The Journal of
Regional
Analysis
& Policy

JRAP 46(1): 22-38.

Effects of Human Capital on the Growth and Survival of Swedish Businesses

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Abstract: This paper examines the effects of human capital on the growth and survival of a large sample of Swedish businesses. Human capital is represented by conventional measures of the educational attainment and experience of an establishment's workers and skills-based measures of the types of occupations present in the company. Controlling for an establishment's size and age, as well as its industry and region of location, we find that the human capital embodied in a company's workers affects its performance. The specific effects, however, depend on how human capital is measured and whether the analysis focuses on growth or survival.

1. Introduction

Human capital is made up of the education, experience, inherited abilities, and developed skills that people use in their jobs to produce goods and services and to come up with new ideas and innovations. A vast body of research has studied the effects of human capital on individuals (Becker 1964; Mincer 1974; Card 1999) as well as regions and entire nations (Lucas, 1988; Glaeser et al., 1995; Acs and Armington, 2004; Abel and Gabe, 2011). Studies focusing on individuals often examine the effects on earnings of conventional measures of human capital, such as formal education (e.g., years of schooling) and experience (e.g., age), while studies focusing on regions typically analyze the effects of the share of the population with a college degree on indicators of regional productivity (e.g., per capita income) and growth (e.g., population change, new firm formation).

The connection between human capital and individual earnings is reasonably straightforward: education, experience, abilities and skills tend to increase a person's productivity, which leads to higher wages and salaries.[1] Human capital contributes to regional vitality in several ways. A large collection of educated and skilled workers increases the output of regions because, as noted above, these people are highly productive. Additionally, the presence of educated and skilled individuals makes those around them more productive through human capital externalities (Rauch, 1993; Moretti, 2004). Knowledge spillovers are also cited as a reason for the positive effect of a region's human capital on new firm formation (Acs and Armington, 2004). Glaeser (2011) explains that cities with highly-educated people outperform their peers because new technologies favor skilled workers and globalization allows for the outsourcing of low-skilled—but not high-skilled—labor.

[1] Although the connection between human capital and earnings is straightforward, empirical studies have used a variety of approaches, including an analysis of siblings and twins and controls for parental education to obtain unbiased estimates of the returns to schooling (Card, 1999).

Business establishments are entities that are sometimes larger than one individual (except in the case of sole proprietorships), but are most often smaller than entire regions. These entities serve the purpose of organizing the activities of workers, combining them with physical and financial capital and entrepreneurial direction in the production of goods and services. The human capital embodied in a business establishment can include the education, experience, and skills of its workforce as well as the inherited abilities and cultural background, such as language competencies, that influence worker productivity (Hofstede, 1980; Throsby, 1999).

Past research analyzing the growth and survival of firms suggests that human capital is an important factor affecting business performance (Colombo and Grilli, 2005; Pennings et al., 2008; Ganotakis, 2012). Many studies, however, often have a narrow definition of human capital focusing on an individual's education and/or experience. Given that human capital is a broad concept with many dimensions, it is important to expand its scope beyond education and experience and also account for an individual's skills. These skills are often reflected by a person's current (or previous) occupation. For example, Boden and Nucci (2000, p.353) suggest that working as a manager can "enhance workers' latent managerial ability as well as their knowledge of their managerial competence." Another feature of past research on the effects of human capital on businesses is that these studies often focus on the human capital of the person who started a company, which is found to have a positive effect on its performance (Colombo et al., 2004; Ganotakis, 2012).

This paper examines the effects of the human capital of all employees working in an establishment − not just the entrepreneur − on the performance of Swedish businesses, both in terms of their survival (i.e., remaining in operation) and employment growth over time.[2] We take a broad view of human capital which accounts for the education, experience, and occupations of individuals working in the business establishment. Thus, this paper makes two main contributions to the literature: i) by focusing on all employees in the establishment, we are able to measure the knowledge stock of the entire establishment; and ii) by accounting for the types of occupations present in the establishment, we are able to examine the effects of skills, along with education and experience, on firm growth and survival. As such, the paper supports recent efforts regarding the importance of skills to the economies of European nations (OECD, 2013).

