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Innovation and Economic Performance at the Enterprise Level

Tore Sandven and Keith Smith

1. Introduction

It is frequently claimed that innovation is essential to economic performance, but such claims are usually quite general and abstract. Often they apply indistinguishably to economic growth generally, to the competitiveness of national economies, to the profitability, survival and growth of individual enterprises, and so on. Clearly, there is need for more precise empirical information that can help us make distinctions as to how innovation relates to economic performance, and this is explored in this paper. We approach this task by looking at relationships between innovation, profitability and growth at the enterprise level, basing our analysis on data on both innovation and performance results for a panel of 640 Norwegian manufacturing enterprises.[13] What are the performance outcomes of innovation? Are innovative firms more profitable than non-innovating firms? Do they grow faster?

2. The data

Our data set merges firm-level data from the Norwegian component of the Community Innovation Survey (CIS) 1992 with accounting data for the firms responding to the innovation survey. The innovation data covers the three-year period 1990-1992, and asks firstly whether the enterprise during this period developed or introduced any technologically changed *products* or *processes.* Affirmative answers to one or both of these questions define a firm as innovative; those who answer no to both questions are regarded here as non-innovators. Roughly, a little less than half of the enterprises in the sample are innovative according to this simple definition. We have merged the data from the innovation survey with ordinary accounting data, reported in company accounts and collected for tax purposes. This data covers all profit and loss accounts and relevant balance sheet data: so we are able to look at various measures of firm profitability, growth of sales, and so on. The accounting data begins before the CIS survey, in 1991, and continues after it, ending in 1997, so we can look at the evolution of profitability and growth over time.

3. The sample

Our basic sample contains 640 enterprises. These are all the enterprises in the innovation survey sample (originally 908) that could be found in the accounting data set for every year in the period 1991-1994, i.e. which had not ceased to exist as separate statistical units in the course of this period. However, when accounting data for 1995-1997 were added, some of these 640 enterprises had also ceased to exist as separate statistical units (whether through bankruptcy, or whether they had continued to exist in a different form, for instance through being involved in merger and acquisition activity). Thus, some of the enterprises have missing values on the accounting data variables for 1995-7.

The data here is not a simple random sample, but rather a disproportionate stratified sample, where the units are sampled from different strata and where the probability of selection varies across the strata.[14] To take this deviation from a simple random sample into account would have complicated the analysis of the data substantially, and we have chosen not to do so. The reason is that it is only important to take variation in the probability of selection into account if the effect of other independent variables (notably, the innovation variables) on the economic performance variables varies significantly with enterprise size and/or industry. This would mean that there are significant interaction effects between the other independent variables and enterprise size and/or industry on economic performance. However, we find virtually no evidence in our data that any such interaction effects are significant.

4. What kinds of relationships can we expect? Theoretical and methodological issues.

What kind of results we would expect to get from an empirical study of the relationship between innovation and economic performance at the enterprise level? If innovation determines economic performance, we might expect to find firstly that innovative enterprises performed better, in terms of conventional performance measures, than non-innovative ones, and that the more intensive the innovation activity, as measured by inputs and outputs, the better the accounting results.

However, there are several reasons why things are not so straightforward. Partly this has to do with measurement problems, affecting both measures of economic performance and measures of innovation, including the timing of measurements. This, among other things, influences to what extent we can consider variation in innovation variables as causes of variation in performance variables in cases where we find significant association between these variables.

But even if we had indicators unaffected by measurement problems, it is not clear that we should simply expect innovative enterprises unambiguously to perform better than non-innovative enterprises. Consider for example Lazonick's distinction between *innovative* and *adaptive* investment strategies. Innovative strategies are strategies for value creation and capacities for future growth; they 'entail a developmental period before they generate returns.' Adaptive strategies are strategies for value extraction; they 'reap the returns on past investments,' while gradually undermining the capacities for generating value in the future.[15] This would suggest that it is an open question whether innovative enterprises are more profitable than non- innovative enterprises in the short run. In the long run we might expect innovative enterprises to experience higher growth rates and better survival probabilities than non-innovative firms, perhaps with greater variance in results, due to the riskiness of innovative strategies. Empirically, this raises the question of whether the seven years (1991-1997) covered by our data constitute a long enough period to register these relationships and effects. In any case, this distinction between innovative and adaptive strategies suggests that we have to distinguish among performance variables, and that we might expect innovative enterprises to perform better than non innovative ones on some variables, but not necessarily on others.

