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Fast-growing firms, product strategies and skills development

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Abstract

This paper draws on matched data from the National Employers Skill Survey (NESS) and the Business Structure Database (BSD) to examine the impact of workforce skills and training on firm growth. Firm growth in both employment and sales is found to be significantly positively related to the deployment of skill-intensive product strategies. In seeking to meet their skill requirements, fast-growing firms are found to engage in substantial training of their employees as well as searching for skilled workers on the open market. This substantial investment in training both precedes rapid growth and persists during the growth period (in spite of the high opportunity costs of providing training during working time when sales are growing rapidly). The assets and capabilities that firms require in order to be able to grow fast appear to equip them well to deal with the skills challenges that are part and parcel of rapid expansion.

JEL Classification: J24, L25

Keywords: Firm growth, skills, product strategy

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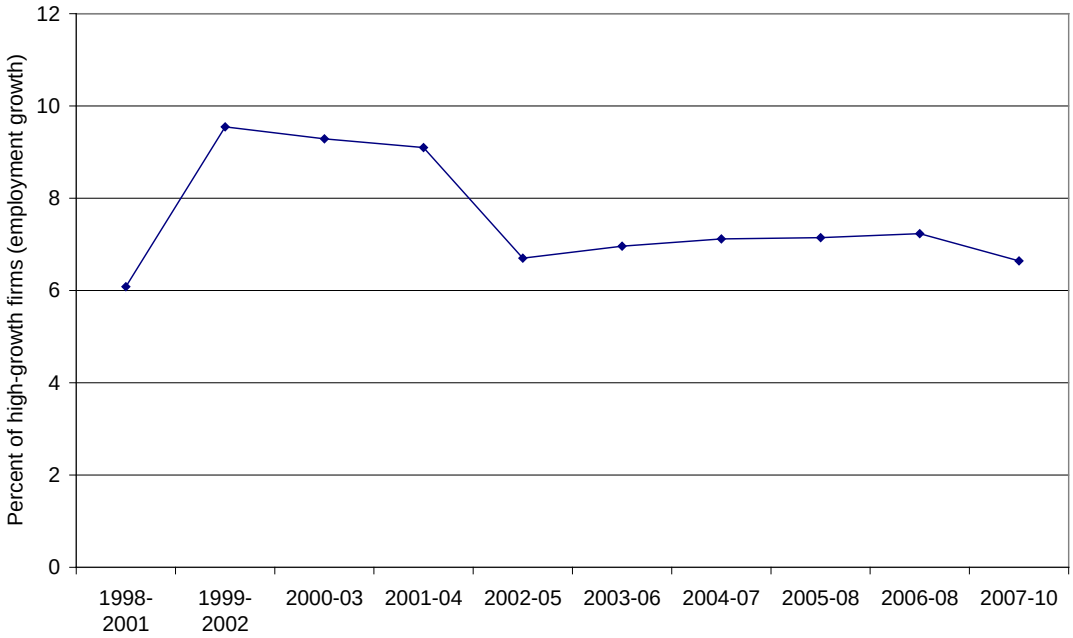
1. Introduction

Even during periods of recession and stagnation in the overall economy, a small proportion of firms manage to achieve relatively high rates of growth. In the UK during 2007-10 which included one year of recession (2008-09) and another of slow growth (2009-10), as many as 6.6% of firms with 10 or more employees could be classed as 'high-growth firms' (HGFs) according to the standard OECD definition of this term – that is, they maintained average annual growth rates in employment of 20% or more throughout the three-year period. This was down only slightly from the 7.1% of firms which achieved HGF status in the three years (2005-08) before the recession began (Figure 1.1).

Figure 1.1: Proportion of firms achieving high-growth firm (HGF) status in terms of employment growth, UK, 1998-2001 to 2007-2010



Source: Derived from ONS, Business Structure Database.

Notes: High-growth firms refer to firms with average annual growth rates in employment of 20% or more throughout each three-year period. Estimates are based on firms which had 10 or more employees in the starting year of each period and were classified as 'active' in the Business Structure Database in both the starting and finishing years of each period. Firms and organisations in the following sectors are not included: agriculture, forestry and fishing; public administration; health; education and social work. Firms are also excluded if they began life during the starting year of each period.

In more detail the distributions of firm growth rates during each of the three years between 2007-10 are shown in Table 1.1. In the case of employment growth, there are

signs of declining growth rates in the lower reaches of the distribution in 2008-09 but declines in growth rates at the upper end of the distribution do not become apparent until 2009-10 (Table 1.1, Part A). Similarly, in the case of sales performance, declines in growth rates are greatest in 2009-10 (Part B). But even in this year of relatively slow overall growth in employment and sales, the top 10% of firms still achieved rapid rates of growth in either employment or sales or both. This relative success of some firms in a recessionary period adds to the importance of learning more about the sources of success for fast-growing firms.

Table 1.1: Annual growth rates in firm employment and sales, BSD, 2007-10

A: Employment growth rates

	2007-08	2008-09	2009-10
Mean	-5.3	-6.6	-8.7
10th percentile	-28.8	-31.8	-35.7
25th percentile	-6.9	-6.9	-10
50th percentile	0	0	0
75th percentile	5.5	6.9	4.8
90th percentile	22.3	24.5	20.5
n =	*187271*	*188127*	*190332*

B. Sales growth rates

	2007-08	2008-09	2009-10
Mean	-0.5	1.0	-3.3
10th percentile	-30	-26.1	-34.8
25th percentile	-10.2	-6.6	-12.4
50th percentile	-0.4	2.6	-0.4
75th percentile	12	15	11.3
90th percentile	32.6	34.8	31.8
n =	*186850*	*187708*	*189894*

Source: Derived from ONS, Business Structure Database.
Notes: Refers to sales in constant 2005 prices. See notes to Figure 1.1 for details of the firms and organisations covered in these estimates.

Recent research in the UK, using data from the Business Structure Database (BSD) has shown that HGFs are found across a wide range of different size groups, sectors and regions (Anyadike-Danes et al, 2009). Two key characteristics on which fast-growing firms differed sharply from slower-growing firms were youthfulness and innovativeness. Relatively young firms aged five years or less were over-represented in the HGF category while rapid firm growth was also found to be closely linked to prior investments in innovation and in the development of innovation-related skills and capabilities (Mason et al, 2009).

These links between firm growth and innovation-related skills and capabilities raise many questions about the impact of skills in general on firm growth and the means by which fast-growing firms seek to meet their skill requirements. However, as yet this facet of firm growth has received little attention from researchers. In this paper we draw on recent data from the National Employers Skill Survey (NESS) to examine the relationship between firm growth and skills development in detail. By matching NESS data against firm-level data in the BSD we are able to explore the extent to which rapid firm growth is rooted in the development and implementation of skill-intensive high value added product strategies. We are also able to use the matched data to examine how fast-growing firms actually meet their skill requirements and to investigate whether firm growth is constrained by different kinds of skill deficiency.

Specifically, we set out to address the following main questions:

- How do fast-growing firms differ from slower-growing firms in terms of product strategy and other elements of business strategy?
- How much does rapid firm growth depend on prior training of firms' own employees?
- Are fast-growing firms heavy trainers of their own employees or do they tend to rely on external recruitment to meet their skill needs?
- Do their commitments to employee training change as their experience of rapid growth is prolonged?
- Is there any evidence that firm growth is restricted by the presence of skill-related external recruitment difficulties or internal skill gaps among their existing workers?

The paper is ordered as follows. In Section 2 we briefly review recent theoretical and empirical literature on product strategies, skills, training and firm performance and set out the main hypotheses to be tested in our analysis. Section 3 outlines our main data sources and presents descriptive statistics on the key variables of interest. Section 4 discusses research methods and sets out our main empirical specifications. Section 5 presents the results of multivariate analyses on the relationships between firm growth and, respectively, product strategies and skills, employer-provided training, skill deficiencies and the persistence of investments in training. Section 6 summarises our main findings.

2. Theory, empirical evidence and hypotheses

In recent decades research has emphasised the role of 'dynamic capabilities' in enabling firms to compete successfully in changing markets and thus grow at above average rates, for example, the skills and knowledge required for new product development, improvement of production processes and organisational routines and the ability to identify and make effective use of relevant new knowledge (Teece et al, 1997; Eisenhardt and Martin, 2001). For example, established firms may achieve faster growth by successfully combining high levels of workforce skills with other intangible assets with which they are complementary. US evidence suggests that workforce skills contribute positively to firm-level performance in part by complementing the introduction of new technologies and forms of business organisation (Abowd et al, 2002; Bresnahan et al, 2002). Focussing on European firms, Brandenburg et al (2007) find that innovation performance at firm level is enhanced by a combination of skills and R&D investments while Cassiman and Veugelers (2006) identify a complementarity between internal R&D activities and the skills required for successful acquisition of external knowledge acquisition.

At the same time, rapid growth in itself may create new and different skill requirements for firms, in particular, relatively new and small fast-growing firms. As such firms strive to achieve a minimum level of activity which will ensure survival and then go beyond that point, they encounter a succession of problems inherent in the scaling-up of operations which call on a very different set of managerial and workforce skills to those required for the initial foundation and development of the firm (Penrose, 1959). The ability of initially fast-growing firms to cope with such problems may well depend on active steps taken to increase learning capabilities within each firm, for example, through investments in training and innovation (Ericson and Pakes, 1995; Jensen and McGuckin, 1997).

Similar connections between the development of innovation-related assets and skills emerge in recent studies of UK firms which have found average skill levels to be significantly and positively related to measures of product strategy derived from NESS data. The term 'product strategy' is widely used to refer to the choices made by

firms about product or service differentiation within particular markets. For example, some firms may attempt to compete on high-specification products at premium prices in certain markets while others target the lower-priced end of those markets or opt for a medium-price strategy. In addition, firms may vary in the extent to which they seek to compete through new product development and other forms of innovation rather than rely on existing products or services.

Using data from NESS 2009, Mason (2011) develops an index of product strategy at establishment level which is based on survey respondents' evaluations of how their establishments compare against others in their industry in terms of three different variables which are highly correlated with each other: their lack of dependence on price in order to achieve competitive success; their involvement in 'premium quality' production as compared to 'standard or basic quality' production; and the extent to which they are innovation leaders in their industries. These estimates show that firms tend to rank more highly on the product strategy index if their principal target markets are international or national in scale rather than confined to local or regional areas. Furthermore, the product strategy index is found to be strongly positively correlated with an index of employee skills at establishment level. This suggests that 'high-end' or 'high value added' product strategies – involving premium quality products and high levels of innovation – are more skill-intensive in nature than are low-end product strategies.

Firms' choices of specialist products and target markets are key components of strategic decision-making that may affect firm growth rates. In the case of new small firms that succeed in growing beyond an initial survival phase to reach a stage of successful operations, these choices are linked to strategic decisions regarding their immediate future: whether to seek to grow organically or whether to pursue other objectives such as growth through mergers or acquisitions, acceptance of a takeover by a larger firm or stability at present size levels (Churchill and Lewis, 1983). More established firms also need to strategise effectively in order to respond to emerging market opportunities while continuing to compete effectively in product markets in which they have previously invested and which still possess growth potential (O'Reilly and Tushman, 2007).

