Assessing the Impact of Skill Shortages on the Productivity Performance of High-Tech Firms in Northern Ireland

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Abstract

This paper utilises data from three separate skill related surveys of firms in the Northern Ireland IT, Electronic Engineering and Mechanical Engineering industries in order to assess the extent to which the performance of high-tech firms are being constrained as a result of hard-to-fill and / or unfilled vacancies. Whist it was found that the determinants of skill shortage varied somewhat depending upon the definitional approach adopted, a high degree of correlation was found. With regards to the impacts of skill shortages on firm level performance, it was found that both hard-to-fill and unfilled vacancies had reduced output per worker levels by between 65 and 75 per cent in affected firms, however, these impacts were only detectable after controlling for selection effects. The evidence suggests that standard OLS procedures can generate highly misleading results in studies of this nature.

Key Words: Skill Shortages, Productivity, High-tech Industries

JEL Codes: J24, J30, J31

Introduction

Skills related issues are now centre stage in UK economic policy, having been identified as one of the five drivers of productivity performance. A critical aspect of government policy has been the attempt to alleviate skill shortages within key sectors of the economy which have led to the establishment of Sector Skills Councils which are charged with the responsibility of reducing skills gaps and shortages within their respective sectors. Thus, policy is underpinned by the assumption that skills shortages within the economy have serious negative impacts on productivity performance. There are certainly a number of reasons why we might expect skill shortages to adversely impact productivity levels, for instance, firms may be forced to lower their recruitment standards and fill positions with less productive workers, and / or workers in the affected occupations may exploit their bargaining power to disproportionately enhance their employment conditions; either way, we would expect the level of output per worker to fall. In the event of skill shortages becoming a wide spread phenomenon, it has been argued that the economy will move towards a low skills, bad jobs, lower wages equilibrium trap, characterised by persistent low productivity levels, under investment in training and few skilled jobs (Snower, 1996; Redding 1996). However, UK evidence supporting such views is limited and somewhat mixed, a factor which is at least partially related to a lack of available datasets linking skill shortages and firm level performance. Forth & Mason (2004) using the 1998 Technical Graduates Employers Survey (TGES) combined with Dun & Bradstreet data found no clear differences in the sales per employee levels of companies that experienced recruitment difficulties compared to those that did not. Similarly, McGuinness & Bonner (2002) failed to find a link between unfilled vacancies and productivity levels within a sample of Northern Ireland (NI) IT firms, whilst McGuinness & Doyle (2005) came to the same conclusion in relation to the NI construction industry. Nevertheless, there does exist some evidence to support the view that skill shortages incur real costs on the firm. Haskel and Martin (1993a) report that the increased skill shortages during the mid-1980s reduced productivity growth by around 0.7 per cent per annum whilst Nickell and Nicolatsis (1997) found that skilled labour shortages at industry level were significantly and negatively related to a number of productivity corollaries such as investment in fixed capital and R&D.

This paper utilises a dataset constructed using information collected during three separate skill related surveys of firms in the NI IT, Electronic Engineering and Mechanical Engineering industries in order to assess the extent to which the performance of high-tech firms are being constrained as a result of skill shortages.

Data and Methods

The data was collected by the Priority Skills Unit (PSU) of the Economic Research Institute of Northern Ireland (ERINI) who work under the direction of the NI Skills Task Force, the body tasked with identifying sectors of importance to the NI economy that are potentially being constrained as a result of labour market shortages. The data consists of a merged dataset comprising information collected in three separate surveys of the electronic engineering sector (surveyed 2000), the mechanical engineering sector (surveyed 2001) and the IT sector (surveyed 2002). In each of the studies, the inter-departmental business register (IDBR) provided the sampling frame. Each sample was skewed towards the larger firms in order to ensure the largest degree of employment coverage; however care was taken to ensure that sufficient numbers of small and medium sized firms were also included to ensure the representativeness of each sample. Given that the surveys were collected at slightly different points in time and related to different sectors, the information contained within each dataset was not fully compatible, however, whilst some data was lost during the merger process, we were able to retain a lot of information on both skill composition and company performance

[1]. At the end of the data reconciliation process we were left with information on 242 high-tech firms employing 39,328 workers. In terms of the employment breakdown 11 per cent of the sample was employed in the IT sector, 40 per cent in the electronic engineering sector and 49 per cent in the mechanical engineering sector. The achieved sample is broken down by firm size in Table 1 and the dominance of large firms becomes wholly apparent with the largest 20 per cent of firms accounting for over 80 per cent of employment. However, it is important to note that the distribution of employment in Table 1 is consistent with the observed facts for each of the sectors and, as such, the samples reflect the respective industry structures.