That it is crucial to distinguish among performance measures is also strongly suggested by what Marshall W. Meyer calls the 'paradox of performance,' namely the fact that 'while performance measures and measurement activity have proliferated over time, performance measures tend to be very weakly correlated with one another.'[16] It is interesting to note that when Meyer chooses one particular measure to use as a criterion to test a hypothesis that 'more successful organizations will exhibit greater variance across performance measures than less successful ones,'[17] he chooses growth in an organization's assets. Although he acknowledges that this is somewhat arbitrary, he also claims that 'it may be justified on several grounds.' He argues that 'growth in an organization's assets not simply in its sales is one of the few performance measures for which there is strong theoretical justification in the literature.'[18] Furthermore, 'most constituencies surrounding a firm favour asset growth,' while 'measures to increase productivity and returns may, by contrast, provoke severe opposition.' Concerning theoretical justification in the literature, he also comments that 'agency theory *asserts* the primacy of shareholder returns, but this is assumed rather than derived from other first premises.'[19] We may add that the assertion of the primacy of shareholder returns rests on an idea of the shareholders as 'residual claimants,' coupled with a fundamental conviction that if investment decisions are made in accordance with the interests of residual claimants, the outcome will be optimal.[20] This latter conviction is not part of the theoretical perspective of the present paper. Correspondingly, from our perspective a preoccupation with an ideal 'true' measure of economic performance and with evaluating the validity of different empirical indicators by the extent to which they reflect this single, true measure, does not appear as a fruitful approach.[21] Rather, we will regard economic performance as in essence a multi-dimensional phenomenon.

This suggests the importance of unobserved, firm-specific factors, making the causal interpretation of any association we should find between innovation variables and economic performance problematic. This kind of relationship may well express the workings of unobserved third variables. Jensen and McGuckin note that it is well documented that adoption of advanced technology is positively related to performance, but then ask: 'does this positive association reflect the impact of the technology on the efficiency (competitiveness) of the adopting firm, or is it primarily a manifestation of well-managed efficient firms being more likely to adopt advanced technologies?'[22]

The importance of 'unobservable factors' has been heavily stressed by Robert Jacobson.[23] Among these he mentions corporate culture, access to scarce resources, management skill, luck, a particular technology, accumulated consumer information, brand name and reputation. He claims that unobservable factors 'can be postulated to be principal determinants of business success,' and that 'failure to control for unobservable factors influencing profitability both biases and exaggerates the effect of strategic factors.'[24] Jacobson argues in favour of using lagged measurements of the dependent variable to control for such firm-specific unobservable factors. The point is that if these unobservable factors are thought of as 'long-lived attributes of the business unit,' which precisely seems to be the rationale for considering them important, then they will influence economic performance both in this particular year and in the earlier year. Consequently, when explaining economic performance this year, economic performance in the earlier year may serve as a proxy for these unobserved factors. If, for instance, the association between adopting advanced technology and economic performance simply reflects the circumstance that well-managed efficient firms are more likely to adopt advanced technology, the effect of adopting new technology on economic performance will become insignificant when we control for economic performance in the earlier year. On the other hand, if the association reflects a real effect of adoption of new technology on economic performance, the effect should remain significant (and substantial) even when we control for economic performance prior to the adoption of the advanced technology.

Clearly, these are complicated questions. The economic performance variable at the earlier date will not simply reflect unobservable factors related to the business unit, but may also to a significant extent express the effects of 'strategic factors' at a still earlier time. Or more generally, these unobservable factors cannot simply be attributed to the business unit as immutable essences, but evolve over time, and may do so partly in response to strategic factors.[25]

5. Empirical investigation: innovation and economic performance

We now turn to the relationship between innovation and economic performance in our data. As measures of economic performance, we use the four variables introduced above: operating profit ratio, return on investment, sales growth and asset growth.

From the innovation side, a basic innovation variable is the dichotomy between innovative and non-innovative enterprises. But we also have a number of variables characterizing the nature of innovations (for instance, product or process innovations), innovation efforts (for instance, measures for different types of innovation costs), and innovation output (for instance, the share of sales accounted for by product innovations).

As a first step we simply use the dichotomous distinction between innovative and non- innovative enterprises to see if there are differences on our economic performance variables between these two groups: we look at the correlation between the dichotomous innovation variable and the different performance measures. Because of a number of extreme outlier values on the performance variables, we use the ordinal *Kendall tau b* correlation coefficient (and not the more familiar *Pearson's r* product moment correlation coefficient).