At all stages of firm development, resource- and knowledge-based theories of the firm suggest that the successful implementation of organic growth strategies requires firms to develop products which are superior and/or cheaper than those of rivals, hard for others to duplicate or imitate and well suited to the markets in which opportunities have been identified (Teece et al, 1997; Phelan and Lewin, 2000; Teece, 2007). In this context firms which score well in terms of key elements of the product strategy measure mentioned above – in particular, innovation leadership and involvement in 'premium quality' production – seem most likely to achieve and maintain rapid growth. Using NESS data matched to the BSD, we are able to submit this proposition to empirical scrutiny by testing the following hypothesis:

H1: All else being equal, firm growth is positively related to the deployment of 'high-end' product strategies [as measured by the NESS-based indicator of product strategy described above]

As noted earlier, there is strong research evidence that firm growth benefits from combining high levels of workforce skills with other intangible assets with which they are complementary. However, as yet, there has been little investigation into how fast-growing firms acquire the skills they need to succeed and, in particular, the extent to which they meet skill requirements by providing training for their employees rather than seeking to recruit skilled workers on the open market. On the one hand, fast-growing firms are likely to be working at high levels of capacity utilisation which will increase the opportunity costs (eg, foregone output) of providing training during working hours (Hoeckel, 2008; Grund and Martin, 2010). These pressures on working time may well encourage external recruitment. On the other hand, the firm-specific nature of the superior products and/or production techniques required for firms to achieve rapid growth may make it essential to commit resources to staff training and development, both for existing staff and for new recruits that are hired.

Economic theory is therefore ambiguous on the question of how much training fast-growing firms will provide. However, given the importance of the firm-specific skills and competences that are needed to support rapid growth, we couch our second hypothesis to be tested as follows:

H2: All else being equal, firm growth is positively related to prior investments in workforce training

Since concerns about the opportunity costs involved in training may intensify for firms which find themselves experiencing long periods of rapid growth, we also examine evidence relating to a third hypothesis:

H3: All else being equal, the level of training provided by fast-growing firms tends to decline in later stages of rapid-growth periods

Finally, we are interested in exploring whether firm growth is restricted by skill deficiencies of different kinds or whether fast-growing firms simply manage to overcome any skill deficiencies that they encounter. NESS data distinguish between two kinds of skill deficiency, one relating to difficulties in recruiting skilled workers in the open labour market and the other relating to 'internal skill gaps' which are defined in terms of existing employees lacking the full proficiency required to do their jobs. Since fast-growing firms are more likely to be in recruitment mode than slower-growing firms, the probability of them encountering skills-related recruitment difficulties is high. The empirical question of interest is whether such difficulties inhibit firm growth. The second type of skill deficiency – skill gaps among existing employees – seems sure to have negative rather than positive effects on firm growth performance. Here the empirical question of interest is the relative importance of these negative effects compared to other factors affecting firm growth in a multivariate context. These issues are explored by testing the following hypotheses:

H4: All else being equal, firm growth is negatively related to the incidence of skills-related recruitment difficulties

H5: All else being equal, firm growth is negatively related to the presence of internal skill gaps

3. Data sources and descriptive statistics

The main data sources for our analysis are the National Employers Skill Survey (NESS) carried out in 2007 and 2009 and the Business Structure Database (BSD).

NESS 2007 and NESS 2009 are nationally representative telephone surveys of establishments in England with at least two people working in them. In total some 79,012 establishments were surveyed in 2007 and 79,152 establishments in 2009. In most establishments with 100 or more employees the principal respondents were senior managers in human resource or personnel departments; in smaller establishments the respondents tended to be owners or general managers (Shury et al, 2010).

Both NESS 2007 and NESS 2009 contain data on training provision and different types of skill deficiency (skills-related recruitment difficulties and internal skill gaps) as described above. However, data on innovation leadership and other components of the product strategy measure are only found in NESS 2009 as are data on geographical market focus and workforce qualifications (which can be used to construct a proxy measure of skill levels).

The BSD is an experimental database constructed by the ONS by utilising snapshots of the Inter-Departmental Business Register (IDBR) each year to construct a panel dataset. The IDBR itself amounts to a census of all firms that are registered for tax purposes in the UK. Among other things the BSD contains employment and sales data for firms between 1998-2010 as well as information on the years of firm births and deaths.

Establishments in NESS 2007 and NESS 2009 were matched to firms in the BSD which had ten or more employees in 2007 and continued to be classified as ‘active’ by the ONS in 2010. In total some 19.3% (15250) of NESS 2007 establishments and 22.3% (17489) of NESS 2009 establishments were matched to BSD firms. There are three main reasons for this level of attrition. First, not all establishments participating in NESS gave permission for their survey responses to be used in data matching

exercises. Second, not all the NESS establishments who were willing to participate could be matched to enterprise reference numbers by the ONS. Third, not all NESS establishments with enterprise reference numbers could be matched to BSD firms which met our chosen employment size and activity criteria. [1]

As a result of these sources of attrition, Table 3.1 shows that, compared with the full NESS samples, the two matched NESS-BSD samples have lower shares of establishments in the under 10 employees size group and in business services and community, social and personal services. Conversely, the two matched samples have slightly larger shares of establishments in retail/wholesale and hotels. However, in both cases the matched samples contain a wide spread of sectors and size groups and in subsequent multivariate analyses we are able to control for the impact of these and other establishment characteristics on firm growth.

Table 3.1: Comparison of full NESS 2007 and 2009 samples against matched NESS-BSD 2007-10 samples

A: Analysis by employment size-group

	NESS 2007	**BSD-NESS 2007**	**NESS 2009**	**BSD-NESS 2009**
	Percentages			
2-9	55	24	52	25
10-24	22	33	21	31
25-49	12	22	14	23
50-99	6	11	7	11
100-199	3	6	3	6
200-250	1	2	1	2
251-499	1	2	1	2
500+	1	1	1	1
Total	**100**	**100**	**100**	**100**
n =	*79018*	*17489*	*79152*	*15250*

[1] See notes to Figure 1.1 for details of these selection criteria. The sectors which were excluded by design from the matched samples were agriculture, forestry and fishing; public administration; health; education and social work.

B: Analysis by sector (a)

	NESS 2007	BSD-NESS 2007	NESS 2009	BSD-NESS 2009
	Percentages			
Manufacturing	16	17	15	16
Other production industries	1	0.3	0.4	0.3
Construction	8	6	8	7
Retail, wholesale	26	31	24	29
Hotels and restaurants	8	11	9	12
Transport, storage and communications	7	7	7	7
Financial services	3	3	4	4
Business services	20	16	21	18
Community, social and personal services	11	7	11	7
Total	**100**	**100**	**100**	**100**

Source: National Employers Skill Survey 2007 and 2009; Business Structure Database 2007-10
Note: (a) Sectoral comparison in Part B excludes establishments in sectors which were excluded by design from the matched sample (agriculture, forestry and fishing; public administration; health; education and social work).

Figures 3.1-3.4 show descriptive statistics on the relationship between firm growth rates between 2007-2010 (derived from the BSD) and summary measures of product strategy, skills and training provision in matched NESS establishments. [2]

Following Mason (2011), the summary measure of product strategy is based on NESS 2009 respondents' answers to questions which invited them to say where their establishment was positioned on different four- or five-point scales -- as compared to other establishments in the same industries -- in respect of the following characteristics:

1. product quality - the extent to which the establishment competed in a 'premium quality' product market as compared to a 'standard or basic quality' product market (5-point scale)
2. innovation leadership - the extent to which the establishment 'tend(ed) to lead the way' in the development of new products, materials or techniques (4-point scale)

[2] As noted above, survey questions relating to the three components of our product strategy measure and to workforce qualifications (which serve as a basis for our skills measure) were included in the NESS 2009 questionnaire but not in the NESS 2007 questionnaire.

3. lack of dependence on low prices for competitive success (5-point scale, with high values denoting that competitive success depended very little on low prices)

These three sets of responses were all highly correlated with each other and factor analysis showed that three separate measures derived from these responses all loaded onto a single factor which was readily interpretable as a summary measure of product strategy.

Figure 3.1 shows a strong positive correlation between this measure of product strategy and average annual growth rates in both employment and sales at firm level, with the highest mean product strategy scores being reached in the upper quartile of the growth rate distributions. [3] Figures A1-A3 in Annex A show similar patterns of correlation between firm employment and sales growth and each of the three components of the product strategy score.

Skill levels are defined on the basis of a wage-weighted qualifications index in which 'effective units of labour' are calculated relative to the unskilled category as follows:

(3.1) $skills = [\sum_{i=1}^{3} w_i q_i] / N$

where three different qualification groups are identified; w_i = mean hourly earnings of qualifications group i (indexed to unity in the case of the 'low qualifications' group); q_i= numbers employed in qualifications group i and N = total employment in each establishment. [4] This approach rests on an underlying assumption that all labour markets are competitive and that relative wages reflect the marginal products of different categories of labour.

[3] In fact, the highest mean product strategy scores are achieved by firms in the top five percentiles of the employment and sales growth distributions which correspond loosely with the HGF category. However, the differences between firms in the top five percentiles and firms in the 75-94th percentiles are not statistically significant at the 95% confidence interval. By contrast, the mean product strategy scores for firms in the upper quartiles of both the employment and sales growth distributions are significantly higher at the 95% level than the mean product strategy scores for firms in all quartiles below the 75th percentile.

[4] Mean hourly earnings for three qualification groups were estimated as follows (Index numbers): Low, Other or No Qualifications: 100; NVQ3: 117; and NVQ4 and above:181 (Source: Labour Force Survey, 2009).

A summary measure of overall training provision is derived through a factor analysis of four indicators of training provision:

- Whether establishments arrange or fund *either* on- *or* off-the-job training (Yes/No)
- Whether establishments arrange or fund *both* on- and off-the-job training (Yes/No)
- Proportion of staff receiving training of some kind
- Training intensity: average number of days training per employee arranged or funded by establishment

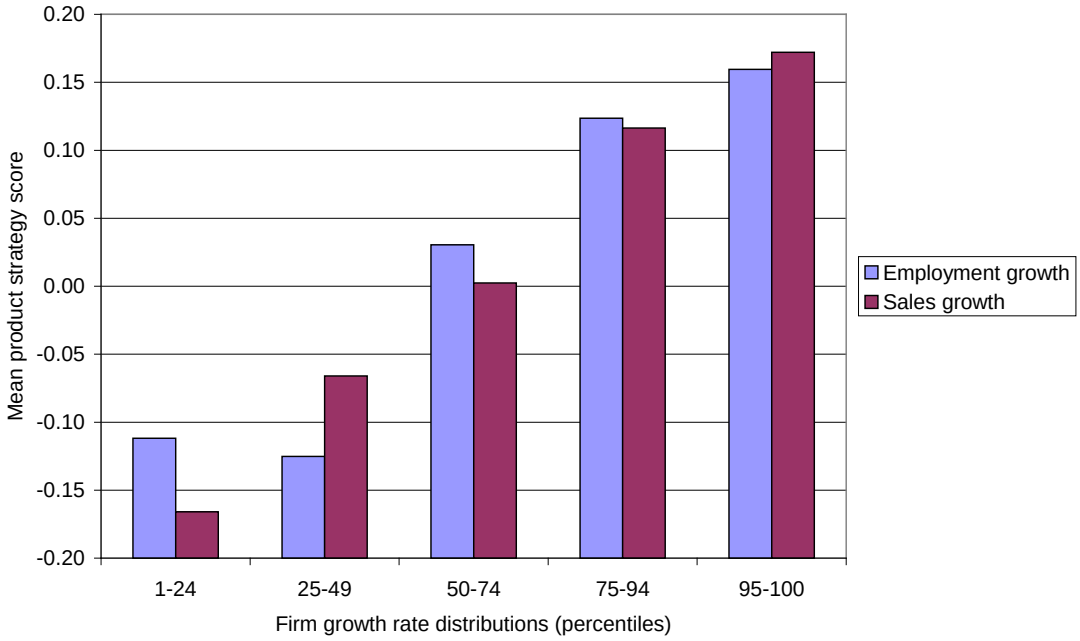
Since NESS respondents were asked to estimate the proportion of training which was devoted solely to health, safety and induction training,[5] a second summary measure of training which excludes those three types of routine training can also be estimated.

Average annual growth rates in employment and sales are also positively related to measured skill levels, albeit with a stronger correlation in the top half of the firm growth distributions than in the bottom half (Figure 3.2). Fast-growing firms are also more likely to provide training than slower-growing firms, irrespective of whether the training measure is adjusted to exclude health, safety and induction training (Figures 3.3-3.4).