As stated, the IDBR provided the populations from which the respective samples were drawn with each sample selected on the basis of the Standard Industrial Classification 1992 (SIC92). The electronics sector was principally defined as those firms operating within divisions 30, 32 and 33. From our final sample of 125 firms we were left with valid responses for 63 firms which gave us a survey response rate of 50.4 per cent, of whom 43 were located in SIC groups 30, 32 and 33[2]. On the basis of our 43 respondent IDBR firms, we had a population coverage rate of 99.5 per cent suggesting that official sources had seriously underestimated the size of the NI sector. The IT sector was defined as consisting of the computer services industry (division 72 of the

SIC 92). A sample was drawn of 121 firms from which a total of 77 firms employing 2,888 agreed to participate in our study giving a survey response rate of 76 per cent (measured in terms of employment) and a population coverage rate of 56 per cent[3]. Finally, the mechanical engineering industry was defined in terms of the amalgamation of five two-digit sectors (SIC 28, SIC 29, SIC 31, SIC 34, and SIC 35) where demand for mechanical engineering skills tends to be most heavily concentrated. Our final sample consisted of 160 firms employing 20,581 persons from which a total of 98 firms employing 16,537 agreed to participate in the study giving a survey response rate of 80 per cent and a target population coverage rate of 77 per cent.

Turning to the key variable within the dataset, it is important to note that the notion of a skills shortage is subject to substantial ambiguity with different surveys using different methodologies, terminologies and phraseologies. The official definition from the Department for Education and Skills (DfES) defines skill shortage vacancies as a "situation where there is a genuine shortage in the accessible external labour market of the type of skill being sought, and which leads to a difficulty in recruitment". This rather ambiguous definition reflects the fact that there is no clear cut approach to measuring skill shortages and generally, studies have tended to use data on either unfilled vacancies or some measure of hard-to-fill vacancies. However, it is far from certain that both measurement approaches will yield similar results given that the evidence would tend to suggest that they have different determining factors. This study has the advantage of containing information on both unfilled and hard-to-fill vacancy data and as such both measures are tested against productivity as measured by the log of output per worker.

< Insert Table 1 Here >

The Incidence of Skill Shortages

Our first measure of skill shortage relates to hard-to-fill vacancies. Firms were asked to assess the degree of difficulty associated with recruiting staff within a set of occupational categories that could be standardized across the various sectors. It should be noted that this, along with the unfilled vacancy rate, is the standard measure of skill shortage used within the UK Skills Monitoring Surveys. As we would expect, the level of recruitment difficulty increases the more experienced and qualified are the staff concerned (Table 2). Just under 70 per cent of firms employing graduates with over two years experience, project leaders and senior managers described the recruitment of such staff as being difficult or very difficult. This is in contrast to the labour market for new graduates (those with no previous experience), which appears to be relatively well supplied with only 24 per cent of firms employing such staff perceiving the labour market to be tight. For all other occupational categories, recruitment appears much less problematic with over 50 per cent of employers describing the process as easy or very easy. In terms of the sectoral breakdown the pattern is generally similar however, some differences are observed. Whilst over half of electronics firms believed the recruitment of new graduates to be problematic, less than 15 per cent of IT and mechanical engineering respondent firms felt that recruitment at this level was difficult (Table 3). The recruitment of craft and technician level staff was much less of a problem for firms operating in the IT sector, with 16 per cent and 10 per cent of firms respectively describing this process as difficult or very difficult compared to over half of firms in electronic and mechanical engineering sectors who described these labour markets as tight.

Whilst hard-to-fill vacancies is a useful measure of labour market difficulty it can also be problematic as such an approach cannot provide us with a concrete empirical measure of shortage nor is it possible to control for sources of subjective bias arising from differences in how respondents define a term such as “difficult”. Consequently, information was also collected on the number of unfilled vacancies occurring in the twelve months preceding our surveys, thus enabling us to generate estimates of the actual rate of shortfall occurring within each of the various occupational groupings. Of the 242 respondent firms, 60 firms reported a total of 420 unfilled vacancies in the twelve months prior to the surveys (Table 4), with 76 per cent of these vacancies occurring at below graduate level. In terms of raw numbers, recruitment problems were most acute at the operator and craft levels. When respondents were asked to attribute these unfilled vacancies to a range of problems, it was obvious that a lack of skilled and qualified workers, as opposed to an inability to pay were the key drivers of unfilled posts. Disaggregating the results by sector, some differences are observable with a lack of technical ability as the most important factor in explaining unfilled vacancies in both the electronics and IT sectors, whilst a shortage of qualified applicants was cited as the most significant problem for firms in the mechanical engineering sector[4]. Thus it is clear from this descriptive analysis that the variable used here is capturing the effects of skill shortage and if it transpires that the hard-to-fill and unfilled vacancies variables are highly correlated, this will also provide support for the view that hard-to-fill vacancy information is a good proxy for skill shortages[5].

