaller firms provide, on average, less training support than their larger counterparts. The combination of these phenomena implies that smaller firms benefit less from firm-

[21] Note that employment growth over a certain year thus actually refers to a one-year period starting some months earlier.

[22] Wintjes and Cobbenhagen (2000) illustrate the restructuring of a knowledge codification process in a case study for a cluster of small local suppliers around Océ, a well-known Dutch multinational making specialized copy machines. They describe how, as part of a co-operation project, the suppliers had to make a big effort to codify their knowledge in order to improve their ability to communicate their knowledge to Océ. This was not easy as the suppliers were used to work on the basis of tacit knowledge, often accumulated by years of learning by doing.

provided training, compared to larger firms[23]. The above argument does not explain the smaller effect for medium-sized firms (compared to small firms).

Similar to the turnover growth regressions, the lagged dependent variable is highly significant with a negative sign. Furthermore, the effect of lagged turnover growth is significantly positive, as expected. When turnover grows, there is more room (and need) to hire new employees.

Regarding control dummies, the most important difference with the earlier results is that the dummy for 2002 is significantly positive. This implies that, unlike turnover, employment has grown structurally faster in 2002 than in 2001. The dummy for 2003 is also significantly positive.

Again, adjusted R^2 values are plausible. They are somewhat higher compared to Table 8 and this is caused mainly by the additional independent variable turnover growth (next to the lagged dependent).

Firm-size effects

For employment growth, there are firm-size effects of codification of knowledge and cooperation with other firms. The positive effect of knowledge codification is significant to micro firms only. A possible reason for this is the dependence on only one or two persons holding the tacit knowledge of the firm. Those micro firms that are able to write down their innovation intentions on paper are less vulnerable to the loss of one or two persons holding the tacit knowledge. For larger firms, knowledge codification does not discriminate between low and high performing firms (in terms of employment), since these firms usually are more professionally organized, compared to small firms.

According to table 9, the effect of cooperating with other firms increases with firm size. For the micro firms the effect is not significant, while the size of the effect for small and medium-sized firms is significant and approximately the same. This may indicate that micro firms are not able to attract employees from contacts with other firms, as they often pay lower wages, and offer less career opportunities than larger firms do.

Robustness tests

In this section we discuss the impact of the additional explanatory variables from table 7. Using the 'benchmark' specifications in tables 8 and 9, we add (separately) the three innovation measures to the model: percentage of employees involved in renewal activities, percentage in turnover obtained from new products or services, and the dummy for R&D investments[24]. The purpose of this exercise is twofold. The first and most obvious reason is to investigate the effects of these variables. Second, because the three variables have considerable numbers of missing values compared to the benchmark estimation samples, the regressions also act as a robustness test for the results found earlier, as the estimation sample becomes different (and smaller)[25].

The results are in the last three columns of tables 8 and 9. We see that none of the variables are significant, not even at 10% level. Apparently these phenomena are not directly important for achieving firm growth. As regards the share of innovating employees and the share in turnover of new products, these results are perhaps not surprising as the corresponding occurrence variables from the Innovation Barometer are also not significant, at least not for turnover growth.

[23] It should be mentioned that the panel data set used by De Kok only includes manufacturing firms larger than 100 employees. Generalization to smaller firms and to other sectors, as represented in our data set, is not straightforward.

[24] Note that these three variables are measured only at one point in time, so they act as time-invariant variables in the panel.

[25] Normality of the residuals is (checked to be) not violated by this reduction of the sample.

Concerning the reliability of the ‘benchmark’ results, we might say that these are reasonably robust. Comparing specifications III, IV and V with specification II, we see that, although the magnitude of certain effects sometimes becomes somewhat different, the sign and significance of the effects remain the same for almost all variable/size-class combinations.