We now go on to explore whether these apparently strong relationships between firm growth, high-end product strategies, skill levels and training provision hold up in the context of multivariate analysis.

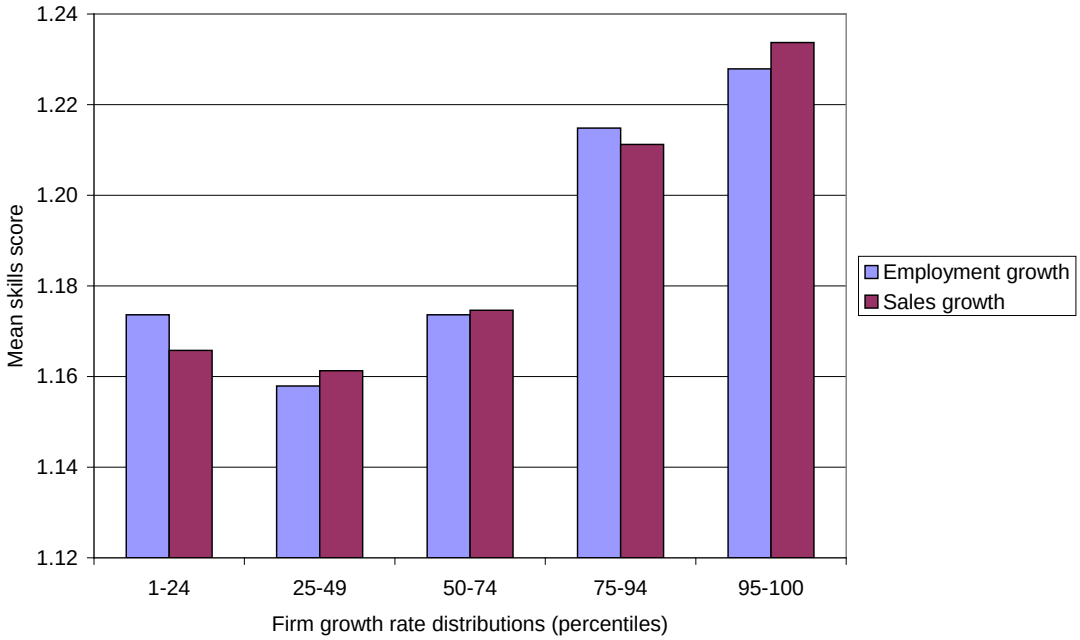
[5] 'Induction training' typically refers to short periods of training for new employees which are designed to familiarise them with basic aspects of their new workplaces. It rarely takes the form of substantive training. The relevant survey questions in NESS bracket induction training together with health and safety training and do not distinguish between them.

Figure 3.1: Mean product strategy score, 2009, analysed by quantiles of firm growth rate distributions, 2007-2010



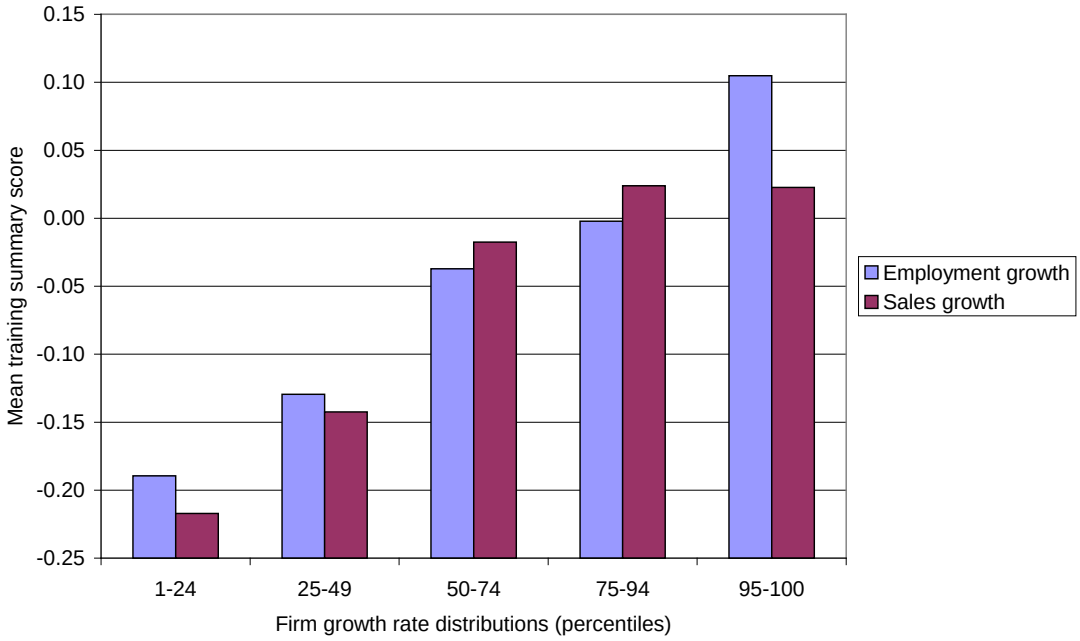
Source: NESS 2009, BSD 2007-10
Notes: Firm-weighted estimates. The product strategy score is a standardised factor score with mean zero and standard deviation of one; see main text for details of how this measure was derived.

Figure 3.2: Mean skills score, 2009, analysed by quantiles of firm growth distributions, 2007-2010



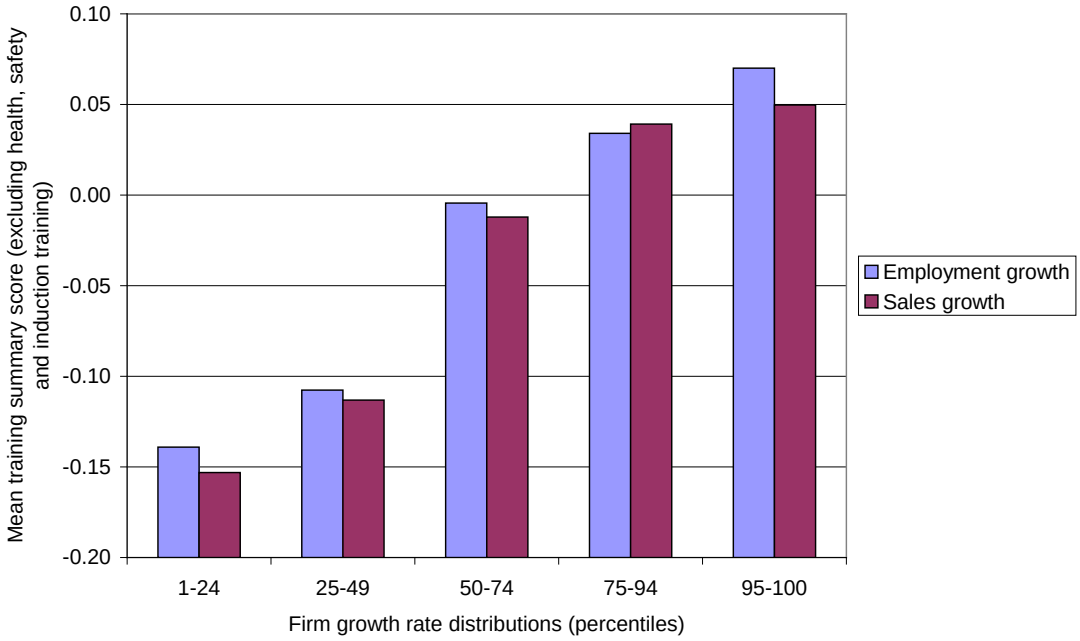
Source: NESS 2009, BSD 2007-10
Notes: Firm-weighted estimates. The skills score is a wage-weighted index of employee qualifications which ranges from 1.00 (when all employees are qualified at levels at NVQ2 or lower) to 1.81 (when all employees are qualified at NVQ Level 4 or above; see main text for details of how this measure was derived.

Figure 3.3: Mean training summary score, 2007, analysed by quantiles of firm growth distributions, 2007-2010



Source: NESS 2007, BSD 2007-10
Notes:
Firm-weighted estimates. The training summary score is a standardised factor score with mean zero and standard deviation of one; see main text for details of how this measure was derived.

Figure 3.4: Mean training summary score (excluding health, safety and induction training), 2007, analysed by quantiles of firm growth distributions, 2007-2010



Source: NESS 2007, BSD 2007-10
Notes:
Firm-weighted estimates. The training summary score is a standardised factor score with mean zero and standard deviation of one; see main text for details of how this measure was derived.

4. Empirical specifications and methodological issues

In order to test the hypotheses set out in Section 2, we estimate a series of empirical models which take, respectively, employment growth and sales growth as dependent variables. These growth rates are derived from BSD data and are defined for firm *i* at time *t* as follows:

(4.1) $EmpGrowth_{it} = \ln(Emp_{it}) - \ln(Emp_{i,t-1})$

(4.2) $SalesGrowth_{it} = \ln(Sales_{it}) - \ln(Sales_{i,t-1})$

Sales are expressed in constant 2005 prices. All analyses are confined to private sector establishments excluding agriculture, forestry and fishing.

Using NESS 2009-BSD matched data we first explore the relationship between firm employment growth and product strategies by estimating the following model:

(4.3)

$$EmpGrowth_{it} = \beta_0 + \beta_1 PS_{it} + \beta_2 Skills_{it} + \beta_3 \sum_j Mkt_{jit} + \beta_4 Training_{it} + \beta_5 \sum_k X_{kit} + \varepsilon_1$$

where *PS* is a summary measure of product strategy, *Skills* is a wage-weighted qualifications index denoting skill levels, Mkt_j is a vector of *j* geographic market focus variables, *Training* is a measure of training provision and X_k is a vector of *k* firm-specific characteristics such as employment size, age, sector, region and whether the organisation is a single-establishment enterprise. Note that this model can only be estimated as a cross-section because NESS data on product strategies and skill levels are only available for a single year (2009). Similar models are also estimated taking $SalesGrowth_{it}$ as dependent variable.

We then draw on NESS 2007-BSD matched data to evaluate the relationship between firm growth and measures of training and skill deficiency:

(4.4) $EmpGrowth_{it} = \beta_0 + \beta_1 Training_{i,t-1} + \beta_2 \sum_k X_{ki,t-1} + \varepsilon_1$

(4.5) $EmpGrowth_{it} = \beta_0 + \beta_1 Training_{i,t-1} + \beta_2 \sum_c SkillCon_{ci,t-1} + \beta_3 \sum_k X_{ki,t-1} + \varepsilon_1$

where $SkillCon_c$ is a vector of *c* indicators of skill constraints such as skills-related recruitment difficulties and internal skill gaps. In these estimations we focus on firm growth between 2008-10 rather than 2007-10 in order to reduce the simultaneity (time-related interdependence) between training provision in 2007 and firm growth. Similar models are then estimated using NESS 2009-BSD matched data to explore the

persistence of training and skill deficiencies towards the end of the growth period under consideration.

One methodological problem to be resolved is that NESS data are derived from establishment-level survey responses whereas BSD data relate to firms. In each matched sample about a third of NESS establishments are single-site firms so, in these cases, there is no disparity between establishments and firms. However, about 40% of NESS respondents across the 2007 and 2009 surveys are part of multi-site firms which have two or more establishments in the sample. And another 28% of NESS respondents to these surveys are part of multi-site firms but are the only establishments from their organisations in the sample.

In order to deal with the fact that each matched sample contains a mix of establishment-level and firm-level data, a weighting procedure was devised which assumes that all establishments are representative of the firms to which they belong. First, establishments which are part of multi-site firms with two or more establishments in the sample are weighted by their shares of total firm employment in the sample. Second, establishments which are part of multi-site firms but are the only establishment from their organisation in the sample are given a weight of one as are single-site firms. In subsequent regression analyses standard errors are then corrected for clustering at firm level to adjust for the fact that some firms in each matched sample are represented by more than one establishment.

