Economics Bulletin

Volume 36, Issue 1

Eager and able: a study of innovation activity among young, mature and old firms in Norway

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Abstract

This article investigates how age is related to innovation activity and innovation outcomes among firms in the Norwegian manufacturing and knowledge-intensive business services (KIBS) sectors. It aims to shed new light on two questions: (i) are young firms or old firms the most prolific innovators and (ii) are young firms more eager to innovate, while old firms are more able to innovate. It makes use of Community Innovation Survey (CIS) data and explores the two questions using probit model regression techniques. The article concludes that firms are at their most prolific state when they are neither young nor old – but mature. At this stage in their life cycle, firms are both eager and able to introduce innovations.

We want to thank the EnergyX program at the Norwegian Research Council for financial support through the ETIS project.
Citation: Pål Børing and Arne Martin Fevolden and Sverre Herstad, (2016) "Eager and able: a study of innovation activity among young, mature and old firms in Norway", *Economics Bulletin*, Volume 36, Issue 1, pages 291-297
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Submitted: March 01, 2016. **Published:** March 17, 2016.

1. Introduction

Researchers disagree about the relative importance of young and old firms for bringing about innovation and economic growth (see Schumpeter 1911, 1942; Nightingale and Coad 2014). Some researchers see young firms as an economy's creative risk-takers. They describe young firms as inherently innovative and claim that they drive structural change by serving as vehicles for introducing new technologies and business practices. Other researchers challenge this view and argue that old firms are the engines of innovation and growth. They point out that innovation-based growth depends on development of routines and knowledge bases that require time to evolve and institutionalize within industrial organizations. Since theoretical and empirical research on the effects of firm age on innovation is limited and largely inconclusive (see e.g. Hansen 1992; Sørensen and Stuart 2000; Huergo and Jaumandreu 2004; Sung and Carlsson 2007; Winters and Stam 2007), it offers no clear and undisputed answers to whether:

(i) Young firms or old firms are the most prolific innovators
(ii) Young firms are more eager to introduce innovations, while old firms are more able to introduce innovations

This paper aims to shed new light on these two issues, by analysing how age is related to innovation activity and innovation outcomes among Norwegian firms in manufacturing and knowledge-intensive business services (KIBS). Like many of their European counterparts, the firms in the Norwegian manufacturing and KIBS sectors struggle to cope with challenges related to technological change, international competition and weak demand. To sustain present levels of economic activity, the firms in these sectors therefore need to introduce a wide range of innovations to improve their competitiveness and establish new sources of revenue. It is therefore a highly relevant and much debated issue whether the innovative potential differs among young and old firms and whether particular age groups should be the target for specific government policies (see for instance, Dagens Næringsliv 2015).

The article will answer the two previously mentioned questions by employing probit model regression techniques. The article will first provide an answer to whether young firms or old firms are the most prolific innovators, by analysing how age affects the likelihood that firms introduce product and process innovations. In this part of the analysis, a special emphasis is put on so-called 'bundles' of complementary product and process innovations, which has been shown to be particularly important for growth (Evangelista and Vezzani 2010). The article will then test the validity of the claim that young firms are more eager to introduce innovations and old firms are more able to introduce innovations, by analysing how age affects the likelihood that firms engage in innovation activities and how age affects the likelihood that these innovation activities leads to the introduction of product and process innovations.

2. The data

The empirical analysis is based on data from the seventh Community Innovation Survey (CIS) for Norway, conducted by Statistics Norway. These data contain information about innovation activity in the Norwegian business enterprise sector in the period 2008–2010. The data are in the form of a representative sample for enterprises with between 5 and 49 employees (20-49 in NACE groups G and H), while enterprises with more than 50 employees are covered completely. The data sample contains 3417 firms (2048 manufacturing firms and 1369 firms in the KIBS sector), where firms are defined at the enterprise level.

2.1 Dependent variables

The paper makes use of three binary dependent variables: 'product innovation' (equal 1 if a firm is product innovative, 0 otherwise), 'process innovation' (equal 1 if a firm is process innovative, 0 otherwise) and 'innovation activity' (equal 1 if a firm has innovation activity, 0 otherwise).

The paper defines product and process innovation in the following way. Product innovative firms have introduced a product (good or service) that is new or significantly improved with respect to its characteristics or intended uses during the period 2008–2010, while process innovative firms have implemented a new or significantly improved production or delivery method during the period 2008–2010. Firms with innovation activity include not only product and/or process innovative firms, but also firms that were engaged in innovation activities that did not result in a product or process innovation during the period 2008–2010 because the activities were abandoned or suspended before completion, or were still ongoing at the end of the 2010.