Table 9 Employment growth regressions, sample 2001-2002-2003

		I	II benchmark	III	IV	V
Constant		-5.8 ***	-5.5 ***	-5.2 **	-5.8 **	-6.2 ***
New products or services, t-1	micro	-1.3	-1.7	-1.1	-3.8 *	-1.6
	small	-3.4 **	-2.5 *	-2.8 *	-1.0	-3.4 *
	med.	-.6	.01	-.2	.1	1.0
Patents, t-2	micro	1.9	1.3	.9	-.3	2.2
	small	-5.3 **	-5.0 **	-4.8 **	-5.0 **	-5.1 **
	med.	2.5	1.7	1.7	1.0	1.7
Improvement of internal processes, t-2	micro	2.3				
	small	2.5				
	med.	1.2				
Constant renewal part of strategy, t-2	micro	-3.4 **				
	small	-1.4				
	med.	.8				
Codification of knowledge, t-1	micro	6.1 ***	5.7 ***	6.3 ***	6.7 ***	5.7 **
	small	-.4	-.1	-.3	-1.1	.9
	med.	-.8	-1.4	-1.7	-2.6	-3.3
External network for knowledge exchange, t-2	micro	-1.5	1.3	1.7	.5	-.4
	small	2.8 **	3.2 **	3.1 **	2.8 *	2.5
	med.	-.6	-.5	-.5	-.07	-1.9
Market research, t-2	micro	-.9				
	small	1.8				
	med.	1.5				
Cooperation with other firms for renewal, t-2	micro	-1.6	-1.7	-2.6	1.0	-1.7
	small	2.6 *	3.0 **	2.5	3.1 *	4.7 ***
	med.	2.6	3.2 *	2.9	2.8	5.3 **
Workers involved in renewal activi-ties, t-2	micro	.9				
	small	2.3				
	med.	-.06				
Firm-provided training, t-1	micro	-1.0	-.8	-1.4	-.5	1.2
	small	3.3 **	3.5 **	3.4 *	4.7 **	3.2
	med.	1.5	1.2	1.4	2.8	2.5
Quality certificate, t-1	micro	.6				
	small	-.8				
	med.	-2.6				
% employees involved in renewal activities, 1999	micro			.0006		
	small			.03		
	med.			.005		
% new products or services in turnover, 1999	micro				.02	
	small				.02	
	med.				-.03	
dummy R&D investments, 1998	micro					-.1
	small					-.05
	med.					.9
Turnover gr., t-1		.09 ***	.08 ***	.12 ***	.09 ***	.09 ***
Empl. growth, t-1		-.08 ***	-.08 ***	-.10 ***	-.06 ***	-.08 ***
Adjusted R2		.17	.16	.18	.16	.17
Observations		717	717	598	458	473

Coefficients for year, sector, and size-class dummies not reported.
*; **; ***: Significant at 10%, 5% or 1% level, respectively.

Finally, we also perform a separate check on the possible impact of firm age. As we already saw in table 7, average firm age increases with size. Because we already control for size in our model, we do not expect firm age to have an additional contribution to explained variation of the dependent[26]. However, as there is quite some variation in firm age in our panel, we test for the possible impact of age.

We included both age and the natural logarithm of age as additional variables in the regressions II until V. It turns out that the natural logarithm performs a bit better. The variable never becomes significant though. For the turnover growth regressions the t-value of the log of age coefficients varies between –1.44 and –1.56. This suggests some effect: older firms seem to grow slower, even after controlling for size. As regards the other variables, the most important difference is in variant III, the effects of both the share of innovating employees (only for micro firms) and lagged turnover growth become significant at the 10% level. The coefficients of other independent variables are hardly affected by the inclusion of firm age.

For the employment growth regressions including firm age do not change results whatsoever: t-values of (the log of) firm age coefficients are low (below one). We conclude that our results are robust for the effect of firm age.

6. Conclusions and discussion

In this paper, we investigate the relationship between strategic renewal activities and firm performance for small enterprises, allowing for variations in effects in three size classes. We link a range of specific strategic renewal and innovation efforts to turnover growth and employment growth. The use of panel data allows us to account for several pitfalls that accompany such research. By including lagged (dependent) variables we are able to test the appropriate causal relationship (the effect of renewal on firm performance, in stead of the other way round). Furthermore, various variables are added to the multiple regressions to control for sector, business cycles and firm age.