The empirical analysis uses a novel data set made up of 467,000 establishments, with information covering the years 2001, 2006, and 2010. Having employment figures for these three years allows us to analyze the factors affecting establishment survival and growth between 2001 and 2006, a time period ending prior to the worldwide economic recession, and a longer interval of 2001 to 2010 (results shown in an appendix).

The data set includes information on the establishments' employment size, years of operation (i.e., business age), industry and location, variables commonly used in empirical "firm growth" studies. For example, seminal work by Gibrat (1931) found that a firm's growth rate is independent of its size. Lotti et al. (2003) suggest that this relationship may depend on a firm's stage in its life-cycle, since small-sized startup businesses have stronger basic survival incentives to grow than firms that have been operating for many years. Others have suggested that growth rates diminish with increasing firm size (e.g., Dunne and Hughes, 1994; Sutton, 1997; Gabe, 2003). Delmar et al. (2003) examined Swedish high-growth firms and concluded that their performance could be explained by firm size, age, and industry affiliation.

Along with these characteristics that have been found in other studies to affect business performance, our data set also includes worker attributes such as level of education, age, and occupations. Past research has found that the characteristics of individuals, such as their education and age, influence their productivity and earnings (Becker, 1962; Griliches, 1969; Welch, 1970). Having information on these attributes of workers, aggregated to the establishment level, allows us to investigate the effects on business performance associated with the educational attainment and experience of workers as well as the relationship between performance and the percentages of workers in several skills-based occupational categories.

Human capital can enhance worker productivity through several channels, all of which should be beneficial to the survival and growth of establishments. For example, possessing high human capital enhances an employee's ability to acquire and decode information about costs and inputs (Welch, 1970).

[2] For other studies on the performance of Swedish firms, see, e.g., Heshmati (2001), Persson (2004), Box (2008), Wennberg and Lindqvist (2010), and Andersson and Noseleit (2011).

Human capital also influences worker productivity by increasing the probability of coming up with new innovations and by enhancing the process of "learning by doing." Furthermore, knowledge created in other businesses is more easily adapted, adopted, and imitated in firms with high levels of human capital (Ballot et al., 2001; Boschma et al., 2009).

Human capital may also enhance a manager's capacity to handle information (Welch, 1970) and maintain and operate an effective organization (Fleming, 1970). Having a business with high human capital workers can reduce business costs due to a lower turnover rate (Oi, 1962; Chang and Wang, 1996) and lower sick leave expenditures (Koopmanschap et al., 1995; Berger et al., 2003). Finally, another potentially important aspect of human capital in business establishments is the externalities that arise as high-human capital individuals increase the productivity of people around them (Jacobs, 1969; Lucas, 1988; Rauch, 1993; Gabe, 2009).

Our analysis of the educational attainment, experience and occupations held by workers in an establishment provides a broad view of human capital. Previous studies on the impacts of human capital have used conventional measures of educational attainment (or years of schooling) and experience (Mincer, 1974; Glaeser et al., 1995; Card, 1999; Moretti, 2004), which give an indication of "how much" human capital a person possesses. In recent years, studies have used occupations as an indicator of the skills required on the job (Ingram and Neumann, 2006; Florida et al., 2008; Bacolod et al., 2009; Gabe, 2009; Florida et al., 2012); this tells us "what types" of human capital workers possess. Studies examining the effects of an entrepreneur's human capital on business performance make a distinction between general human capital (e.g., education and experience) and knowledge that is specific to the company's industrial sector (Gimeno et al., 1997; Colombo et al., 2004; Ganotakis, 2012). Bacolod et al. (2009) make a similar distinction between a "vertical" orientation of human capital, related to educational attainment, and a "horizontal" orientation, which is based on occupations and skills.

A vast number of past studies on human capital and firm growth provide a point of departure for the research presented in this paper. Borrowing from the firm growth literature, we use an empirical framework suggested by Evans (1987a; 1987b) as the foundation for our regression analysis. Building from the literature on human capital, we examine the effects of several types of human capital, including skills-based measures that have gained prominence in recent years. Of particular interest are the influences of management and cognitive skills, as opposed to motor occupations, given the previously discussed connection between these skills and productivity. To extend both areas of literature, the current study examines the effects of these multiple measures of human capital on the performance of Swedish businesses. As is common in firm growth and human capital studies, we also take into account the influences of industrial and regional contexts.