2.2 Independent variables

The paper uses 'firm age' as the main explanatory variable and a series of covariates as control variables. Firm age is equal to the number of years from an enterprise's founding year up until 2010. In the empirical analysis, firm age consists of the following three dummy variables: 'young' (age 1-3 years), 'mature' (age 4-9 years) and 'old' (age >9 years) – which are used to capture potential curvilinearity. The other covariates include log of firm size (firm size measured as the number of employees), industrial sector (NACE codes for manufacturing and KIBS, SIC2007), and geographic market (whether a firm has sold products abroad in 2008–2010). All independent variables are dummy variables, except for log of firm size.

2.3 Survivorship bias

A possible limitation in the article´s research design is a potential selection bias associated with firm survival rates (see for instance, Mangelab and Samaniegoc 1984; Nightingale and Coad 2014). As firms age, some survive while other perish, and those that perish fall out of the data set and create a potential survivorship bias that may lead to wrongful conclusions. For instance, older firms do not necessarily become more innovative because age has provided them with the time to accumulate organizational capabilities, but because less innovative firms have perished and are therefore no longer part of the sample. A common way of controlling for such selection biases is to use a panel data design, where data on the same firms are collected at different periods. Unfortunately, the CIS is a cross-sectional data set, and we have to relegate controls for potential survivorship biases to future research.

3. The econometric method

We use the probit and bivariate probit models in the estimations. There are two binary dependent variables Y_1 (product innovation) and Y_2 (process innovation) in the bivariate probit model, and thus two latent variables Y_1^* and Y_2^*. It is assumed that $Y_j = 1$ if $Y_j^* > 0$ and $Y_j = 0$ otherwise ($j = 1,2$), with

$$(1) \quad Y_j^* = X_j\beta_j + \varepsilon_j,$$

where X_j is a row vector of K explanatory variables (with first-element unity), and β_j is a column vector of coefficients. $(\varepsilon_1, \varepsilon_2)'$ is bivariate normal distributed with $E(\varepsilon_j) = 0$, $Var(\varepsilon_j) = 1$ and $Cov(\varepsilon_1, \varepsilon_2) = \rho$.

In the probit model there is only one binary dependent variable Y (innovation activity), and thus only one latent variable Y^* with $\varepsilon \sim N(0,1)$. All the empirical results are weighted by using sampling weights from the innovation data.

4. The empirical results

In order to investigate whether young or old firms are the most prolific innovators, we use a bivariate probit model to estimate the effect firm age has on the likelihood that firms introduced product and process innovations. As advised by Hoetker (2007), Table 1 reports the marginal effect estimates for the two outcomes independently and in combination, instead of coefficients estimates. Table 1 shows a distinct curvilinear relationship between firm age and innovation output, with young firms (age 1-3) and old firms (age > 9) both yielding marginal effect estimates that are significantly lower than for mature firms (age 4-9). This relationship remains the same for estimates of the probability of product innovation, process

innovation and 'bundles' of complementary product and process innovations. Hence, the analysis indicates that the mature firms are the most prolific innovators.

Table 1. Estimation results, marginal effects on innovation outcomes

Explanatory variables	Product	Process	Both product and process
Firm age			
Young (age 1-3 years)	-0.144 ***	-0.139 ***	-0.106 ***
	(0.037)	(0.035)	(0.024)
Mature (age 4-9 years)	Reference	Reference	Reference
Old (age >9 years)	-0.060 ***	-0.049 ***	-0.040 ***
	(0.019)	(0.018)	(0.012)
Log of firm size	0.045 ***	0.033 ***	0.028 ***
	(0.006)	(0.006)	(0.004)
Geographic market			
Sold products abroad	0.155 ***	0.097 ***	0.088 ***
	(0.017)	(0.016)	(0.011)
F value			6.340
Prob > F			0.000
Number of enterprises			3371
Population size			8842

Notes: 1) Estimated marginal effects of independent variables (standard errors in parentheses), which are based on the bivariate probit model and calculated for all sample firms. 2) *** Significant at the 1% level, ** significant at the 5% level, * significant at the 10% level. 3) Estimated marginal effects of the dummies for industrial sector are not shown in the table. 4) The reference firm is: mature firms (age 4-9 years), only sold products at the Norwegian market in 2008–2 010, and included in the sector of manufacture of food products (NACE code 10).