We then proceeded to calculate actual vacancy rates[6] and these were derived for each occupational aggregate by standardising the number of unfilled vacancies in each category by the number of persons employed in that category. The highest rate of shortage, at 4.5 per cent, was recorded for experienced graduates (more than two years experience) suggesting that the recruitment of staff to this level has been particularly difficult, a finding broadly consistent with the more subjective measure. To a lesser extent, problems were also experienced in the recruitment of technician level staff (HNC/D) and new graduates with these categories recording an unfilled vacancy rate of 3.2 and 2.8 per cent respectively. Table 5 shows the comparative vacancy rates for each sector. The rate of shortfall for technician level staff is similar in both the electronic and mechanical engineering sectors, however the similarity ends here. Vacancy rates for all of the occupational groupings are much higher in the electronics sector with difficulties particularly acute for graduates with more than two years experience. Electronics vacancy rates are also very high for new graduates and craft level staff at 12.1 and 10.4 per cent respectively.

< Insert Table 2 Here >

< Insert Table 3 Here >

< Insert Table 4 Here >

< Insert Table 5 Here >

< Insert Table 6 Here >

Whilst both measures of skill shortage yield generally similar patterns, it is unclear to what extent these key measurement variables are correlated and subject to the same driving factors. To investigate this matter further we modeled the likelihood of hard-to-fill and unfilled vacancies using standard econometric analysis. A composite measure of hard-to-fill vacancies was derived by attributing the level of assessed recruitment difficulty for each non assembler grouping a value between 1 and 4[7] and then calculating the average for each firm. If the firm reported an average recruitment difficulty level of greater than three then they were deemed to have been affected by hard-to-fill vacancies and the relevant variable was assigned the value one (and zero otherwise). In relation to the unfilled vacancy measure, the dependent variable takes the value 1 if the firm experienced an unfilled vacancy in the previous 12 months, and zero otherwise[8]. As both variables are binary in nature and likely to be highly correlated we estimate a bivariate probit model, the use of binary variables is also useful as they will facilitate the estimation of selection controls within the productivity regressions. In terms of explanatory variables, we use a number of firm level characteristics which include employment structure, location, ownership, salary, age, size, R&D and sector.

Table 7 gives the results from the Bivariate probit and the first thing to note is that the model yields a positive and significant correlation coefficient indicating, not surprisingly, that that firms affected by shortage are likely to report both unfilled and hard-to-fill vacancies. In relation to the explanatory variables both measures of shortage share a number of determining factors. The coefficient on the wage variable and the female graduate share of total employment are both positive and highly significant. The wage impact is in line with the findings of Dickerson (2003), who reported that higher local relative wages are associated with both higher vacancy incidence and higher vacancy propensity. In contrast to this, Green et al (1998) find that in higher wage establishments there is a reduced probability of having skill shortages or hard-to-fill vacancies, whilst Haskel & Martin (2001) observed a significant negative effect on the wage variable on hiring difficulties[9]. In relation to female employment structure, there is no obvious explanation; however, it may be the case that as females are more likely to exit the labour market due to family reasons, this may in turn lead to higher levels of recruitment activity and consequently skill shortages. Our results also demonstrate that firms employing a lower proportion of new and inexperienced graduates will be more likely to report unfilled vacancies. This implies that firm level preferences and Human Resource Management (HRM) practices are a significant driver of skill shortages, specifically, those firms setting higher entry requirements and thus recruiting a relatively low proportion of new and inexperienced graduates are the firms most likely to have vacancies that remain unfilled. Therefore, firms, by restricting their available pool of labour, through low levels of new graduate utilization, are leaving themselves more open to unfilled vacancies; McGuinness & Bonner (2002) also report this result. Finally, in keeping with our more descriptive analysis, skill shortages were found to be more common within the electronics sector.

A number of variables are unique to one or other of the measures of shortage, however, this was particularly the case within the unfilled vacancy model. The location variable was significant indicating that firms located in central Belfast, the main urban conurbation in Northern Ireland, are less likely to suffer from unfilled vacancies. This is perhaps unsurprising given that the regions universities are both located in the Belfast area thus providing increased access to a source of highly skilled and educated labour. Firms reporting unfilled vacancies were also more likely to view new labour market entrants from the regions educational and training institutions as being deficient in either, technical, interpersonal or business awareness skills. This negative perception is likely to influence the recruitment activities of firms and specifically, may result in firms restricting their available labour pool by holding out for more experienced staff which in turn increases the likelihood of an unfilled vacancy occurring. Again this result is consistent with the findings of McGuinness & Bonner (2002). Therefore, to conclude, whilst there are many similarities in the determinants of both measures of skill shortage, some differences are also present. On the grounds that both hard-to-fill and unfilled shortages may impact firms' behavior in different ways, it is also possible that both variables will generate distinct impacts with respect to productivity and therefore, whilst potentially correlated, they cannot be thought of as interchangeable.