Another methodological issue concerned the fact that the two matched NESS-BSD datasets are separate from each other because we lack the information required to identify establishments which were included in both NESS 2007 and NESS 2009. Rather than be confined to cross-sectional analysis of each matched NESS-BSD dataset, we seek to take advantage of the time series element of the BSD data by exploring the determinants of firm growth through a two-stage process:

First, we explore the relationship between employment (sales) growth and lagged sales (employment) growth between 2008-2010 by estimating reduced-form vector auto-regression (VAR) models of the kind suggested by Coad (2010), namely:

$$(4.6.1)\quad \begin{aligned} EmpGrowth_{it} &= \beta_0 + \beta_1 EmpGrowth_{i,t-1} + \beta_2 SalesGrowth_{i,t-1} \\ &+ \beta_1 EmpGrowth_{i,t-2} + \beta_2 SalesGrowth_{i,t-2} + \varepsilon_1 \end{aligned}$$

Because equations of this kind are expressed in first differences, we are able to take account of firm fixed effects (unobserved time-invariant heterogeneity) during this first stage of the estimation.

Second, following the method employed by Black and Lynch (2001) and other researchers using datasets with a similar mix of time series and cross-sectional data, the residuals from the first-stage equation (which capture unexplained variation in the dependent variable) are regressed against measures of training and other firm-level characteristics which are only available for a single year:

$$(4.6.2)\quad \mathrm{Re}\,siduals(EmpGrowth_{it}) = \beta_0 + \beta_1 Training_{i,t-1} + \beta_2 \sum_k X_{ki,t-1} + \varepsilon_2$$

In the analyses which follow, this two-stage estimation method provides a more solid test of the robustness of statistical inferences than would cross-sectional analysis on its own. In the first stage the relationship between employment growth and sales growth between 2008-10 is estimated net of the effects of unobserved heterogeneity between firms. In the second stage we examine some of the factors which account for variation in firm growth which is left unexplained by the first stage estimates. In this stage we are able to reduce the potential effects of time-related interdependence between training provision and firm growth by regressing the residuals from the 2008-10 growth estimates on 2007 values of different measures of training. We also take some account of possible endogeneity of the training measures by the use of instrumental variables in the second-stage equation.

Descriptive statistics for all variables used in this regression analysis are set out in Annex B.

5. Multivariate analyses

5.1 Firm growth, product strategies and skills

Standard OLS estimates of Equation 4.3 are shown in Table 5.1. They suggest that firm growth in employment is positively and significantly related to indices of both product strategy and skills (Part A). These findings are robust to the inclusion of different measures of training and to interaction terms which capture the effects of combining employment of skilled workers (defined in terms of formal qualifications) with employer-provided training to supplement the skills that workers bring with them when they are first recruited. [6] When controlling for the interaction of skills and training, a one standard deviation increase in the product strategy score is associated with a 0.68 percentage point (pp) increase in employment growth rates (Table 5.1A, Column 3). In the same specification a one standard deviation increase in the skills index is associated with a 0.52 pp increase in employment growth rates. [7] Quantile regression estimates suggest that product strategies are significantly positively related to firm growth in sales across the whole growth distribution while skills are positively significantly related to firm growth in employment in the top half of the distribution (Table 5.2A). All these models control for the geographical range of markets in which firms are competing and a number of other firm-level characteristics which might be expected to affect firm growth (such as sector, employment size, firm age and region).

In the case of sales growth, the coefficients on product strategy and skills in the main regressions are positively signed but fall short of statistical significance (Table 5.1B). However, quantile regressions point to significant positive links between sales growth and product strategies at several points across the sales growth distribution while, as

[6] A positive significant coefficient attached to the skills*training interaction term suggests that the growth effects of training provision are enhanced when the workers receiving training are already well-qualified. The results for employment growth indicate that this effect is found when training is measured by the summary measure of training (Table 5.1A, Columns 3-4) but not when training is measured solely by the average number of days training per employee (Columns 5-6).

[7] Recall that the wage-weighted skills index defined in Section 2 ranges from 1.00 (when all employees are qualified at levels at NVQ2 or lower) to 1.81 (when all employees are qualified at NVQ Level 4 or above, eg, at Foundation or Bachelor degree level). Evaluated at the mean, a one standard deviation increase in the skills index equates to raising the average qualification level of employees from 1.18 (equivalent to NVQ Level 3) to 1.39, bridging about a third of the gap between Level 3 and Level 4+.

with employment growth, skills are positively significantly related to firm growth in sales in the top half of the distribution (Table 5.2B).

These findings therefore provide strong support for Hypothesis 1 which posited that, all else being equal, firm growth is positively related to the deployment of 'high-end' product strategies. Given that high values of the product strategy index -- derived from indicators of innovation leadership, product quality and the ability to compete effectively without resort to low prices – imply high levels of skill requirements, it is of considerable interest to learn more about how fast-growing firms seek to acquire those skills.

5.2 Firm growth and employer-provided training

In order to implement skill-intensive product strategies, firms have two main options open to them in seeking to obtain the skills they need. Either they can rely primarily on external recruitment of skilled workers or they can devote resources to training of their existing workers and new recruits. In order to examine the role and importance of employer provided training to firm growth, we first carry out standard OLS estimates of Equation 4.3 using training data derived from NESS 2007. We then go on to implement the two-stage approach described in Equations 4.6.1-2 which, as described above, makes use of the time series element in the BSD data to control for firm fixed effects. As noted above, in both sets of estimates, we confine attention to firm growth in the 2008-10 period in order to better assess the importance of *prior* investment in workforce training for firm growth.

Initial OLS results suggest that training provision is positively and significantly related to subsequent firm growth in the case of employment growth (Table 5.3, Column 1). The estimated marginal effect of a one standard deviation increase in the training summary measure is to increase firm employment growth rates by 0.57 percentage points. The coefficient on the training summary variable in the sales growth equation is of a similar size and sign but falls short of statistical significance (Column 2). These findings therefore provide initial support for Hypothesis 2 – that, all else being equal, firm growth is positively related to prior investments in workforce training – in the case of employment growth.

Table 5.1: OLS analysis of firm growth, product strategies and skills

A: Employment growth

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**
Product strategy, 2009	0.0074***	0.0066***	0.0068***	0.0068***	0.0073***	0.0071***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Skills index, 2009	0.0296**	0.0257**	0.0251**	0.0232*	0.0272**	0.0289**
	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]	[0.013]
Regional market, 2009	0.0113**	0.0106*	0.0110*	0.0112*	0.0111*	0.0110*
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
National/international markets, 2009	0.0091*	0.0092*	0.0095*	0.0092*	0.0089*	0.0084
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Training - summary score, 2009		0.0066***	-0.0234**			
		[0.002]	[0.011]			
Skills*Training summary, 2009			0.0258***			
			[0.010]			
Training (non-HSI) - summary score, 2009				-0.0187		
				[0.012]		
Skills*Training (non-HSI) summary, 2009				0.0213**		
				[0.010]		
Training intensity, 2009					-0.0003	
					[0.001]	
Skills*Training intensity, 2009					0.0004	
					[0.001]	
Training intensity (non-HSI), 2009						0.0009
						[0.001]
Skills*Training intensity (non-HSI), 2009						-0.0002
						[0.001]
Observations	12,215	12,140	12,140	11,856	12,215	11,915
Adj R2	0.0623	0.0632	0.0639	0.062	0.0625	0.0614
SEE	0.1809	0.1809	0.1808	0.1807	0.1809	0.1807

Sources: NESS 2009, BSD 2007-10
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted OLS estimates. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region. The reference category for geographical market focus variables is local markets. The training (non-HSI) measure refers to training excluding health, safety and induction training.

B. Sales growth

Dependent variable:	Sales growth, 2007-10	Sales growth, 2007-10	Sales growth, 2007-10	Sales growth, 2007-10	Sales growth, 2007-10	Sales growth, 2007-10
Product strategy, 2009	0.0045	0.0037	0.004	0.004	0.0045	0.0039
	[0.003]	[0.004]	[0.004]	[0.003]	[0.003]	[0.004]
Skills index, 2009	0.0219	0.0167	0.0158	0.0132	0.0199	0.0175
	[0.030]	[0.030]	[0.030]	[0.029]	[0.031]	[0.032]
Regional market, 2009	0.0137	0.013	0.0135	0.0144	0.0135	0.0135
	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]
National/international markets, 2009	0.0258***	0.0261***	0.0266***	0.0273***	0.0257***	0.0261***
	[0.007]	[0.007]	[0.007]	[0.008]	[0.007]	[0.008]
Training - summary score, 2009		0.0051	-0.0384			
		[0.004]	[0.024]			
Skills*Training summary, 2009			0.0374*			
			[0.020]			
Training (non-HSI) - summary score, 2009				-0.0532**		
				[0.024]		
Skills*Training (non-HSI) summary, 2009				0.0451**		
				[0.020]		
Training intensity, 2009					-0.0003	
					[0.001]	
Skills*Training intensity, 2009					0.0003	
					[0.001]	
Training intensity (non-HSI), 2009						-0.0002
						[0.001]
Skills*Training intensity (non-HSI), 2009						0.0005
						[0.001]
Observations	12,192	12,117	12,117	11,834	12,192	11,893
Adj R2	0.0541	0.0542	0.0545	0.0543	0.054	0.0537
SEE	0.35	0.3507	0.3507	0.3525	0.35	0.352

Sources: NESS 2009, BSD 2007-10

Notes:

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

Firm-weighted OLS estimates. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region. The reference category for geographical market focus variables is local markets. The training (non-HSI) measure refers to training excluding health, safety and induction training.

Table 5.2: Quantile analysis of firm growth, product strategies and skills

A: Employment growth

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**	**Employ-ment growth, 2007-10**
	10th percentile	**25th percentile**	**50th percentile**	**75th percentile**	**90th percentile**
Product strategy, 2009	0.0071***	0.0057***	0.0061***	0.0039**	0.0037
	[0.003]	[0.002]	[0.001]	[0.002]	[0.003]
Skills index, 2009	-0.0296**	0.0019	0.0235***	0.0590***	0.0730***
	[0.014]	[0.008]	[0.005]	[0.010]	[0.018]
Regional market, 2009	0.0027	0.0042	0.0042	0.0110**	0.0204**
	[0.008]	[0.005]	[0.003]	[0.005]	[0.009]
National/international markets	-0.0097	-0.0023	0.001	0.0062	0.0111
	[0.007]	[0.004]	[0.002]	[0.004]	[0.008]
Training - summary score	-0.0139	-0.0022	-0.0095*	-0.0227**	-0.0440***
	[0.015]	[0.008]	[0.006]	[0.010]	[0.017]
Skills*Training summary	0.0139	0.0039	0.0103**	0.0260***	0.0471***
	[0.012]	[0.007]	[0.005]	[0.008]	[0.014]
Observations	12,140	12,140	12,140	12,140	12,140

B: Sales growth

Dependent variable:	**Sales growth, 2007-10**	**Sales growth, 2007-10**	**Sales growth, 2007-10**	**Sales growth, 2007-10**	**Sales growth, 2007-10**
	10th percentile	**25th percentile**	**50th percentile**	**75th percentile**	**90th percentile**
Product strategy	0.0096***	0.0075***	0.0044***	0.0053***	0.0073**
	[0.002]	[0.001]	[0.001]	[0.002]	[0.003]
Skills index	-0.0230*	-0.0011	0.0141*	0.0426***	0.0494***
	[0.014]	[0.007]	[0.008]	[0.009]	[0.018]
Regional market	0.0036	-0.0012	0.0023	0.0156***	0.0175*
	[0.008]	[0.004]	[0.004]	[0.005]	[0.010]
National/international markets	-0.0024	-0.0041	0.0101***	0.0269***	0.0488***
	[0.006]	[0.003]	[0.003]	[0.004]	[0.008]
Training - summary score	-0.0353**	-0.0131*	-0.0069	-0.0096	-0.0086
	[0.014]	[0.007]	[0.008]	[0.009]	[0.019]
Skills*Training summary	0.0352***	0.0156**	0.0082	0.0134*	0.014
	[0.012]	[0.006]	[0.006]	[0.007]	[0.016]
Observations	12,117	12,117	12,117	12,117	12,117

Sources: NESS 2009, BSD 2007-10
Notes: *** p<0.01, ** p<0.05, * p<0.1
Firm-weighted quantile regression estimates. Standard errors in brackets. All models include controls for single-site enterprises, employment size, firm age, sector and region. The reference category for geographical market focus variables is local markets.