To investigate whether young firms are more eager to introduce innovations, we use a probit model to estimate the effect firm age has on the likelihood that firms engaged in innovation activities. The marginal effect estimates for the probability of engaging in innovation activities are shown in Table 2 (first column of estimates). Table 2 depicts the same curvilinear relationship between firm age and innovation activity as in the previous analysis of innovation outcomes, with young firms and old firms both yielding marginal effect estimates that are significantly lower than for mature firms. Hence, the analysis indicates that the mature firms are most eager to innovate.

Table 2. Estimation results, marginal effects on innovation activity and innovation outcomes

Explanatory variables	Innovation activity	Product	Process	Both product and process
Firm age				
Young (age 1-3 years)	-0.124 ***	-0.168 **	-0.194 **	-0.199 ***
	(0.040)	(0.076)	(0.082)	(0.075)
Mature (age 4-9)	Reference	Reference	Reference	Reference
Old (age >9 years)	-0.083 ***	-0.016	-0.016	-0.017
	(0.023)	(0.038)	(0.039)	(0.031)
Log of firm size	0.064 ***	0.015	0.007	0.011
	(0.007)	(0.012)	(0.012)	(0.010)
Geographic market				
Sold products abroad	0.210 ***	0.073 **	0.000	0.032
	(0.019)	(0.036)	(0.038)	(0.030)
F value	13.700			1.620
Prob > F	0.000			0.001
Number of enterprises	3371			1576
Population size	8842			3209

Notes: 1) Estimated marginal effects of independent variables (standard errors in parentheses). 2) Marginal effects on innovation activity (based on the probit model) are calculated for all sample firms. 3) Marginal effects on innovation outcomes (based on the bivariate probit model) are only calculated for firms with innovation activity. 4) *** Significant at the 1% level, ** significant at the 5% level, * significant at the 10% level. 5) Estimated marginal effects of the dummies for industrial sector are not shown in the table. 6) The reference firm is: mature firms (age 4-9 years), only sold products at the Norwegian market in 2008-2010, and included in the sector of manufacture of food products (NACE code 10).

In order to investigate whether old firms are more capable of introducing innovations, we use a bivariate probit model to estimate the effect firm age has on the likelihood that the firms' innovative activities led to the introduction of product and process innovations. Table 2 (columns 2-4 of estimates) reports the marginal effect estimates for the probability of product and process innovation for firms that were engaged in innovative activities. It shows a positive relationship between firm age and the ability to introduce innovations, in the sense that young firms have a marginal effect estimate that is significantly lower than for mature firms, while the difference between mature and old firms is insignificant. This relationship remains the same for estimates of the probability of product innovation, process innovation and 'bundles' of complementary product and process innovations. Hence, the analysis indicates that both mature and old firms are more capable of introducing innovations than young firms.

The results hold after controlling for the log of firm size and international market presence. Both these control variables yield positive marginal effect estimates for the likelihood that firms introduced product and process innovations (reported in Table 1) and positive estimates for the likelihood that firms were engaged in innovative activities (reported in Table 2, first column of estimates). These control variables do not however yield positive marginal effect estimates for the likelihood that firms introduced product and process innovations given that they were engaged in innovative activities. This suggests that firm size and international market presence increases foremost the eagerness to innovate, and have less effect on the firm's ability to introduce innovation.

5. Interpretation and Conclusions

This article has investigated how age is related to innovation activity and innovation outcomes among Norwegian firms in manufacturing and knowledge-intensive business services. More specifically, the article set out to investigate two questions: (i) whether young firms or old firms are the most prolific innovators and (ii) whether young firms are more eager to innovate, while old firms are more able to innovate. In terms of the first question, the analysis found that neither young firms nor old firms were as prolific innovators as mature firms were. Put differently, the analysis found that the frequency in which firms introduced product, process and bundles of product and process innovation fell both as the firms became younger and older.

In terms of the second question, the analysis found that neither young firms nor old firms were as eager to innovate as mature firms were, while only young firms were less able. Put differently, the analysis found that as firms grow older, the *eagerness* to innovate first increases and then declines, while the *ability* to innovate increases and stabilizes. To paraphrase the title of the article, we can say that young firms are neither eager nor able to innovate, mature firms are both eager and able to innovate and old firms are only able to innovate without being eager to do so.

These results point to some interesting implications. In terms of theory, the results indicate that cumulative development of routines and knowledge bases improves firms' chances of successfully introducing innovations, although the returns on additional capability building diminish after a few years. They also corroborate the idea that creativity and risk taking is associated with youth and declines with age, although the results indicate that the eagerness to innovate emerges later in the firms' lifecycle, once they have become more able to innovate. In terms of policy, the results indicate that policy makers should encourage old firms to increase their innovative activities and both encourage and enable young firms to innovate.

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