Our results provide mixed evidence on the effects of human capital on business performance. The percentage of workers in a business with a college degree increases the likelihood that an establishment remains in operation but has in general no consistent effect on its employment growth over time. Results of the analysis show that businesses made up of older (i.e., more experienced) workers are less likely to remain in operation, and the experience of workers has a negative effect on employment growth. Finally, our results indicate that the shares of workers in occupations using management and administration, cognitive, and social skills reduce the likelihood of survival (relative to an omitted category of occupations using motor skills), while these three skills-based occupational groups are associated with higher rates of employment growth.

The rest of the paper is organized as follows. Section 2 provides a conceptual framework for the analysis of establishment growth, along with a discussion of the variables used in the regressions. In section 3, we present the regression models and results. Section 4 provides a summary of the paper, as well as conclusions of the study.

2. Conceptual framework and data

Many studies have examined the effects of initial size and age on business growth (Gibrat, 1931; Simon and Bonini, 1958; Hymer and Pashigian, 1962; Singh and Whittington 1975; Hall, 1987; Lotti et al., 2003; Petrunia, 2008; Teruel-Carrizosa, 2010). Evans (1987a; 1987b) analyzed the relationship between employment growth and these business characteristics using the conceptual framework and the regression model shown as equations 1 and 2:

$$S_{t'} = [G(S_t, A_t)]^d(S_t)e_t \quad (1)$$

$$(\ln S_{t'} - \ln S_t) / d = \ln G(S_t, A_t) + u_t \quad (2)$$

where S and A are establishment size and age, G(.) is a firm growth function, t indicates time where $t' > t$ and $d = t' - t$, e is a log-normally distributed error term,

and u is normally distributed with mean zero and independent of S and A. The partial derivatives of an establishment's logarithmic growth rate with respect to firm size and age are denoted as $g_S = \partial \ln G / \partial \ln S$ and $g_A = \partial \ln G / \partial \ln A$.

Evans (1987a, 1987b) used this framework to test Gibrat's law (Gibrat, 1931; Hart and Prais, 1956), which implies that firm growth is independent of size ($g_S = 0$). Most empirical studies have rejected Gibrat's law and instead find that business growth rates are negatively related to initial size (Evans, 1987a and 1987b; Dunne et al., 1989; Petrunia, 2008; Teruel-Carrizosa, 2010). Evans (1987a, 1987b) also used this framework to test Jovanovic's (1982) passive firm learning hypothesis, which implies a negative relationship between firm growth and age ($g_A < 0$).

As is common in empirical studies of business growth, we extend Evans' (1987a, 1987b) framework and include a set of human capital variables that are expected to affect an establishment's employment change:

$$\begin{aligned}(\ln S_{t'} - \ln S_t) = {} & \alpha + \beta_1 \ln S_t + \beta_2 \ln A_t + \beta_3 (\ln S_t)^2 \\ & + \beta_4 (\ln A_t)^2 + \beta_5 (\ln S_t) \cdot (\ln A_t) + \beta_6 \mathit{Education} \\ & + \beta_7 \ln \mathit{Experience} + \beta_8 \mathit{Mgmt.\ \&\ Admin.} \\ & + \beta_9 \mathit{Cognitive} + \beta_{10} \mathit{Social} \\ & + \text{Industry}_{\text{dummy}} + \text{Region}_{\text{dummy}} + u_t\end{aligned} \tag{3}$$

where *Education*, *Experience*, *Mgmt. & Admin.*, *Cognitive*, and *Social* are human capital variables, and $\text{Industry}_{\text{dummy}}$ and $\text{Region}_{\text{dummy}}$ are indicators of the establishment's industry and region of location, respectively.

The variables labeled as *Education* and *Experience* are conventional measures of human capital that capture the share of employees in the establishment with a BA (Bachelor of Arts) degree or higher level of formal education and the average number of years that employees in the establishment could have worked (defined as an individual's age minus the years of education minus six). We also use several human capital variables based on the shares of workers in broad occupational groups within each establishment: management and administration occupations (*Mgmt. &Admin.*), cognitive occupations (*Cognitive*), and social occupations (*Social*). Another broad occupational group defined by Johansson and Klaesson (2011), referred to as motor occupations (*motor*), is not shown in equation 3 because it is the "excluded category" in the regression analysis.