However, we should here at the same time draw attention to a background variable in the innovation data set, namely *gross investment* (in machinery, equipment, buildings, etc.) in 1992. This variable does not specifically refer to innovation, but is likely to be correlated with innovation activity, and is certainly a candidate for explaining economic performance. It is important therefore to look at the correlation not only between the dichotomous innovation variable and the different performance measures, but also between investments and performance. For the investment variable to be meaningful investments must of course be related to the size of the enterprise or the activities carried out by it. We use three different versions of the investment variable: investments (in 1992) as a proportion of sales (in 1992) (INVINT), per employee (in 1992)(INVEMP), and as a proportion of total assets (in 1992)(INVCAP). Later, we explore the impacts of the innovation variables, controlling for the investment variable.

We first look at the correlation of the innovation variable and the three versions of the investment variable with the *operating profit ratio* (OPR), defined as total earnings as a proportion of sales.

Table 1. Correlation (tau-b) of dichotomous innovation and investments in 1992 with operating profit ratio (OPR), 1991-1997.

Kendall Tau b Correlation Coefficients Prob > lrl under H0: Rho=0 Number of Observations							
	OPR91	OPR92	OPR93	OPR94	OPR95	OPR96	OPR97
INNO01	0.04058	0.08074	0.02128	0.02721	0.05323	0.03367	0.01098
	0.2094	0.0125	0.5103	0.3999	0.1097	0.3170	0.7477
	640	640	640	640	604	591	574
INVINT	0.11937	0.13045	0.08467	0.08021	0.11463	0.12181	0.06146
	<.0001	<.0001	0.0019	0.0032	<.0001	<.0001	0.0327
	637	637	637	637	601	588	571
INVEMP	0.10272	0.11981	0.06512	0.06987	0.10797	0.09330	0.04366
	0.0002	<.0001	0.0168	0.0103	0.0001	0.0010	0.1293
	637	637	637	637	601	588	571
INVCAP	0.06914	0.07626	0.03181	0.02878	0.06145	0.07122	0.01212
	0.0111	0.0051	0.2425	0.2904	0.0285	0.0120	0.6735
	637	637	637	637	601	588	571

Innovation seems to have little impact on this profit measure. Only for 1992 do we find any statistically significant positive relationship between the dichotomous innovation variable and the operating profit ratio. By contrast, the investment variables show a much clearer relationship with the operating profit ratio, and do so for most of the period for which we have data. This especially applies to investments as a proportion of sales. The association is almost as clear for the investment per employee version. The investment as a proportion of total assets variable seems more weakly associated with OPR.

Let us concentrate on the investment as a proportion of sales version. Here the association is significant at the 5 per cent level for all the years from 1991 to 1997, and at the 1 per cent level for all the years but the last. Investment as a proportion of sales in 1992 is correlated in a highly significant way with OPR as late as in 1996.

Questions of causality are complex here and there are sharp limits to what can be concluded from these correlations. Note that investments in 1992 correlate positively with the profit rate both the year before, in the same year and in the following years. We may speculate that what we see here is part of a pattern where high investments lead to high profit rates which in turn lead to high investments. No such pattern is indicated for the relationship between innovation and profits.

There might of course be random year to year variation in the operating profit ratio here, masking a more stable relationship between the innovation and investment variables, on the one hand, and the operating profit ratio, on the other. To get an indication of this, we have also averaged the operating profit ratio over several years in various ways and correlated these average profit ratio variables with the dichotomous innovation variable and the investment variables. The results give no indication that averaging OPR over several years generates any relationships masked by year to year random variation.

We now turn to our second measure of profitability, *return on investment* (ROI), defined as net income this year divided by total assets last year. Consequently, here we have only data from 1992 to 1997, since return on investment for 1991 would require data on total assets in 1990. The correlation coefficients are shown in Table 2, below.

Table 2. Correlation of dichotomous innovation variable and investments in 1992 with return on investment (ROI), 1992-1997.