< Insert Table 7 Here >

Firms reporting unfilled vacancies were then asked to outline the main difficulties arising as a result of these recruitment shortfalls. The impact on company performance was believed to be very important with the majority of firms reporting that their development was being constrained in one or more ways (Table 8). Over half of affected firms asserted that their organizations ability to meet deadlines was severely impeded with a further 47 per cent of firm's experiencing lower productivity as a direct result of unfilled vacancies, thus providing preliminary evidence of a link between skill shortages and output. Reduced credibility and higher running costs were also reported to be a direct result of skill shortages. Generally speaking, the results for the individual sectors broadly reflected those reported in Table 8.

< Insert Table 8 Here >

Finally, in terms of the policies introduced by firms when attempting to alleviate skill shortages (Table 9), the majority of affected firms did appear to have undertaken some form of longer-term strategy. Sixty-three per cent of firms were prepared to increase salary, with a further 58 per cent choosing to train and up-skill their existing staff to fill these positions. Forty-seven per cent of firms were also willing to recruit staff from other backgrounds and train with a third of firms stating that they would be willing to adjust internal structures and practices. Therefore, in addition to the obvious response of increasing wages, additional training and flexible HRM practices appear to have a very important role in combating skill shortages within the high tech sectors. In relation to the sub-sectoral analysis, the up-skilling of existing staff was the most common reaction within the IT and electronics sectors whilst the offering of higher wages was the dominant strategy within mechanical engineering[10].

< Insert Table 9 Here >

Productivity Impacts

Whilst the descriptive analysis indicates that just under 50 per cent of firms incurring unfilled vacancies believe that their productivity has been adversely affected, it is not always the case that such opinions are validated when tested within the context of econometric models (McGuinness & Bonner (2002)). Consequently, OLS models were estimated to assess the productivity / skills shortage relationship more formally both in the context of unfilled and hard-to-fill vacancies[11]. On the grounds that both variables were correlated and potentially highly endogenous with respect to each other, separate models were estimated on efficiency grounds. As before a parsimonious approach was adopted. Under both models it was found that productivity was lower the higher the R&D intensity of the firm, however, output per worker was higher if the firm was R&D intensive and large (Tables 10 and 11). Thus the interaction term indicates higher returns to scale in relation to R&D investment whereas the negative effect may indicate that many small firms within the sectors, all of which were experiencing rapid growth at the time of survey, were still very much in the investment stage of the R&D cycle. Externally owned firms were found to have higher productivity within both models. Over and above the R&D and foreign ownership effects, the models yielded slightly different results with the model containing hard-to-fill vacancies somewhat better specified than that including unfilled vacancies. Within the hard-to-fill vacancies specification firms less than two years old had higher productivity whilst a higher proportion of female graduates tended to lower output; within the unfilled vacancy model there was some evidence to suggest that firms employing a higher proportion of new and inexperienced graduates were less productive. The finding relating to new and inexperienced graduates is consistent with the findings of McGuinness & Bonner (2002) and would perhaps explain why firms are apparently willing to exclude this type of labour from their recruitment pool despite the fact that such a strategy will lead to unfilled and hard to fill vacancies (Table 6). The finding in relation to female graduates is slightly more contentious as it tends to suggest substantially lower rates of human capital accumulation amongst female professionals due, for example, to more demanding family commitment or periodic absences from the labour market. However, most significantly, despite the fact that almost half of firms (47 per cent) with unfilled vacancies reported that their productivity levels were being adversely affected, no statistical relationship was established. Conversely, we found that firms with hard-to-fill vacancies had higher productivity[12]. This result runs contrary to ex ante reasoning and previous studies in this area and, given the early descriptive evidence of Table 9, may lead us to believe that the HRM policies and organizational restructuring introduced to combat hard-to-fill vacancies have had the additional impact of improving productivity performance.