These broad occupational groups are based on the classifications of Johansson and Klaesson (2011), which attempt to measure the types of skills that are used by individuals working in these jobs. For example, individuals classified as having a "cognitive occupation" (e.g., engineers and teaching professionals) are involved in knowledge generation and dissemination, while those classified as having a "motor occupation" perform physical and hands-on tasks. The shares of workers in these occupational groups provide an indication of the types of tasks that are performed and, thus, the corresponding skills that are needed.

Although our empirical design and approach to measuring human capital differ from what has been employed previously, as we broaden the concept of human capital to include the composition of occupational skills in the establishment, we can use insights from other studies to inform our expectations about the impacts of the human capital variables on the growth of Swedish businesses. Previous studies tend to uncover stronger impacts on business performance associated with the specific types of education and skills held by workers (e.g., the company's founder) than more general human capital indicators of experience and the amount of overall education. For instance, Colombo et al. (2004) find that the amount of education in economic, law, and management-related fields, similar to our skills-based measure of management and administration, has a positive effect on the start-up size of new businesses, whereas the effects associated with general education are mixed (depending on the control variables used in the regression). Furthermore, they report a larger impact on start-up size related to the owner having experience specific to the new firm's sector than the effect on size associated with general experience.

The importance of business-related skills was also uncovered by Almus and Nerlinger (1999) and Ganotakis (2012). Ganotakis' (2012) analysis of the performance of technology-based firms in the United Kingdom shows that business-related education and experience have a positive effect on company size, whereas the impact associated with the amount of general education is not statistically significant. Almus and Nerlinger (1999) also find that business skills increase the growth of "non-innovative" firms in Germany.

Based on these previous studies, we expect the types of skills used by Swedish workers to have a larger impact on establishment growth than the effects associated with general education and experience. It is important to note, however, that our analysis focuses on the general patterns of how human capital influences firm survival and growth, as the data set includes all firms in Sweden regardless of

their industry affiliation. The relationship between human capital and firm performance might depend on an establishment's industry, because different sectors vary in their human capital intensity and necessity of education and skills for business growth and survival. These issues are considered near the end of the paper with a brief discussion of how the results vary between agricultural, manufacturing, and services-based businesses.

In our regression analysis, which has the variable measuring motor skills as the omitted category, the occupational-based groups of management and administration, cognitive, and social skills capture the extent to which workers can organize a company's activities, develop strategies and communicate with others. We expect these types of skills to increase the growth of Swedish businesses. On the other hand, past studies, which reported mixed results related to the role of general education and experience on business performance, do not suggest clear expectations about the impacts of these conventional measures of human capital on establishment growth.

Table 1. Variable definitions and summary statistics (n=467,034).

Variable	Definition	Mean	St. Dev.
Dependent Variables			
Survival	= 1 if establishment was in operation in 2006 (2010), = 0 otherwise	0.579 (0.446)	NA NA
Growth	Logarithmic growth rate of employment between 2001 and 2006 (2001 and 2010)	0.028 (0.045)	0.519 (0.617)
Explanatory Variables	**(all measured as of 2001)**		
Size	Establishment employment size	8.365	55.16
Age	Establishment age (i.e., years in operation)	8.071	5.719
Education	Share of employees with at least 3 years of higher education, equivalent to a bachelor's degree in Sweden	0.123	0.284
Experience	Average experience of employees, where experience is measured as an individual's age minus 6, minus years of education	26.82	10.72
Cognitive	Share of employees with a "cognitive" occupation	0.094	0.253
Mgmt. & Admin.	Share of employees with a "management and administration" occupation	0.139	0.279
Social	Share of employees with a "social" occupation	0.173	0.324
Motor	Share of employees with a "motor" occupation	0.593	0.449
Share Entry, industry	Share of establishments in industry that began operations over period of analysis: 2-digit SIC code	0.139	0.051
Average Establishment Size, industry	Mean industry employment size of establishments: 2-digit SIC code	8.365	10.199
Industry Dummies	Dummy variables based on establishment's 2-digit SIC code, 60 categories in total	NA	NA
Regional Dummies	Dummy variables based on establishment's location, 4 regions in total	NA	NA

Notes. Regional dummies are defined by the Swedish Board of Agriculture: i) metropolitan municipalities (*municipalities in the functional regions of Stockholm, Gothenburg and Malmö*), ii) urban municipalities (*regional center's outside the metropolitan areas and their "suburb municipalities"*), iii) rural municipalities (municipalities not part of (i) or (ii) with a *population density above 5 people per km²*), and iv) sparsely populated rural municipalities (*population density below 5 people per km²*) (Westlund 2011).