Kendall Tau b Correlation Coefficients Prob > lrl under H0: Rho=0 Number of Observations						
	ROI92	ROI93	ROI94	ROI95	ROI96	ROI97
INNO01	0.08127	0.00815	0.00721	0.04891	0.01447	-0.02070
	0.0119	0.8010	0.8234	0.1416	0.6677	0.5426
	640	640	640	604	589	579
INVINT	0.09622	0.02227	0.01373	0.05454	0.05328	-0.01380
	0.0004	0.4133	0.6142	0.0519	0.0607	0.6301
	637	637	637	601	586	576
INVEMP	0.10744	0.02279	0.01655	0.06322	0.02754	-0.01946
	<.0001	0.4027	0.5435	0.0243	0.3324	0.4972
	637	637	637	601	586	576
INVCAP	0.10539	0.03504	0.01796	0.05130	0.04462	-0.02125
	0.0001	0.1980	0.5094	0.0674	0.1161	0.4582
	637	637	637	601	586	576

Both the innovation variable and the three investment variables correlate positively with ROI in 1992, with coefficients similar to the ones we found for OPR above. However for none of the other years do we find any significant correlations between these variables. Averaging ROI over several years in different ways does not appear to change this picture. ROI thus appears to be less associated with innovation and investment than OPR. A reason may be that ROI includes financial income and costs in the net income concept of the numerator. This may bring in too much random variation in relation to the results of productive efforts.

We now turn to *growth in sales* as a performance indicator. We here simply use sales in one year divided by sales in a previous year. In the table below 1991 is the base year: sales in all the following years have been divided by sales in 1991. We have used nominal values since taking account of inflation would not have affected the ranking of the enterprises. **Table 3**, below, shows the tau correlation coefficients between the innovation and investment variables and sales growth: *SGR92* means growth in sales from 1991 to 1992, *SGR93* means growth in sales from 1991 to 1993, etc.

Table 3. Correlation of dichotomous innovation variable and investments in 1992 with sales growth (SGR) from 1991 to each of the years 1992-1997.

Kendall Tau b Correlation Coefficients Prob > lrl under H0: Rho=0 Number of Observations						
	SGR92	SGR93	SGR94	SGR95	SGR96	SGR97
INNO01	0.02625	0.05234	0.06378	0.11276	0.07978	0.04905
	0.4168	0.1054	0.0485	0.0007	0.0177	0.1508
	640	640	640	604	591	574
INVINT	0.06498	0.07063	0.09254	0.06031	0.04650	0.03922
	0.0170	0.0095	0.0007	0.0316	0.1012	0.1729
	637	637	637	601	588	571
INVEMP	0.06782	0.06010	0.08172	0.06728	0.04766	0.03012
	0.0128	0.0273	0.0027	0.0165	0.0930	0.2954
	637	637	637	601	588	571
INVCAP	0.09231	0.08501	0.09504	0.06103	0.04803	0.03323
	0.0007	0.0018	0.0005	0.0296	0.0903	0.2481
	637	637	637	601	588	571

The investment variables correlate significantly with sales growth from 1991 up to 1995, but not beyond this. There is a different, and potentially interesting, pattern for the correlation between the innovation variable and sales growth from 1991 variable. For sales growth to 1992 and 1993 we find no significant correlation with the innovation variable, and neither for sales growth to 1997. However, we do find significant coefficients for sales growth to 1994, 1995 and 1996, and in the case of 1995 the coefficient is highly significant. This may mean that we here see an effect on sales growth of introducing new products and processes that appears first after a few years and then wears off. This is consistent with a product-cycle view of the relation between innovation and sales, for an individual product.

Table 4. Correlation (tau-b) of dichotomous innovation variable and three indicators of investments in 1992 with asset growth (AG) from 1991 to each of the years 1992-1997.

Kendall Tau b Correlation Coefficients Prob > lrl under H0: Rho=0 Number of Observations						
	AG92	AG93	AG94	AG95	AG96	AG97
INNO01	0.08381	0.08783	0.07566	0.09667	0.07950	0.07719
	0.0095	0.0066	0.0193	0.0037	0.0180	0.0232
	640	640	640	603	592	579
INVINT	0.18802	0.12717	0.10378	0.08377	0.08414	0.06153
	<.0001	<.0001	0.0001	0.0029	0.0030	0.0318
	637	637	637	600	589	576
INVEMP	0.17409	0.11952	0.09178	0.08896	0.08168	0.05913
	<.0001	<.0001	0.0008	0.0015	0.0040	0.0391
	637	637	637	600	589	576
INVCAP	0.17340	0.14247	0.12667	0.10696	0.10427	0.08615
	<.0001	<.0001	<.0001	0.0001	0.0002	0.0026
	637	637	637	600	589	576

Lastly we turn to our fourth performance indicator, growth in total assets. In **Table 4**, below, 1991 is again used as base year, and asset growth is asset growth from 1991 to the year in question (for instance, *AG95* means asset growth from 1991 to 1995, that is, total assets in 1995 divided by total assets in 1991).