However, we also know from the bivariate probit that the probability of a firm experiencing skill shortages is not randomly distributed and, if this proves to be the case with respect to productivity, the results observed in Tables 10 and 11 may be biased. Given the lack of any obvious instrument for skill shortages, treatment models were estimated following the framework developed by Heckman (1979). The adopted methodology gets around the problem of selection bias by estimating a two stage model; stage 1 involves a probit model describing the key characteristics of firms experiencing skill shortages whereas stage 2 involves the productivity OLS augmented with a control term, drawn from stage 1, that explicitly accounts for any differences in the characteristics of firms experiencing skill shortages. Assuming the error terms from both models are drawn from a bivariate normal distribution we can derive the following:

$$E(P_i / x_{1i}, m_i = 1) = x_{1i}\beta_1 + \rho\sigma_1\lambda_i. \qquad (1)$$

Where P_i measures firm level productivity, m_i is a dummy variable indicating firm level unfilled / hard-to-fill vacancies, x_1 is a vector of explanatory variables, ρ is the correlation coefficient between the stage 1 and stage 2 error terms, σ_1 is the standard deviation of the probit model and λ_i is the Inverse Mills Ratio (IMR) given by:[13]

$$\lambda_i = \frac{\phi(x_{2i}\beta_2 / \sigma_2)}{\Phi(x_{2i}\beta_2 / \sigma_2)} \quad (2)$$

Where ϕ and Φ are density and distribution functions of the standard normal distribution and σ_2 is the standard deviation of the OLS. In order to ensure that the models were properly identified (see Himler, 2001) we used the evidence from the bivariate probit and the parsed productivity regressions to select at least one variable that, whilst determining the likelihood of a shortage occurring, had no impact on productivity. Consequently, the electronics variable was omitted from the unfilled vacancy model whilst the electronics and perceived shortages variables were omitted from the hard-to-fill treatment models[14].

The results of both treatment models are reported in Tables 12 and 13 with the results generally consistent with the bivariate probits and OLS models reported earlier with the critical exception of the skill shortage impacts within the selection consistent productivity models. The results reveal that firms experiencing skill shortages, of whatever kind, have ex ante productivity levels approximately 50 per cent higher than the average and that these skill shortages substantially reduce productivity levels by 65 per cent in the case of hard-to-fill vacancies and 75 per cent in the case of unfilled vacancies. The analysis thus provides weight to the assertion that skill shortages incur real costs on firms within key economic sectors and demonstrate that a failure to account for non-randomness in the incidence of skill difficulties can produce highly misleading results.

Summary and Conclusions

This paper sought to examine the extent and nature of both hard-to fill and unfilled vacancies amongst a group of high-tech firms and the extent to which such skill shortages impacted on productivity performance. Not surprisingly, problems of skill shortage were more acute for experienced graduates across each of the technical disciplines with firms attributing unfilled vacancies to a combination of supply side shortages and the existence of skill gaps amongst applicants. Consistent with the finding of previous research the results indicate that the determinants of skill shortage vary depending upon the definitional approach adopted, nevertheless, a high level of correlation was found. In relation to the impacts of skill shortages on firm level performance, it was found that ex ante high productivity firms were much more likely to experience skill shortages and that such labour market constraints had the effect of reducing productivity levels by between 65 and 75 per cent. The results suggest that skill shortages can almost completely eradicate the productivity advantage of the best performing high-tech firms. However, on the grounds that the highest rates of shortage were found for experienced professionals it is not clear that the solution to the problem is be found by simply expanding higher education supply, this is particularly the case given that many firms appear to actively desist from employing new graduates and are of the view that they are not being adequately equipped with the requisite skills at university. In support of the skills gap hypothesis there was some evidence of a productivity cost associated with employing large numbers of new graduates. Finally, from a methodological perspective, the results highlight the importance of controlling for selection effects when estimating the impact of labour market constraints on firm level performance.

< Insert Table 10 Here >

< Insert Table 11 Here >

< Insert Table 12 Here >

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[1] All financial information within the study is expressed in 2002 prices.

[2] 20 of our respondent firms were added by key informants and were classified within these SIC groups by IDBR.

[3] In addition to the IDBR firms, a further 4 firms employing 200 persons were added to the sample by key informants giving us a total of 81 IT firms for whom we have full information.

[4] Results available from the authors.

[5] Unfortunately a question was not asked on the reasons behind unfilled vacancies.

[6] The unfilled vacancy rate is calculated as (unfilled vacancies / employment + unfilled vacancies)*100

[7] Where 1 = Very Easy, 2 = Quite Easy, 3 = Difficult and 4 = Very Difficult.

[8] This variable was not restricted to professional level vacancies as only a few firms' reported unfilled vacancies at assembler level only; however, when the sample is restricted all subsequent findings hold.

[9] The authors point out that this finding was not detected in their previous studies, for example, Haskel & Martin (1993b).

[10] Results available from the authors.

[11] Due to incomplete information the sample size was reduced to 227. This consists of 162 firms who provided turnover information and a further 65 whose financial data was obtained from databases held within ERINI. All information is given at 2002 current prices.

[12] Given that unfilled vacancies and firms perceived hard-to-fill vacancies may be correlated and thus, in addition to being technically inefficient, may have been canceling each other out, we re-estimate the regression excluding one variable alternatively and we find our results are still robust (results available from authors).