Table 5.3: OLS regressions of 2008-10 firm growth on 2007 training provision and firm-level controls

Dependent variable:	Employment growth, 2008-10	Sales growth, 2008-10
Training (summary measure), 2007	0.0057**	0.0057
	[0.003]	[0.007]
Single-site establishment	-0.0156***	0.0082
	[0.005]	[0.017]
Size10_24	0.0236***	0.0241*
	[0.007]	[0.014]
Size25_49	0.0363***	0.0462**
	[0.008]	[0.021]
Size50_99	0.0294***	0.0434*
	[0.010]	[0.023]
Size100_199	0.0046	0.0303
	[0.011]	[0.025]
Size200_499	0.0046	0.1954*
	[0.011]	[0.102]
Size500-plus	0.001	0.0098
	[0.020]	[0.024]
Age_2 years	-0.0631	-0.0912
	[0.064]	[0.095]
Age_3 years	-0.0749	-0.1171
	[0.061]	[0.105]
Age_4 years	-0.047	-0.1397
	[0.070]	[0.091]
Age_5 years	-0.0027	-0.1616*
	[0.067]	[0.094]
Age_6-9 years	-0.0812	-0.1802**
	[0.060]	[0.088]
Age_10-19 years	-0.1031*	-0.2117**
	[0.060]	[0.087]
Age_20-plus years	-0.1239**	-0.2135**
	[0.059]	[0.088]
Observations	13088	13081
Adj R2	0.0229	0.009
SEE	0.2209	0.6056

Sources: NESS 2007, BSD 2008-10
Notes: *** p<0.01, ** p<0.05, * p<0.1
Firm-weighted OLS estimates. Robust standard errors in brackets are corrected for clustering on firm. All independent variables are for 2007. All models include controls for sector and region. The reference category for establishment size group variables is under 10 employees. For the firm age group variables the reference category is one year old. The training summary score is a standardised factor score with mean zero and standard deviation of one; see Section 3 of main text for details of how this measure was derived.

First stage vector auto-regression (VAR) results based on panel data analysis of BSD data for 2008-2010 suggest that the impact of lagged employment growth on current sales growth (Table 5.4, Column 2) is considerably stronger than is the impact of lagged sales growth on current employment growth (Column 1). For example, 10% growth in employment is associated with sales growth of 1.8% in the following year, almost three times higher than the estimated impact of sales growth on subsequent employment growth. The implication that employment growth tends to precede sales growth (more than the other way round) mirrors the relationship between employment and sales growth which Coad (2010) found in his analysis of French manufacturing firms.

When the residuals from the VAR equations are regressed on 2007 training variables and firm-level controls, the results (shown in Table 5.5) continue to provide support for Hypothesis 2 in the case of employment growth and are robust to the use of alternative training measures which exclude health, safety and induction training and which capture the intensity of training provision (defined as the average number of days training per employee). However, these second-stage results still provide only limited support for Hypothesis 2 in the case of sales growth (Table 5.6). For example, the coefficient on the training summary measure in the sales growth equation is statistically significant when health, safety and induction training are included as part of training but not when they are excluded (Columns 1-2). In addition, it is only at the upper end of the training intensity distribution that prior training intensity is found to be significantly positively related to sales growth (Columns 3-4).

Since we have concerns about the potential endogeneity of the training measures, Table 5.7 reports Instrumental Variable (IV) estimates of the second-stage equations. Here training summary measures are instrumented by a measure of barriers to training[8] and by rank order versions of themselves. The rank order terms possess the two key properties required of instruments in that, first, they are highly correlated with the original training measures and, second, they are purged of 'errors in variables' (measurement error) which makes them less likely to be related to the error

[8] This measure of training barriers encountered by firms is based on responses to NESS 2007 Question E23 which asked firms that did not do any training to state what barriers to training they had encountered and Questions E24a-b which asked firms that had done training whether they were doing as much training as they would like and, if not, what the barriers preventing training were.

terms in the main regressions (Durbin, 1954; Johnston, 1972). The validity of these instruments is supported by test statistics shown in Table 5.7. [9]

Overall, the IV estimates continue to support Hypothesis 2 in relation to firm employment growth (Table 5.7, Columns 1 and 3) and provide new support for this hypothesis in respect of sales growth as well (Columns 2 and 4). However, the relevant C statistics cast doubt on the endogeneity of the training summary measures and suggest that OLS estimates are to be preferred to IV. Thus we still conclude that prior training has a greater impact on employment growth than sales growth.

Table 5.4: Vector autoregression estimates of firm growth, 2008-2010

Dependent variable:	Employment growth rate	Sales growth rate
Employment growth (t-1)	-0.0287***	0.1778***
	[0.005]	[0.007]
Sales growth (t-1)	0.0675***	-0.1735***
	[0.004]	[0.005]
Employment growth (t-2)	-0.0224***	0.1022***
	[0.004]	[0.006]
Sales growth (t-2)	0.0447***	-0.0879***
	[0.003]	[0.004]
Observations	44297	44297
Adj R2	0.0106	0.0405
SEE	0.3154	0.4334

Sources: BSD 2008-2010
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted vector autoregression estimates. The dependent variables are annual rates of growth. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region.

[9] Note that for each equation shown in Table 5.7, Breusch-Pagan tests clearly reject a null hypothesis of homoscedasticity (p<0.001). In the presence of heteroscedasticity, Hansen J tests of overidentifying restrictions are an appropriate test of instrument validity and the C statistic is an appropriate test of the potential endogeneity of selected regressors (Baum et al, 2003).

Table 5.5: OLS regressions of 2008-10 employment growth residuals from VAR equations on 2007 training variables and firm-level controls

Dependent variable:	Employment growth (residuals)	Employment growth (residuals)	Employment growth (residuals)	Employment growth (residuals)
Training (summary measure)	0.0074***			
	[0.002]			
Training, excluding HSI training (summary measure)		0.0065***		
		[0.002]		
Training intensity - 2nd quartile			0.0104**	
			[0.005]	
Training intensity - 3rd quartile			0.0111**	
			[0.005]	
Training intensity - upper quartile			0.0151***	
			[0.005]	
Training intensity (excl. HSI) - 2nd quartile				0.0117**
				[0.005]
Training intensity (excl. HSI) - 3rd quartile				0.0115**
				[0.005]
Training intensity (excl. HSI) - upper quartile				0.0128**
				[0.006]
Observations	40492	39500	40492	39500
Adj R2	0.0071	0.0071	0.0068	0.0069
SEE	0.3094	0.3107	0.3095	0.3107

Sources: NESS 2007, BSD 2008-10
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted OLS estimates. The dependent variables are the residuals from the employment growth equation shown in Table 5.4, Column 1. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region. The reference categories for the training intensity variables are the lower quartiles on these measures. HSI training refers to health, safety and induction training.

Table 5.6: OLS regressions of 2008-10 sales growth residuals from VAR equations on 2007 training variables and firm-level controls

Dependent variable:	Sales growth (residuals)	Sales growth (residuals)	Sales growth (residuals)	Sales growth (residuals)
Training (summary measure)	0.0061**			
	[0.002]			
Training, excluding HSI training (summary measure)		0.004		
		[0.003]		
Training intensity - 2nd quartile			0.0078	
			[0.007]	
Training intensity - 3rd quartile			0.0055	
			[0.007]	
Training intensity - upper quartile			0.0158**	
			[0.007]	
Training intensity (excl. HSI) - 2nd quartile				0.0093
				[0.007]
Training intensity (excl. HSI) - 3rd quartile				0.0086
				[0.007]
Training intensity (excl. HSI) - upper quartile				0.0176**
				[0.007]
Observations	40491	39499	40491	39499
Adj R2	0.0112	0.0113	0.0111	0.0113
SEE	0.4307	0.4328	0.4307	0.4328

Sources: NESS 2007, BSD 2008-10
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted OLS estimates. The dependent variables are the residuals from the sales growth equation shown in Table 5.4, Column 2. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region. The reference categories for the training intensity variables are the lower quartiles on these measures. HSI training refers to health, safety and induction training.

Table 5.7: Instrumental variables (IV) regressions of 2008-10 employment and sales growth residuals from VAR equations on 2007 training variables and firm-level controls

Dependent variable:	Employment growth (residuals)	Sales growth (residuals)	Employment growth (residuals)	Sales growth (residuals)
Training (summary measure)	0.0085***	0.0061**		
	[0.002]	[0.003]		
Training, excluding HSI training (summary measure)			0.0075***	0.0057**
			[0.002]	[0.003]
Observations	38748	38747	37804	37803
Hansen J test	0.8485	1.1043	1.0381	1.0203
Hansen P value	0.3570	0.2933	0.3083	0.3124
C statistic	0.0689	1.9002	0.0534	0.0834
C statistic P value	0.7929	0.1681	0.8172	0.7727
Kleibergen-Paap LM statistic	3977.10	3976.83	4132.50	4132.38
Kleibergen-Paap P value	<0.000	<0.000	<0.000	<0.000

Sources: NESS 2007, BSD 2007-10
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted instrumental variables estimates; see main text for descriptions of the instruments which are used. The dependent variables are the residuals from the employment and sales growth equations shown in Table 5.4. Robust standard errors in brackets are corrected for clustering on firm. HSI training refers to health, safety and induction training. All models include controls for single-site enterprises, employment size, firm age, sector and region. In the presence of heteroscedasticity (clearly indicated by Breusch-Pagan tests for all models shown), the Hansen J statistic is an appropriate test of the null hypothesis of instrument validity. The C statistic tests the null hypothesis that potentially endogenous regressors are in fact exogenous. The Kleibergen-Paap LM statistic tests the null hypothesis that the matrix of reduced-form coefficients in the first-stage regression is under-identified.

5.3 Is firm growth held back by skill deficiencies?

As discussed in Section 2, there is considerable interest in learning more about whether firm growth is restricted by prior deficiencies in skills, for example, skills-related recruitment difficulties and/or internal skill gaps. In order to assess the impact of such deficiencies, we enter measures of these two different types of skill shortfall into new versions of the second-stage Equation 4.6.2. Focussing first on NESS 2007 indicators of skill deficiency, we find that firm employment growth between 2008-10 is positively and significantly related to skills-related recruitment difficulties. In the case of internal skill gaps the relevant coefficients are negatively signed but not statistically significant (Table 5.8, Columns 1, 3 and 5). Firm sales growth is found to be significantly positively related to skills-related recruitment difficulties in a specification which does not control for training provision (Column 2) but is not significantly associated with either kind of skill deficiency in other specifications (Columns 4 and 6).

Thus we find no support using NESS 2007 data for Hypotheses 4 and 5 which posited negative effects of skills-related recruitment difficulties and internal skill gaps on firm growth. Although firms which are growing fast in terms of employment are clearly more likely than slower-growing firms to encounter skills-related recruitment difficulties, it is clear that they usually find ways of surmounting them, presumably including the heavy involvement in employee training which was identified in Section 5.2.