All coefficients in this table are significant at the 5 per cent level. There does not seem to be much difference between the three investment measures when it comes to correlation with asset growth. For asset growth from 1991 to 1992, 1993 and 1994, correlation is higher with investment (in 1992) than with the dichotomous innovation variable (referring to the period 1990-92). In particular, the correlation between investment in 1992 and asset growth from 1991 to 1992 is higher than other correlations we have seen so far. This is not surprising, since asset growth also is a type of measure of investment. The coefficient is not particularly high, though. For asset growth from 1991 to 1995, 1996 and 1997, the correlation with the innovation variable is as high as with the investments variable.

It thus seems that we here have *a consistent difference between innovative and non-innovative enterprises in performance.* Using 1991 as our base year, innovative enterprises have had a higher growth of total assets than non-innovative enterprises from 1991 to every later year for which we have data, i.e. to 1992 through to 1997. For both the sales growth and asset growth variables we have averaged values over more than one year in various ways to see if this brings anything new into the analysis. For instance, growth from an average of 1991 and 1992 to an average of 1996 and 1997 has been calculated and correlated with innovation and investment. This kind of averaging does not change the picture.

To conclude this very simple bivariate analysis, we find evidence that innovative enterprises perform better than non-innovative enterprises. First, concerning the two profit rate measures, we only find a significant difference between innovative and non-innovative enterprises for the year 1992, i.e. the last year of the three year period to which the definition of being innovative applies. For sales growth and asset growth we find differences in performance between innovative and non-innovative enterprises several years after the period defining the innovation variable. In the case of sales growth, we the innovative enterprises have had a higher growth rate from 1991 to both 1994, 1995 and 1996, the difference in sales growth from 1991 to 1995 in particular being highly significant. In the case of asset growth, the innovative enterprises tend to have higher growth rates from 1991 to all later years in the period for which we have data, that is through to 1997.

Multivariate analysis

A question that immediately arises when we look at the correlations above is what happens to the association between the innovation variable and the economic performance variables when we control for investment. This requires a multivariate analysis. The correlations between the dichotomous innovation variable and the three different versions of the investment variable are shown in the correlation matrix in **Table 5**, below.

The innovation variable is clearly correlated with the investment variables. Innovative enterprises tend to have higher investments relative to both turnover, number of employees and total assets than non innovative enterprise, as one would expect. The three investment variables are of course strongly correlated with each other.

That investments are positively correlated with both innovation and some of the performance variables means that there is a possibility that the association we found between innovation and some of the performance variables will disappear or be weakened when we control for investment. However, as pointed out above, the question of causality is a difficult one here, so that even if we should find that the effect of innovation on economic performance disappears when we control for investment, what this means would still be an open question. We should not automatically conclude that this indicates that innovation, as measured here, has no effect on the performance variables. One should remember here the time periods to which the variables refer. The investments variable is investments in 1992, while the dichotomous innovation variables refers to innovations introduced during the three year period 1990-1992, and they may thus be the results of activities and investments made both in this period and prior to this period.

Table 5. Correlations (tau-b) between the dichotomous innovation variable and the three indicators of investments in 1992.

Kendall Tau b Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations	INNO01	INVINT	INVEMP	INVCAP
INNO01	1.00000	0.33179	0.38226	0.30321
		<.0001	<.0001	<.0001
	640	637	637	637
INVINT	0.33179	1.00000	0.80670	0.81311
	<.0001		<.0001	<.0001
	637	637	637	637
INVEMP	0.38226	0.80670	1.00000	0.75113
	<.0001	<.0001		<.0001
	637	637	637	637
INVCAP	0.30321	0.81311	0.75113	1.00000
	<.0001	<.0001	<.0001	
	637	637	637	637

Methodology

The following analysis is based on ordinal logistic regression analysis with cumulative probabilities, supplemented by ordinary least squares (OLS) regression analysis to check the results. The reason for this choice is that the dependent variables in our analysis, deviate substantially from a normal distribution. The profit ratio variables are not particularly skewed, and neither are the sales growth and assets growth variables when we use the log of their values. However, all are heavily marked by a small number of extreme outlier values which may to an unreasonable extent influence the results of analyses which are based on prediction of the mean. Therefore when we supplement the logistic regression analyses with ordinary least squares regression analysis to get a check on the results, the OLS analysis is made with the most extreme observations on the dependent variable in question deleted.