Table 1 presents definitions and summary statistics of the variables used in the analysis, which are constructed from data provided by Statistics Sweden that has restricted public access. Establishments that remained in the sample grew by an average of 2.8 percent between 2001 and 2006 and an average growth of 4.5 percent between 2001 and 2010. Focusing on the human capital variables, we see that establishments in the sample have an average of 12.3 percent of their workers with a bachelor's degree and have workers with an average of 26.8 years of (potential) experience. With an average of close to 60 percent of the workers in Swedish business establishments, the skills-based category of motor occupations has the

highest employment share, followed by social occupations (17 percent), management and administration occupations (14 percent), and cognitive occupations (9 percent). The presence of outliers is examined using a method proposed by Hadi (1992, 1994), with no detection of severe outliers in the variables.

3. Regression results

Several versions of the regression model (shown as equation 3) are estimated to examine the determinants of business growth in Sweden. The first specification is the base model, which focuses on the effects of establishment size and age (Evans, 1987a and 1987b). The second and third specifications include the education and experience variables, respectively, and the fourth specification includes the skills-based occupational categories (motor occupations are the excluded group). The final version of the model includes all of the human capital variables.

The estimation procedure is a two-stage sample selection model (Heckman, 1979) in which the first stage (i.e., survival model) is a probit regression of whether the establishment was in operation at the end of the period and the second stage is the analysis of employment growth (equation 3, with the sample selection variable λ that is estimated from the first-stage regression). Although other studies of firm survival employ a Cox model (see e.g., Audretsch and Mahmood, 1995), we use a Heckman two-stage model given our interest in survival and firm growth. For identification purposes, the first-stage probit regression has two industry-level variables that are not included in the second-stage establishment growth model: *Share Entry, industry* and *Average Establishment Size, industry*.

The *Share Entry, industry* variable is the share of establishments in an industry that began operations over the 2001 to 2006 period of analysis (or 2001 to 2010 in the appendix). This variable represents the amount of competition in the industry as well as the turnover of businesses. As more establishments enter the same industry, it becomes less likely that a given establishment survives throughout the period as more businesses are competing for the same limited resources and customers. Based on past research, we expect to find a negative relationship between survival and the share of establishments that began operations over the period (Utterback and Suárez, 1993; Staber, 1998; Agarwal and Gort, 1996, 2002). The *Average Establishment Size, industry* variable is a measure of economies of scale in the industry.

Marginal effects estimated for the second-stage model incorporate the (direct) effects of the explanatory variables on employment growth as well as the (indirect) effects of the variables on growth through their influence on survival (which is transmitted through the sample selection variable). Thus, the marginal effects can be interpreted as the impact of a given variable on the employment growth of a (typical) business establishment in operation at the beginning of the period, in our case 2001. An OLS estimation of employment growth, without the sample selection variable, would produce biased results because an analysis of only those establishments that survived over the period does not account for the influence of weaker performing businesses that disappeared from the sample.

Table 2 presents regression results for all five versions of the model (estimations 1 to 5) using data over the time period of 2001 to 2006, and these models are repeated in an appendix (Table 3) using data from 2001 to 2010. For each of the specifications, results are presented for the probit survival regression (first column of results), the second-stage employment growth regression (second column of results), the estimated marginal effect on employment growth accounting for a variable's influence on survival (third column of results), and an OLS regression that examines only those establishments (270,455 of the original 467,034) that remained in operation (final column). A comparison of the OLS results to the estimated marginal effects provides an idea of the bias due to the influence of sample selection. We considered the issue of multicollinearity by examining a correlation matrix and did not find high bivariate correlation among the variables (except the squared variables of age and size and the interaction term). The results from a variance inflation factor test are similar.