Another possibility is that rapid firm growth actually contributes to skill deficiencies since fast-growing firms might be expected to encounter new problems and difficulties which call for different skills and knowledge than those they possessed when they first began to grow. When we turn to NESS 2009 data to examine the relationship between skill deficiencies and ongoing firm growth, we again find a significant positive relationship between employment growth and skills-related recruitment difficulties (Table 5.9, Columns 1, 3 and 5). However, there is no significant relationship between sales growth and skills-related recruitment difficulties, and neither employment growth nor sales growth is significantly related to internal skill gaps. We now go on to examine the extent and nature of changing

skill needs as firms grow and the ways in which fast-growing firms seek to deal with them.

Table 5.8: OLS regressions of 2008-10 employment and sales growth residuals from VAR equations on 2007 measures of skill deficiency and firm-level controls

Dependent variable:	Employment growth (residuals)	Sales growth (residuals)	Employment growth (residuals)	Sales growth (residuals)	Employment growth (residuals)	Sales growth (residuals)
Skills-related recruitment difficulties	0.0181***	0.0133*	0.0166***	0.0064	0.0164***	0.0056
	[0.006]	[0.008]	[0.006]	[0.008]	[0.006]	[0.008]
Internal skill gaps	-0.0015	0.0069	-0.0041	0.0044	-0.0042	0.0046
	[0.004]	[0.005]	[0.004]	[0.006]	[0.004]	[0.006]
Training (summary measure)			0.0071***	0.0057**		
			[0.002]	[0.003]		
Training, excluding HSI training (summary measure)					0.0065***	0.0042
					[0.002]	[0.003]
Observations	42687	42686	39474	39473	38517	38516
Adj R2	0.0066	0.0105	0.0071	0.0106	0.0071	0.0108
SEE	0.3127	0.432	0.3092	0.4322	0.3105	0.4342

Sources: NESS 2007, BSD 2008-10
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted OLS estimates. The dependent variables are the residuals from the employment and sales growth equations shown in Table 5.4. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region. For definitions of skills-related recruitment difficulties and internal skill gaps, see Section 2 of the main text. HSI training refers to health, safety and induction training.

Table 5.9: OLS regressions of 2008-10 employment and sales growth residuals from VAR equations on 2009 measures of skill deficiency and firm-level controls

Dependent variable:	Employment growth (residuals)	Sales growth (residuals)	Employment growth (residuals)	Sales growth (residuals)	Employment growth (residuals)	Sales growth (residuals)
Skills-related recruitment difficulties	0.0157*	0.019	0.0152*	0.0184	0.0155*	0.0172
	[0.009]	[0.014]	[0.009]	[0.014]	[0.009]	[0.014]
Internal skill gaps	0.0024	0.0074	0.0008	0.0062	0.0019	0.0071
	[0.004]	[0.005]	[0.004]	[0.005]	[0.004]	[0.005]
Training (summary measure)			0.0048**	0.0039		
			[0.002]	[0.002]		
Training, excluding HSI training (summary measure)					0.0048**	0.0021
					[0.002]	[0.003]
Observations	39221	39212	38938	38929	37954	37946
Adj R2	0.0125	0.0164	0.0128	0.0164	0.0124	0.0164
SEE	0.2984	0.3989	0.2988	0.3994	0.2995	0.3967

Sources: NESS 2009, BSD 2008-10
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted OLS estimates. The dependent variables are the residuals from the employment and sales growth equations shown in Table 5.4. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region. For definitions of skills-related recruitment difficulties and internal skill gaps, see Section 2 of the main text. HSI training refers to health, safety and induction training.

5.4 The persistence of investments in training by fast-growth firms

Since concerns about the opportunity costs involved in training may intensify for firms which find themselves experiencing long periods of rapid growth, we hypothesised in Section 2 that, all else being equal, the level of training provided by fast-growing firms tends to decline in later stages of rapid-growth periods (Hypothesis 3). We first consider some of the evidence relating to this proposition by examining survey responses on skill updating needs and how they are met by firms.

In NESS 2009 respondents were asked whether they expected that, over the next 12 months, any of their employees would need to acquire new skills or knowledge as a result of various factors which were read out in turn. Examples included new products and new work practices. Those who responded affirmatively to at least one type of skills updating need were then asked to identify the single occupation most affected by such needs, and to indicate which of a list of different types of skills were most in need of improvement for the occupation they had selected.

As many as 69% of all establishments in NESS 2009 reported having skill updating needs compared to 19% who reported internal skill gaps and only 3% who were experiencing skills-related recruitment difficulties at the time of the survey (Shury et al, 2010). [10] The most important factors driving skill updating needs were new legislative or regulatory requirements, the introduction of new goods or services, new work practices and new technologies and increased competitive pressure in general. When asked about the specific nature of the skills that needed updating, respondents cited a wide range of generic skills (such as customer-handling, team-working, problem-solving and communication skills), technical, practical or job-specific skills and management skills.

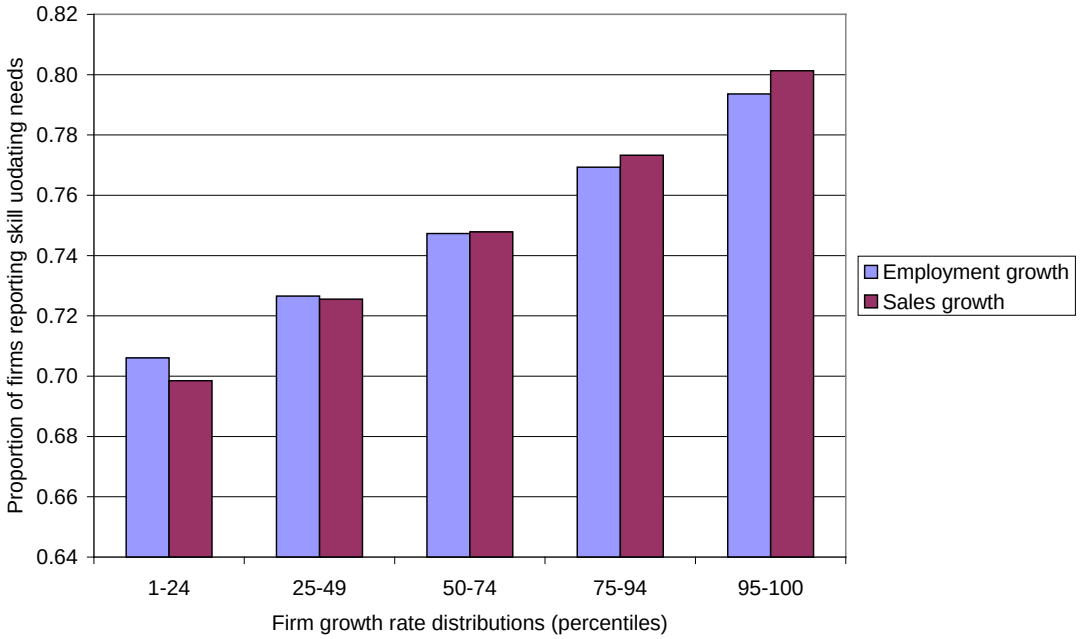
Figure 5.1 shows that, in the NESS 2009-BSD matched sample, both employment and sales growth were positively correlated with the incidence of reported skill updating

[10] The 3% figure for skills-related recruitment difficulties may seem low but this reflects the way that the NESS survey question on this topic is worded. Respondents are asked to report on whether their firms have vacancies which are hard-to-fill for skills-related reasons at the specific point in time of the survey. The question does not refer to a longer time period such as, for example, the previous 12 months. At a given point in time only a minority of firms report having a vacancy of any kind (the proportion reporting vacancies in NESS 2009 was 11%).

needs. [11] What effect did the relatively high level of skill updating needs among fast-growing firms have on training provision in 2009? Figures 5.2 and 5.3 show strong positive links between training provision in 2009 and firm growth in both employment and sales between 2007-10. Interestingly, the link between training and rapid growth in sales during this period appears to be stronger in 2009 than in 2007 (see Figures 3.3-3.4 for comparison). Furthermore, estimates of the determinants of training provision in 2009 suggest that training provision was significantly positively correlated with both employment and sales growth at firm level, with the relationship apparently stronger in respect of sales growth than employment growth (Table 5.10), which contrasts with the findings for training provision in 2007. This inference is sensitive to the specification used which takes training levels in the lower quartiles of firm growth distributions as reference categories for the firm growth indicators, and therefore further analysis needs to be carried out before making a strong comparison of the links between sales growth and training in 2007 and 2009. However, it is clear that there is no support for Hypothesis 3 which posited that, all else being equal, the level of training provided by fast-growing firms tends to decline in later stages of rapid-growth periods

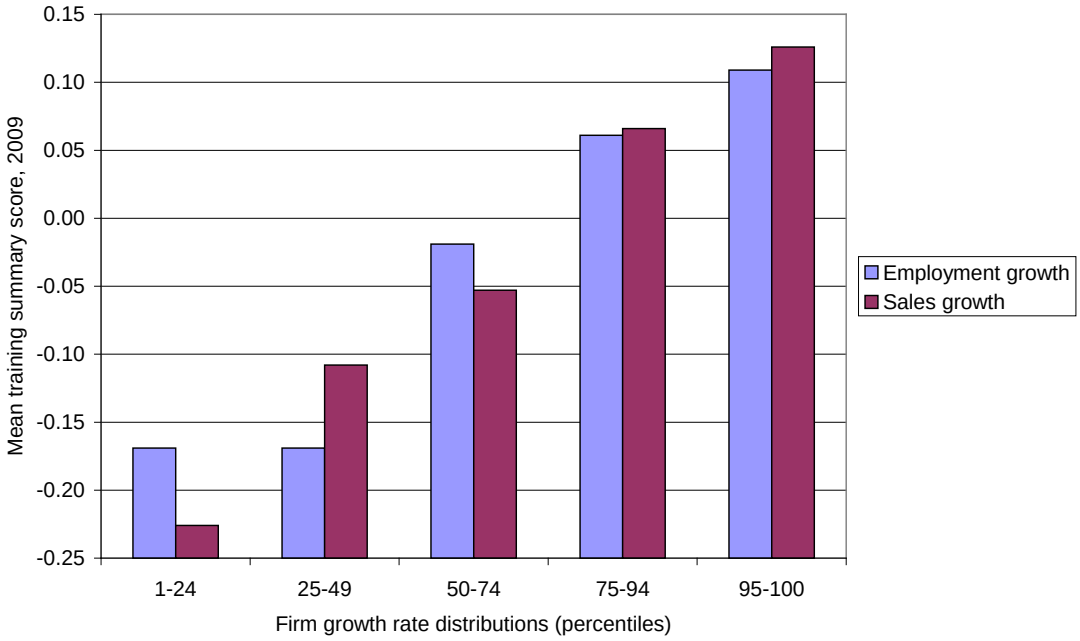
[11] The differences in incidence of skill updating needs between the fastest-growing firms (75th-100th percentiles) and the slowest-growing firms (1st-49th percentiles) are statistically significant at the 95% level in terms of both employment growth and sales growth.