[13] It should be noted that equation five was estimated using a maximum likelihood procedure which solves the model simultaneously as opposed to adopting a two-step process.

[14] The models were estimated in Stata using maximum likelihood.

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Table 1: Size Distribution of All Firms

Firm Size	N	% N	Employment	% Employment
1 – 20	89	37	895	3
21 – 50	64	26	2,139	5
51 – 150	48	20	4,234	11
151 – 500	19	8	4,915	12
501 – 1500	19	8	15,310	39
1501 +	3	1	11,835	30
Total	**242**	**100**	**39,328**	**100**

Source: ERINI, 2005

Table 2: Ease / Difficulty of Recruitment – All Firms (%)

	V Easy	Quite Easy	Difficult	V. Difficult	N
Operators / Assemblers	22	32	29	17	144
Non-Grad Tech Support – Level 3	26	32	29	13	120
Non-Grad Tech Support – HNC/D	24	31	29	17	108
Graduates with no experience	36	39	12	12	105
Graduates with < 2 yrs experience	29	28	26	18	98
Graduates with 2 + yrs experience	6	26	32	35	62
Project Leaders	13	19	34	35	107
Senior Managers	14	17	26	42	99

Source: ERINI, 2005

Table 3: Firms Describing Recruitment as Difficult / Very Difficult by Sector (%)

	Electronics	IT	Mechanical Engineering
Operators / Assemblers	42	-	49
Non-Grad Tech Support – Level 3	57	16	52
Non-Grad Tech Support – Level 4	51	10	59
Grads no experience	57	12	14
Grads < 2 yrs experience	78	24	48
Grads 2 + yrs experience	80	-	59
Project Leaders	82	58	66
Senior Managers	72	62	71

Table 4: Number and Rate of Unfilled Vacancies in last 12 months – All Firms (%)

	No. Firms	No. Vacancies	Total Employment	Vacancy Rate
Operators / Assemblers	22	168	18523	0.9
Non-Grad Technical Support – Level 3	24	109	6219	1.7
Non-Grad Technical Support – HNC / D	17	41	1244	3.2
Graduates with no experience	9	16	547	2.8
Graduates with < 2 yrs experience	7	19	2085	0.9
Graduates with 2 + yrs experience	16	44	932	4.5
Project Leaders	13	20	1352	1.5
Senior Managers	3	3	840	0.4
Total	60	420	31742	1.3

Source: ERINI, 2005

Table 5: Comparative Vacancy Rates

	Electronics	IT	Mechanical
Operators / Assemblers	1.3	-	0.5
Non-Grad Technical Support – Level 3	10.4	0	1.0
Non-Grad Technical Support – HNC / D	4	0	3.6
Graduates with no experience	12.1	0.6	0
Graduates with < 2 yrs experience	7.8	0	0
Graduates with 2 + yrs experience	14.3	-	0.4
Project Leaders	5.8	0.5	0.2
Senior Managers	0	0.4	0.5
Total	1.7	0.2	0.7

Source: ERINI, 2005

Table 6: Reasons for Unfilled Vacancies - All Firms (n= 60)[1]

%	Shortage of Qualified Applicants	Lack of Technical Ability	Shortage of Sufficient Experience	Cannot Pay Enough	Competition from Other Employers
Very Important	60	67	53	16	59
Important	20	21	33	30	21
Not Important	20	13	13	54	21

Source: ERINI, 2005

[1] The percentages in each of these tables below vary as not all firms were able to rate the level of importance for each reason given.

Table 7: Bivariate probit – Hard-to-Fill and Unfilled Vacancies

	Had-to-fill	Unfilled
Constant	-1.949 (0.427)***	-1.781 (0.429)***
Externally Owned (dummy)	-0.531 (0.305)*	-0.118 (0.300)
Located in Belfast (dummy)	-0.000 (0.28)	-0.579 (0.307)**
Technical staff share of total employment	-0.017 (0.581)	0.303 (0.572)
New and inexperienced graduate share of employment	-4.704 (2.830)*	-8.462 (4.056)**
Graduate project leader share of total employment	0.677 (1.271)	1.157 (1.378)
Lost workers to competitor companies (dummy)	-0.046 (0.286)	0.143 (0.293)
Perceived deficiencies in of new entrants (dummy)	0.034 (0.229)	0.477 (0.224)**
Mean technical salary (logged)	0.091 (0.029)***	0.067 (0.028)**
Proportion of Firms activity concentrated in R&D	-0.001 (0.006)	0.005 (0.006)
Firm is less than 2 years old (dummy)	-0.706 (0.506)	-1.185 (0.558)**
Female graduate share of total employment	1.634 (0.618)***	1.800 (0.751)**
Firm Size (logged)	0.072 (0.091)	0.064 (0.088)
Electronic Engineering Firm (dummy)	1.210 (0.294)***	1.057 (0.282)***
IT Firm (dummy)	-0.067 (0.375)	-0.710 (0.419)*
No. of Observations	242	
Wald Chi^2 (28)	68.89***	
ρ	0.620***	

Notes: The figures are regression coefficients with the standard errors in parentheses.
The significance of each coefficient is also noted, *** denotes significance at the 99% level; ** at the 95% level; and * at the 90% level.