In the following we have transformed all the dependent variables by dividing them into deciles. On each variable the observations have been ranked, and then the 10 per cent highest ranked have received the value 10, the next 10 per cent the value 9, and so on down to the value 1 for the 10 per cent lowest ranked. With the dependent variable divided into 10 values, we get 9 different dichotomies of high against low values. The ordinal logistic regression model with cumulative probabilities predicts the probability that a given observation is among the 10 per cent highest ranked (i.e. has the value 10), that it is among the 20 per cent highest ranked (i.e. has the value 9 or 10), and so on down to the probability that it is among the 90 per cent highest ranked (has a value of 2 or higher), given the assumption that the odds ratio connected with a unit increase in each independent variable is the same for all 9 divisions of the dependent variable into binary responses.[26] We also test the appropriateness of the proportional odds assumption. If the predicted values given the proportional odds assumption deviate significantly from the values predicted by a model which does not impose this assumption and thus uses more degrees of freedom, this would mean that the set of independent variables is better at predicting some dichotomized versions of the dependent variable than others. For instance, this might mean that the model better predicts the probability of being among the 20 per cent highest ranked observations than of being among the 50 per cent highest ranked observations.

Some of the independent variables we will use also deviate strongly from being normally distributed. In addition to being characterized by some very extreme outlier values, they are also heavily skewed. This especially applies to the innovation cost variables, as well as to the investment variables. Therefore, we also here divide the variables into 10 values, with roughly the same number of observation in each category. However, these variables are also marked by a large number of observations with the value 0. Consequently, these have been given the value 0 also on the new variable, and the observations with a positive value have been ranked and divided into 10 categories. These variables thus have 11 categories, from 0 to 10. The employment variable is also heavily skewed, of course, but here a simple log transformation seems to function well.

Asset growth

We do not have space here to report on all aspects of a multivariate analysis of links between innovation, investment and performance. We explored the relationship between innovation and two measures of profitability, operating profit ratio and return on investment, and found that any effect of innovation and innovation activity as measured partly for the year 1992, partly for the three year period 1990-1992, quite quickly vanishes. We found some highly significant effects on both performance measures for the year 1992, but then little or nothing for later years.

However, for growth of total assets we have reason to believe that the picture is different, and we focus on that here. We saw above that the dichotomous innovation variable correlates positively and significantly with asset growth from 1991 to every later year for which we have data, i.e. up to 1997. We now look more closely at the relationship between innovation and asset growth by means of multivariate logistic regression analysis, to see what happens when we bring in other variables. For instance, we saw that investment is correlated with both asset growth and innovation, and there is thus again the possibility that the effect of innovation will turn out to be not significant when we control for investment. Furthermore, we will also here introduce other innovation variables. In the following, we look at asset growth from 1991 to 1997.

As our investments indicator we will here use investments as a proportion of total assets. This seems the most logical version here, as we are precisely examining the growth of total assets. Of the three investment indicators, this should thus be the one that exposes the hypothesis of an effect of innovation on asset growth to the most difficult test.

Growth of total assets from 1991 to 1997

Both the dichotomous innovation variable and the investments variable correlate significantly, and positively, with asset growth from 1991 to 1997, the innovation variable at the 5 per cent level, the investment variable at the 1 per cent level. When we control the relationship between the dichotomous innovation variable and asset growth first only for investments and then both for investments and enterprise size, exactly the same thing happens as in the case of asset growth from 1991 to 1995, above. When we control for investments, the innovation variable is no longer significant, but when we also add the enterprise size variable, it gets significant at the 5 per cent level again (p-value 0.0166), and actually more so than the investments variable (which now has a p-value of 0.0227). In contrast to the case above, the exports variable does not contribute significantly.

However, also as in the case above, when we also add other innovation variables, specifying more closely in what ways and to what extent the enterprise is innovative, the nature and intensity of the innovation effort, etc., the dichotomous innovation variable is no longer significant at all. Following the same logic as previously, the model which we end up with as the one which best predicts asset growth from 1991 to 1997 is the one presented in **Table 6**, below.