Figure 5.1: Incidence of skill updating needs, 2009, analysed by quantiles of firm growth distributions, 2007-2010



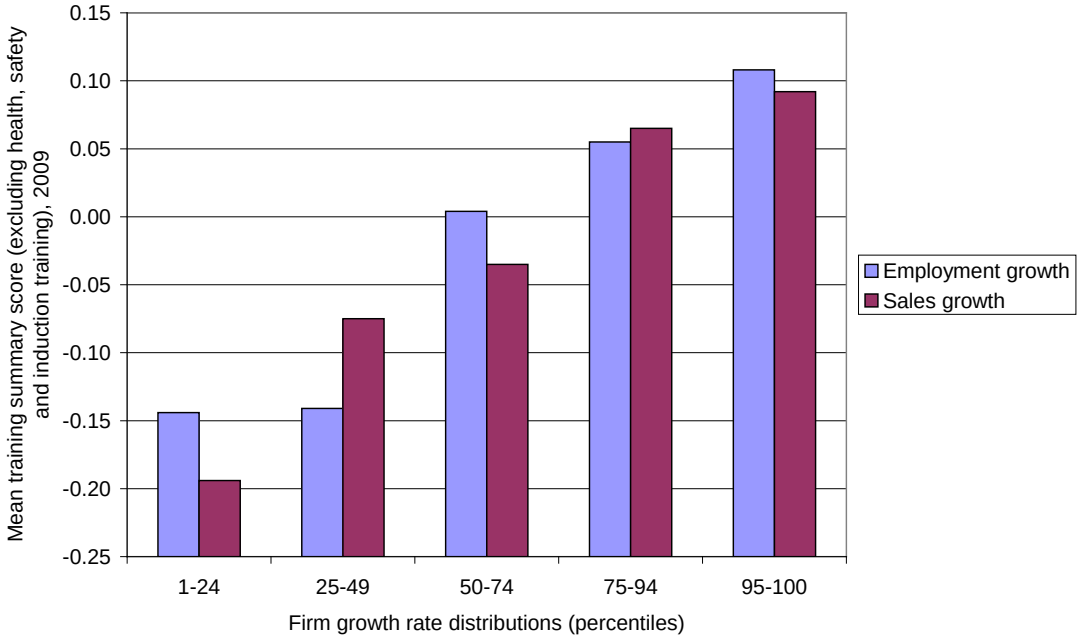
Source: Matched NESS 2009-BSD dataset
Notes:
Firm-weighted estimates. Survey respondents were deemed to have skill updating needs if they expected that, over the next 12 months, any of their employees would need to acquire new skills or knowledge as a result of factors such as new products, new work practices and/or competitive market pressures.

Figure 5.2: Mean training summary score, 2009, analysed by quantiles of firm growth distributions, 2007-2010



Source: NESS 2009, BSD 2007-10
Notes: Firm-weighted estimates. The training summary score is a standardised factor score with mean zero and standard deviation of one; see main text for details of how this measure was derived.

Figure 5.3: Mean training summary score (excluding health, safety and induction training), 2009, analysed by quantiles of firm growth distributions, 2007-2010



Source: NESS 2007, BSD 2007-10
Notes: Firm-weighted estimates. The training summary score is a standardised factor score with mean zero and standard deviation of one; see main text for details of how this measure was derived.

Table 5.10: Determinants of training provision, 2009

Dependent variable:	Training (summary measure)	Training (summary measure)	Training, excluding HSI training (summary measure)	Training, excluding HSI training (summary measure)
Employment growth – 25th to 49th percentiles	-0.0806***		-0.0531**	
	[0.022]		[0.022]	
Employment growth – 50th to 74th percentiles	0.028		0.0169	
	[0.025]		[0.025]	
Employment growth – 75th to 94th percentiles	0.0732***		0.0680***	
	[0.025]		[0.025]	
Employment growth – 95th to 100th percentiles	0.0601		0.0558	
	[0.037]		[0.038]	
Sales growth – 25th to 49th percentiles		0.0972***		0.0984***
		[0.023]		[0.024]
Sales growth – 50th to 74th percentiles		0.1075***		0.1013***
		[0.023]		[0.024]
Sales growth – 75th to 94th percentiles		0.1527***		0.1393***
		[0.024]		[0.025]
Sales growth – 95th to 100th percentiles		0.1112***		0.0918**
		[0.037]		[0.038]
Observations	14453	14442	14072	14062
Adj R2	0.0838	0.0835	0.0735	0.0743
SEE	0.9513	0.9509	0.96	0.9592

Sources: NESS 2009, BSD 2007-10
Notes:
*** p<0.01, ** p<0.05, * p<0.1
Firm-weighted OLS estimates. Robust standard errors in brackets are corrected for clustering on firm. All models include controls for single-site enterprises, employment size, firm age, sector and region. The reference categories for the employment and size growth variables are the lower quartiles of the growth distributions in each case. HSI training refers to health, safety and induction training.

6. Summary and assessment

This paper draws on matched data from National Employers Skill Surveys (NESS) and the Business Structure Database (BSD) to examine the impact of workforce skills on firm growth and the means by which fast-growing firms seek to meet their skill requirements.

Our main findings are:

1. Firm growth in both employment and sales is significantly positively related to the deployment of 'high-end' product strategies which typically rest on innovation leadership, supplying premium quality products and the ability to compete effectively without resort to low prices.

2. Such product strategies are known to be skill-intensive. In seeking to meet their skill requirements, fast-growing firms clearly engage in substantial training of their employees as well as searching for skilled workers on the open market. Our estimates show that firm growth is significantly positively related to *prior* investment in training in the case of rapid growth in employment. However, the picture is not so clearcut in the case of rapid firm growth in sales.

3. Consistent with other studies, our estimates suggest that employment growth tends to precede sales growth at firm level. It is plausible that training tends to be provided more intensively when employment is growing than when sales are growing for two reasons: first, training needs are bound to be more apparent when new recruits are first being introduced to firms; second, the opportunity costs of providing training during working hours might be expected to be greater at times of rapid sales growth.

4. However, when we examine the relationship between firm growth and training at a later stage in the growth period under consideration, we find strong positive links between training provision and firm growth in both employment and sales. This is associated with a greater incidence of reported skill updating needs among existing employees in fast-growing firms irrespective of whether growth is defined in terms of employment or sales.

5. High levels of training at a late stage of a rapid growth period might be thought surprising given the high opportunity costs of providing training during working time when sales are growing rapidly. We surmise that considerations regarding the opportunity costs of training are outweighed by the pressing need for fast-growing firms to develop new skills and competences in order to deal with the problems and challenges that are part and parcel of rapid expansion. The ability to identify skill updating needs and take steps to meet them through training may well facilitate continued firm growth.

6. Firms that are growing fast in terms of employment are more likely to encounter skills-related recruitment difficulties than are slower-growing firms, simply because fast-growing firms have more vacancies to fill. However, fast-growing firms' heavy investments in training appear to help them surmount such problems rather than be held back by them. Firm growth also does not appear to be hindered by internal skill gaps (defined as lack of full proficiency) among existing employees. Although internal skill gaps can be expected to have negative effects on growth rather than positive effects, the relative importance of internal skill gaps appears to be small compared to other factors that affect growth prospects. Put another way, the assets and capabilities that firms require in order to be able to grow fast also appear to equip them to deal with any deficiencies in workforce skills that might hinder that growth.

7. In this sense fast-growing firms seem to be very different from slower-growing firms that do not surmount their skill deficiencies. In future research it would be useful to gather data which permitted close examination of precisely how fast-growing firms go about dealing with changing skill needs, with a view to informing government policy on skills and training.

REFERENCES

Abowd, J. and Haltiwanger, J. et al. (2002), The relation among human capital, productivity and market value: building up from Micro evidence, US Census Bureau Technical Paper No. 2002-14, LEHD Programme.

Anyadike-Danes, M., Bonner, K., Hart, M. and Mason, C. (2009), Measuring Business Growth: High-growth firms and their contribution to employment in the UK, Research Report MBG/35, London: National Endowment for Science, Technology and the Arts (NESTA).

Baum, C., Shaffer, M. and Stillman, S. (2003), Instrumental variables and GMM: Estimation and testing, Boston College Department of Economics Working Paper No. 545.

Black, S. and Lynch, L. (2001), How to compete: the impact of workplace practices and information technology on productivity, *Review of Economics and Statistics*, LXXXIII, 434-445.

Brandenberg, B. Gůnter, J. and Schneider, L. (2007), Does qualification drive innovation? A micro-econometric analysis using linked employer-employer data, *Halle Institute for Economic Research Working Paper*, No. 10, September.

Bresnahan, T., E. Brynjolfsson, and L. Hitt (2002), Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence, *Quarterly Journal of Economics*, 11(2): 339-376

Cassiman, B. and R. Veugelers (2006), In search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition, *Management Science*, 52 (1): 68-82.

Churchill, C. and Lewis, V. (1983), Five stages of small business growth, *Harvard Business Review*, 30-50.

Coad, A. (2010), Exploring the processes of firm growth: evidence from a vector auto-regression, *Industrial and Corporate Change*, 19(6): 1677-1703.

Durbin, J. (1954), Errors in variables, *Review of the International Statistical Institute*, 22:22-32.

Eisenhardt, K. and J. Martin. (2001), Dynamic capabilities: what are they?, *Strategic Management Journal*, 21: 1105-1121.

Ericson, R. and Pakes, A. (1995), Markov perfect industry dynamics: a framework for empirical work, *Review of Economics and Statistics*, 62: 53-82.

Grund, C. and Martin, J. (2010), Determinants of Further Training: Evidence for Germany, IZA Discussion Paper No. 5315, Bonn: Institute for the Study of Labor.

Hoeckel, K. (2008), Costs and Benefits in Vocational Education and Training, Paris: Organisation for Economic Cooperation and Development.

Jensen, J., and McGuckin. E., (1997), Firm performance and evolution: empirical regularities from US micro data, *Industrial and Corporate Change*, 6(1): p25-45.

Johnston, J. (1972), *Econometric Methods*, New York: McGraw-Hill.

Mason, G., Bishop, K. and Robinson, C. (2009), *Business growth and innovation: the wider impact of rapidly-growing firms in UK city-regions*, Research Report BGI/36, London: National Endowment for Science, Technology and the Arts (NESTA).

Mason, G. (2011), *Product strategies, skills shortages and skill updating needs in England:New evidence from the National Employer Skills Survey, 2009*, Evidence Report 30, London: UK Commission for Employment and Skills.

O'Reilly, C. and M. Tushman. (2007), Ambidexterity as a dynamic capability: resolving the innovators dilemma, *Research in Organisation Behaviour*, 28:p1-60.

Penrose, E. (1959), *The Theory of the Growth of the Firm*. New York: John Wiley.

Phelan, S. and Lewin, P (2000), Arriving at a strategic theory of the firm, *International Journal of Management Reviews*, 2(4): 305–323.

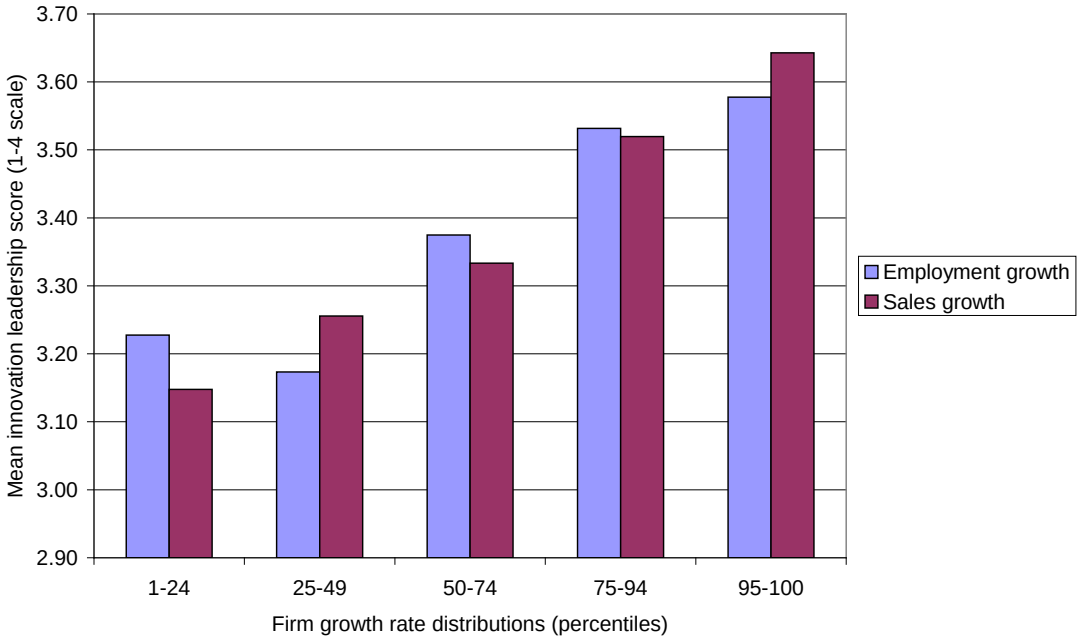
Shury, J., Winterbotham, M., Davies, B., Oldfield, K., Spilsbury, M. and Constable, S. (2010), *National Employer Skills Survey for England 2009: Key findings report*, London: UK Commission for Employment and Skills.