Our estimation results indicate that knowledge creation and knowledge diffusion are important aspects of the strategic renewal process influencing the performance of small firms. Market research and the use of external networks for knowledge exchange are associated with higher turnover growth. In addition, we find a positive effect of the improvement of internal processes, indicating that process innovation creates higher turnover growth. These effects are in line with the hypotheses. The direct effects of actual new products and services on turnover growth are limited, as are the involvement and training of employees and the cooperation with other firms. Apparently, knowledge creation and diffusion effects are dominant. Of course this does not mean that involvement and training of employees and cooperation with other firms are not important in the process of strategic renewal, nor in creating and adopting knowledge. The direct effects of the knowledge generation efforts are simply more important for turnover growth.

For employment growth, firms that use external networks for knowledge exchange and firms that cooperate with other firms experience more growth than firms that do not. In addition, one might argue that being a player in networks shortens the process of finding qualified personnel to fill vacancies. Other positive effects are regarding the codification of knowledge and firm provided training. Explicit innovation intention (constant renewal as a strategy) has particularly strong impact on employment growth for micro firms. Once again, these effects are in line with the hypotheses. Renewals as a strategy and process innovation

[26] The correlation coefficients between firm age on the one hand, and the size-class dummies for micro and medium-sized firms on the other hand, are –0.3 and +0.3 respectively.

have unclear effects on employment growth. Balancing exploration and exploitation means that some firms grow while persisting in strategic renewal and process innovation, while others (temporarily) shrink while pursuing strategic renewal and process innovation (in line with some previous results (e.g. Mohnen and Thierren (2002)).

We find clear firm-size effects for holding patents, for applying constant renewal as part of strategy (turnover growth), for codification of knowledge and for cooperation with other firms (employment growth). Some additional scale effects arise from our *descriptive statistics*. For nearly all of the strategic renewal variables the probability of performing the activity increases with size. In particular, we find a stylized scale effect concerning the incidence of renewal and the employees involved in renewal activities. Larger firms are more likely to bring new products or services on the market and to employ people for renewal activities compared to micro firms. Micro firms report a higher share of new activities in total turnover, and, a higher share of employees involved in renewal activities in total employment. This indicates that small firms first have to overcome particular "thresholds" in order to be innovative. The most obvious thresholds in this respect are financial risks and capital restrictions. While decreasing the financial risks involved with investment in strategic renewal remains somewhat difficult, policy makers might at least attempt to improve the possibilities of attracting financial capital for the smallest innovative and high-potential firms.

Further research would be particularly useful in three directions. Firstly, based on this study one would expect knowledge management to be of critical importance to small business performance. The particular organization of such efforts has received relatively little attention, particularly for small and networked firms. Secondly, the complexity and structure of the internal and external environment for innovation have not been included in the analysis here. Including measures of the centrality and proximity of particular partners could enlighten our insight of optimal timing and effective organization of strategic renewal for small businesses. Thirdly, our analysis has been limited to several years. Continuity of data collection on strategic renewal efforts for longer periods would enable us to further deepen our understanding of the relevance of strategic renewal to business performance in the long run.

Based on our results, policy makers interested in stimulating productivity and effective business innovation should stimulate knowledge creation and knowledge diffusion. Firms may be encouraged to participate in networks (universities, competitors, suppliers, advisors) and to cooperate with each other. For small firms in particular, the knowledge exchange is critical in the success of strategic renewal and innovation efforts. It should be a point of attention to the entrepreneurs. Small firms often lack the financial capacity to make full use of new methods and innovations developed by academic researchers. On the other hand, universities have little incentives to share their (newly created) knowledge with small firms. One might, like the Dutch government is planning at the moment, experiment with so-called 'knowledge vouchers' for small firms. These vouchers may be exchanged for knowledge accumulation projects at universities. In turn, universities cash the vouchers after delivering the knowledge to the small firm. In this way, both small firms and universities are given additional incentives to cooperate with each other. It is also being considered to encourage university researchers to work temporarily at small innovative firms, so that employees and entrepreneurs can benefit from academic knowledge and integrate this knowledge in the business process. Both initiatives are in spirit with our results, although it should be noted that there is more to effective strategic renewal and innovation than just sitting in at "innovation meetings" or visiting a university professor once in a while. The entrepreneurial spirit should be real for any such measures to be effective (as was true for earlier efforts in supporting the development of innovative regions and clusters around specific universities (Wever and Stam (1999)).

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