Table 6. Results from ordinal logistic regression model with equal odds ratios, with growth of total assets from 1991 to 1997 (divided into 10 categories) as dependent variable and investments in 1992 (as a proportion of total assets), log of number of employees in 1992 and R&D expenditures per employee in 1992 as independent variables (N=576).

The LOGISTIC Procedure					
	Response Variable		AG97G10		
	Number of Response Levels		10		
	Number of Observations		576		
	Link Function		Logit		
Score Test for the Proportional Odds Assumption					
	Chi-Square	DF	Pr > ChiSq		
	32.5800	24	0.1132		
Testing Global Null Hypothesis: BETA=0					
Test	Chi-Square		DF	Pr > ChiSq	
Likelihood Ratio	26.4134		3	<.0001	
Score	25.4887		3	<.0001	
Wald	26.4414		3	<.0001	
Analysis of Maximum Likelihood Estimates					
			Standard		
Parameter	DF	Estimate	Error	Chi-Square	Pr > ChiSq
Intercept	1	-2.0486	0.2360	75.3579	<.0001
Intercept2	1	-1.2186	0.2178	31.2997	<.0001
Intercept3	1	-0.6714	0.2123	9.9992	0.0016
Intercept4	1	-0.2037	0.2103	0.9383	0.3327
Intercept5	1	0.2035	0.2103	0.9367	0.3331
Intercept6	1	0.6305	0.2117	8.8716	0.0029
Intercept7	1	1.0796	0.2148	25.2513	<.0001
Intercept8	1	1.6355	0.2217	54.4105	<.0001
Intercept9	1	2.4770	0.2416	105.0756	<.0001
INVC10	1	0.0556	0.0217	6.5408	0.0105
LOGEMP	1	-0.1670	0.0563	8.8090	0.0030
RD2E10	1	0.1096	0.0277	15.5893	<.0001

Compared to the models discussed so far, there is just one new variable introduced in the present model. This is R&D intensity, measured as R&D expenditures per employee in 1992, divided into 10 positive categories plus a 0 category, in the same way as previously explained for other variables. Thus we have only three variables in this model: the investments variable, the enterprise size variable and one innovation variable.

The investment variable is here slightly less significant than in the previous model, but it is still significantly associated with asset growth from 1991 to 1997, also when we control for innovation variables. The enterprise size variable *(logemp)* functions in exactly the same way as in the previous model. In the bivariate case, it is not significantly correlated with asset growth. However, controlling for the other variable it becomes quite significantly negative (at the 1 per cent level). Furthermore, it serves to amplify and make more significant the effects of the other variables, as explained in connection with asset growth from 1991 to 1995, above.

The innovation variable included in the model is R&D intensity. As we can see, it is highly significant, with a p-value of less than 0.0001. It contributes substantially more to the model than the investments variable. It is interesting that it is the R&D intensity variable that gives the best fit here, not the intensity of total innovation expenditures, as in the previous model. These variables are of course highly correlated. The innovation expenditures intensity variable is significant when entered without the R&D intensity variable, but it contributes less. When both are entered together, intensity of total innovation expenditures is not significant, but R&D intensity is.

We can tell a story which makes some sense here. Innovation expenditures are to a large extent expenditures for enhancing the capacity for growth in the future, and this in particular applies to R&D expenditures. Therefore, it is interesting that while investments intensity contributes more than innovation expenditures to the model for asset growth from 1991 to 1992, it is the other way round for the models for asset growth from 1991 to 1995 and from 1991 to 1997. Furthermore, in the model for asset growth from 1991 to 1995, it is the intensity of total innovation expenditures which contributes most of the innovation expenditures variables, while for the model for asset growth from 1991 to 1997, it is R&D intensity. Thus, with 1991 as the point of departure, as we examine asset growth to 1992, then to 1995, then to 1997, the more important innovation expenditures become relative to investments, and among the former, the more important R&D expenditures relative to total innovation expenditures.

6. Conclusion

This very preliminary investigation suggests that innovation activity is indeed a key component of firm performance. However what it affects is not so much profitability as conventionally measured: firms do not appear to take the benefits of innovation in the form of higher rates of profit. Innovating firms grow more rapidly than non-innovating firms, both in terms of sales and assets, and so innovation appears to drive both an evolutionary process of firm growth, and well as output growth more generally.