Teece, D. (2007), Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance, *Strategic Management Journal*, 18: p1319-1350.

Teece, D., Pisano, G. and Shuen, A. (1997), Dynamic capabilities and strategic management, *Strategic Management Journal*, 18(7): p509–33.

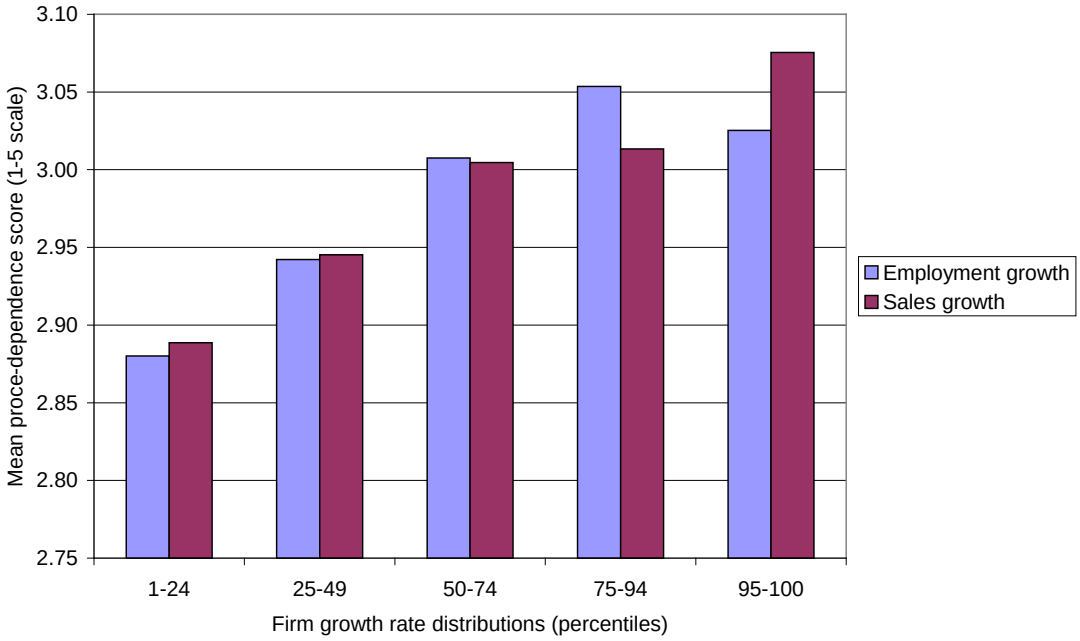
Annex A

Figure A1: Mean innovation leadership score, 2009, analysed by quantiles of firm growth rate distributions, 2007-2010



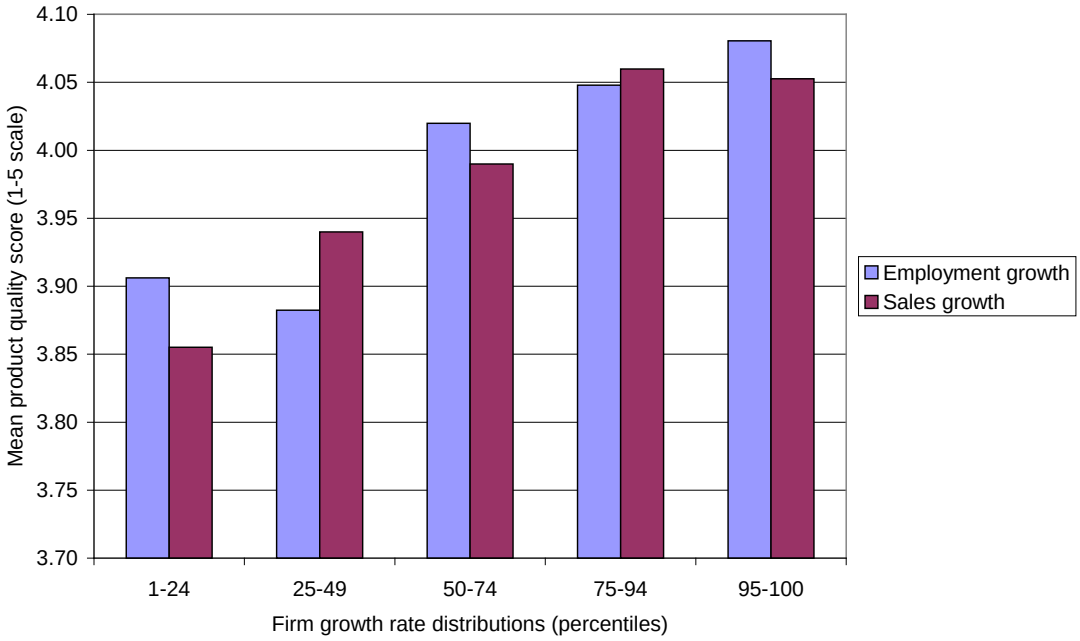
Source: NESS 2009, BSD 2007-10
Notes:
Firm-weighted estimates. The innovation leadership score is based on a 4-point scale which measures the extent to which establishments are leaders in their industries in the development of new products, materials or techniques; see main text for details of how this measure was derived.

Figure A2: Mean price-dependence score, 2009, analysed by quantiles of firm growth rate distributions, 2007-2010



Source: NESS 2009, BSD 2007-10
Notes:
Firm-weighted estimates. Firm-weighted estimates. The price-dependence score is based on a 5-point scale which measures the extent to which establishments depend on low prices to secure competitive success, with high values denoting very little dependence on low prices to achieve success; see main text for details of how this measure was derived.

Figure A3: Mean product quality score, 2009, analysed by quantiles of firm growth rate distributions, 2007-2010



Source: NESS 2009, BSD 2007-10
Notes:
Firm-weighted estimates. The product quality score is based on a 5-point scale which measures the extent to which establishments competed in a 'premium quality' product market as compared to a 'standard or basic quality' product market; see main text for details of how this measure was derived.

Annex B

Table B1: Matched BSD 2007/10 - NESS samples: descriptive statistics

	BSD - NESS 2007	BSD - NESS 2007	BSD - NESS 2007		BSD - NESS 2009	BSD - NESS 2009	BSD - NESS 2009
Variable	**Obs**	**Mean**	**Std. Dev.**		**Obs**	**Mean**	**Std. Dev.**
Average annual growth rates in:							
Employment 2007-10	14316	0.01	0.17		13666	0.03	0.19
Sales 2007-10	14270	0.05	0.35		13640	0.06	0.37
Employment 2008-10	14319	0.01	0.23		13665	0.03	0.42
Sales 2008-10	14312	0.06	0.64		13654	0.07	0.66
Vacancy	15406	0.30	0.46		13598	0.16	0.36
Hard-to-fill vacancy	15406	0.13	0.34		13598	0.05	0.21
Skill shortage vacancy	15406	0.11	0.31		13598	0.04	0.19
Internal skills gap	15844	0.29	0.45		13856	0.34	0.47
Skill updating need					13854	0.74	0.44
Training - either on and off the job	15844	0.84	0.37		13856	0.84	0.37
Training - both on and off the job	15844	0.50	0.50		13856	0.57	0.49
Proportion of staff receiving training	15844	0.49	0.38		13751	0.44	0.36
Intensity of training (average days training per employee per year)	14639	6.54	20.07		13856	3.67	13.21
Apprenticeship training	15056	0.25	0.43		13835	0.15	0.36
Training summary - factor score	14639	0.00	1.00		13751	0.00	1.00
Training summary (excluding health, safety and induction training) - factor score	14286	0.00	1.00		13393	0.00	1.00
Product strategy - factor score					12836	0.00	1.00
Skills index (1-1.80 scale)					13569	1.18	0.21
Innovation leadership (1-4 scale)					13358	3.32	1.34
Premium quality (1-5 scale)					13513	3.96	1.06
Price dependence (1-5 scale)					13162	2.96	1.16
Geographical market focus (1-4 scale)					13674	2.57	1.11
Local market					13746	0.25	0.43
Regional market					13746	0.17	0.37
National market					13746	0.34	0.47
World market					13746	0.24	0.43
Single-site enterprise	15844	0.52	0.50		13784	0.50	0.50
Size2_9	15844	0.19	0.39		13856	0.20	0.40
Size10_24	15844	0.36	0.48		13856	0.33	0.47
Size25_49	15844	0.23	0.42		13856	0.24	0.43
Size50_99	15844	0.11	0.31		13856	0.12	0.33
Size100_199	15844	0.07	0.25		13856	0.06	0.25
Size200_499	15844	0.04	0.19		13856	0.03	0.18
Size500plus	15844	0.01	0.10		13856	0.01	0.08
Age_one	15844	0.01	0.10		13856	0.01	0.11

Age_two	15844	0.01	0.12		13856	0.01	0.12
Age_three	15844	0.02	0.14		13856	0.02	0.13
Age_four	15844	0.02	0.14		13856	0.02	0.13
Age_five	15844	0.02	0.15		13856	0.02	0.15
Age_6-9	15844	0.11	0.32		13856	0.11	0.31
Age_10-19	15844	0.30	0.46		13856	0.30	0.46
Age_20 or more	15844	0.49	0.50		13856	0.50	0.50
East Midlands	15844	0.09	0.29		13856	0.10	0.30
London	15844	0.15	0.36		13856	0.15	0.36
Eastern	15844	0.11	0.32		13856	0.11	0.31
North East	15844	0.07	0.26		13856	0.06	0.24
North West	15844	0.12	0.33		13856	0.12	0.33
South East	15844	0.14	0.35		13856	0.14	0.35
South West	15844	0.10	0.30		13856	0.11	0.31
West Midlands	15844	0.10	0.30		13856	0.10	0.30
Yorkshire and Humberside	15844	0.11	0.31		13856	0.10	0.30
Food and drink manufacturing	15695	0.03	0.16		13702	0.03	0.16
Printing	15695	0.04	0.19		13702	0.03	0.16
Chemicals	15695	0.03	0.17		13702	0.03	0.16
Metal goods	15695	0.04	0.19		13702	0.03	0.18
Electrical/electronic engineering	15695	0.03	0.16		13702	0.03	0.16
Mechanical engineering	15695	0.04	0.19		13702	0.04	0.19
Other Manufacturing	15695	0.06	0.24		13702	0.06	0.23
Building, civil	15695	0.05	0.21		13702	0.04	0.20
Building, installation	15695	0.05	0.22		13702	0.06	0.24
Motor vehicle sales	15695	0.06	0.24		13702	0.06	0.23
Wholesale	15695	0.08	0.28		13702	0.08	0.26
Retail- specialised	15695	0.07	0.26		13702	0.08	0.26
Retail - other	15695	0.02	0.13		13702	0.02	0.13
Hotels	15695	0.02	0.15		13702	0.02	0.15
Restaurants	15695	0.03	0.17		13702	0.03	0.18
Bars	15695	0.03	0.16		13702	0.02	0.15
Transport services	15695	0.03	0.18		13702	0.04	0.19
Post and telecoms	15695	0.01	0.10		13702	0.01	0.11
Auxiliary travel services	15695	0.03	0.17		13702	0.02	0.15
Financial services	15695	0.03	0.18		13702	0.03	0.18
Computer service	15695	0.03	0.17		13702	0.03	0.16
Legal and accounting services	15695	0.04	0.19		13702	0.05	0.23
Architecture and engineering services	15695	0.05	0.21		13702	0.05	0.22
Other business services	15695	0.11	0.32		13702	0.11	0.32
Other private services	15695	0.01	0.10		13702	0.01	0.12