Table 8: Difficulties Arising from Unfilled Vacancies (n=58)

%	Lower Productivity	Loss of Orders	Lower Quality Product	Higher Running Costs	Inability to Develop New Products	Failure to Meet Deadlines	Reduced Credibility
Very Important	47	34	28	43	31	57	43
Important	33	33	26	19	22	24	28
Not Important	21	33	47	38	47	19	29

Source: ERINI, 2005

Table 9: Actions Taken Regarding Unfilled Vacancies - All Firms (%)

	Total (n = 60)
Upskill Existing Staff	58
Increase Salary	63
Recruit from Other Backgrounds and Train	47
Recruit Less Qualified Persons	40
Change Internal Structure and Practices	33
Other	12

Source: ERINI, 2005

Table 10: Results from Productivity Level Regressions – Hard-to-Fill

	Unparsed	Parsed
Constant	10.986 (0.241)***	10.925 (0.074)***
Hard-to-fill Vacancies	0.318 (0.144)**	0.277 (0.128)**
Externally Owned (dummy)	0.428 (0.140)***	0.402 (0.109)***
Located in Belfast (dummy)	-0.041 (0.125)	
Technical staff share of total employment	-0.056 (0.269)	
New and inexperienced grad share of employment	-0.639 (0.615)	
Graduate project leader share of total employment	-0.481 (0.531)	
Lost workers to competitor companies (dummy)	0.037 (0.129)	
Perceived deficiencies in new entrants (dummy)	-0.097 (0.116)	
Participates in on-the-job training (dummy)	-0.046 (0.171)	
Participates in off-the-job training (dummy)	-0.029 (0.122)	
Proportion of Firms activity concentrated in R&D	-0.012 (0.006)**	-0.015 (0.005)***
Firm is less than 2 years old (dummy)	0.318 (0.198)	0.315 (0.185)*
Female graduate share of total employment	-0.522 (0.329)	-0.586 (0.280)**
Firm Size (logged)	0.021 (0.048)	
Firm size * Prop R&D	0.002 (0.001)*	0.003 (0.001)**
Electronic Engineering Firm (dummy)	-0.164 (0.146)	
IT Firm (dummy)	0.052 (0.184)	
No. of Observations	227	227
F-Stat	2.42***	6.13***
R^2	0.164	0.143

Notes: The figures are regression coefficients with the standard errors in parentheses. The significance of each coefficient is also noted, *** denotes significance at the 99% level; ** at the 95% level; and * at the 90% level.

Table 11: Results from Productivity Level Regressions - Unfilled

	Unparsed	Parsed
Constant	11.015 (0.243)***	10.978 (0.070)***
Firm has Unfilled Vacancies (dummy)	0.082 (0.136)	
Externally Owned (dummy)	0.382 (0.140)***	0.402 (0.109)***
Located in Belfast (dummy)	-0.033 (0.127)	
Technical staff share of total employment	-0.038 (0.273)	
New and inexperienced grad share of employment	-0.725 (0.622)	-0.960 (0.508)*
Graduate project leader share of total employment	-0.448 (0.537)	
Lost workers to competitor companies (dummy)	0.040 (0.130)	
Perceived deficiencies in new entrants (dummy)	-0.090 (0.119)	
Participates in on-the-job training (dummy)	-0.077 (0.172)	
Participates in off-the-job training (dummy)	-0.012 (0.123)	
Proportion of Firms activity concentrated in R&D	-0.012 (0.006)**	-0.012 (0.005)**
Firm is less than 2 years old (dummy)	0.322 (0.200)	
Female graduate share of total employment	-0.381 (0.327)	
Firm Size (logged)	0.024 (0.048)	
Electronic Engineering Firm (dummy)	-0.099 (0.147)	
IT Firm (dummy)	0.017 (0.186)	
Firm size * Prop R&D	0.002 (0.001)*	-0.002 (0.001)*
No. of Observations	227	227
F-Stat	2.11***	7.39***
R^2	0.146	0.1175

Notes: The figures are regression coefficients with the standard errors in parentheses. The significance of each coefficient is also noted, *** denotes significance at the 99% level; ** at the 95% level; and * at the 90% level.

Table 12: Results from Treatment Model for Hard-to-Fill Vacancies

Results from Probit:	
Constant	-1.408 (0.412)***
Externally Owned (dummy)	-0.762 (0.309)**
Located in Belfast (dummy)	0.103 (0.277)
Technical staff share of total employment	0.668 (0.524)
Lost workers to competitor companies (dummy)	0.154 (0.261)
New and inexperienced graduate share of total employment	-5.326 (3.439)
Graduate project leader share of total employment	-0.376 (1.207)
Perceived deficiencies in the quality of new entrants (dummy)	0.306 (0.223)
Proportion of Firms activity concentrated in R&D	-0.012 (0.015)
Firm is less than 2 years old (dummy)	-0.607 (0.502)
Female graduate share of total employment	2.579 (0.797)***
Firm size * prop R&D	0.004 (0.004)
Firm Size (logged)	0.041 (0.092)
Electronic Engineering Firm (dummy)	0.981 (0.264)***
IT Firm (dummy)	-0.691 (0.389)*
Results from Selection Model:	
Constant	11.048 (0.243)***
Firm has Hard-to-Fill Vacancies (dummy)	-0.641 (0.240)***
Externally Owned (dummy)	0.320 (0.140)**
Located in Belfast (dummy)	-0.046 (0.132)
Technical staff share of total employment	0.050 (0.283)
Lost workers to competitor companies (dummy)	0.034 (0.136)
New and inexperienced graduate share of total employment	-1.013 (0.655)
Graduate project leader share of total employment	-0.355 (0.560)
Perceived deficiencies in the quality of new entrants (dummy)	-0.025 (0.123)
Female graduate share of total employment	-0.001 (0363)
Participates in on-the-job training (dummy)	-0.043 (0.167)
Participates in off-the-job training (dummy)	0.008 (0.115)
Proportion of Firms activity concentrated in R&D	-0.012 (0.006)*
Firm is less than 2 years old (dummy)	0.327 (0.209)
Firm Size (logged)	0.036 (0.050)
Firm size * Prop R&D	0.002 (0.002)*
IT Firm (dummy)	-0.113 (0.189)
Λ	0.563 (0.125)
Wald Chi^2 (16)	39.14***
No. of Observations	227

Notes: The figures are regression coefficients with the standard errors in parentheses. The significance of each coefficient is also noted, *** denotes significance at the 99% level; ** at the 95% level; and * at the 90% level.

Table 13: Results from Treatment Model for Unfilled Vacancies

Results from Probit:	
Constant	-1.319 (0.433)***
Externally Owned (dummy)	-0.147 (0.285)
Located in Belfast (dummy)	-0.487 (0.300)*
Technical staff share of total employment	0.873 (0.521)*
Lost workers to competitor companies (dummy)	0.258 (0.270)
New and inexperienced graduate share of total employment	-6.968 (3.936)*
Graduate project leader share of total employment	-0.098 (1.373)
Perceived deficiencies in the quality of new entrants (dummy)	0.556 (0.203)***
Proportion of Firms activity concentrated in R&D	-0.005 (0.016)
Firm is less than 2 years old (dummy)	-1.012 (0.543)*
Female graduate share of total employment	2.148 (0.789)***
Firm Size (logged)	0.032 (0.092)
Firm size * prop R&D	0.003 (0.003)
IT Firm (dummy)	-0.956 (0.402)**
Electronic Engineering Firm (dummy)	0.871 (0.248)***
Results from Selection Model:	
Constant	11.117 (0.246)***
Firm has unfilled vacancies (dummy)	-0.753 (0.272)***
Externally Owned (dummy)	0.380 (0.139)***
Located in Belfast (dummy)	-0.128 (0.135)
Lost workers to competitor companies (dummy)	0.036 (0.135)
Technical staff share of total employment	0.125 (0.284)
Graduate project leader share of total employment	-1.089 (0.652)*
Participates in on-the-job training (dummy)	-0.066 (0.169)
Participates in off-the-job training (dummy)	-0.010 (0.115)
Proportion of Firms activity concentrated in R&D	-0.011 (0.006)*
Female graduate share of total employment	-0.021 (0.359)
Firm is less than 2 years old (dummy)	0.295 (0.208)
Firm Size (logged)	0.042 (0.050)
Firm size * prop R&D	0.003 (0.002)*
IT Firm (dummy)	-0.201 (0.197)
Λ	0.529 (0.156)
Wald Chi^2 (15)	39.39***
No. of Observations	227

Notes: The figures are regression coefficients with the standard errors in parentheses. The significance of each coefficient is also noted, *** denotes significance at the 99% level; ** at the 95% level; and * at the 90% level.