Results of the baseline analysis (estimation 1) show that establishment size and age are positively associated with business survival, and there is a negative relationship between the employment growth of Swedish business establishments and these initial conditions, as shown by the marginal effects in the third column of results. Such results are similar to those reported in the seminal study by Evans (1987a, 1987b) and in numerous other studies of business growth.

The variables *Share Entry, industry* and *Average Establishment Size, industry*, which are used to identify the first-stage regression model, have a negative effect on the survival of Swedish businesses. Our result of a negative relationship between survival and the share of establishments that began operations over

the period is consistent with the findings of previous research (Utterback and Suárez, 1993; Staber, 1998; Agarwal and Gort, 1996 and 2002). The findings related to the *Average Establishment Size, industry* variable, considered along our result related to the size of an establishment itself, suggest that larger establishments are more likely to survive (Headd, 2003), whereas operating in an industry that is typically made up of larger companies reduces an establishment's probability of survival.

Table 2a. Human Capital effects on growth and survival, 2001 to 2006, Estimation 1 (n=467,034)

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.411**	-0.081**	-0.125**	-0.131**
	(0.006)	*(0.004)*	*(0.004)*	*(0.003)*
Size^2 (ln)	-0.051**	0.006**	0.011**	0.010**
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*
Age (ln)	0.380**	-0.088**	-0129**	-0.138**
	(0.008)	*(0.006)*	*(0.006)*	*(0.005)*
Age^2 (ln)	-0.042**	0.017**	0.021**	0.022**
	(0.003)	*(0.001)*	*(0.002)*	*(0.002)*
*Size*Age* (ln)	0.036**	0.010**	0.006**	0.011**
	(0.002)	*(0.001)*	*(0.001)*	*(0.001)*
Share Entry, industry	-3.772**	NA	NA	NA
	(0.052)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.185**	NA	NA
		(0.012)		
Wald Chi-Squared	3,654**	NA	NA	NA
R-squared	NA	0.038	NA	0.046

Note: Standard errors in parentheses (robust se for OLS); ** and * denote statistical significance at the 1-percent and 5-percent levels. The intercepts and sets of dummy variables that control for an establishment's industry and region of location are not shown in the table.

Table 2b. Human Capital effects on growth and survival, 2001 to 2006, Estimation 2 (n=467,034)

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.413**	-0.080**	-0.125**	-0.131**
	(0.006)	*(0.004)*	*(0.004)*	*(0.003)*
Size^2 (ln)	-0.051**	0.006**	0.011**	0.010**
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*
Age (ln)	0.380**	-0.088**	-0.129**	-0.138**
	(0.008)	*(0.006)*	*(0.006)*	*(0.005)*
Age^2 (ln)	-0.042**	0.016**	0.021**	0.022**
	(0.003)	*(0.001)*	*(0.002)*	*(0.002)*
*Size*Age* (ln)	0.036**	0.010**	0.006**	0.011**
	(0.002)	*(0.001)*	*(0.001)*	*(0.001)*
Education	0.049**	0.004**	-0.001	-0.001
	(0.007)	*(0.004)*	*(0.004)*	*(0.004)*
Share Entry, industry	-3.793**	NA	NA	NA
	(0.052)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.187**	NA	NA
		(0.012)		
Wald Chi-Squared	3,948**	NA	NA	NA
R-squared	NA	0.037	NA	0.046

Note: Standard errors in parentheses (robust se for OLS); ** and * denote statistical significance at the 1-percent and 5-percent levels. The intercepts and sets of dummy variables that control for an establishment's industry and region of location are not shown in the table.

The results of estimation 2 show that the percentage of employees with at least a bachelor's degree has a positive effect on business survival and educational attainment has a positive effect on the growth of establishments that remained in operation over the period, as seen in the second-stage regression that includes the sample selection variable. The marginal effect associated with educational attainment is insignificant in the analysis of the growth of Swedish businesses between 2001 and 2006, but it is positive and significant over the period of 2001 to 2010 (results shown in the appendix). The marginal effects, estimated over both time periods, are similar to the OLS coefficients corresponding to the educational attainment variable. Our finding of "no consistent" effect on growth associated with education is similar to the results reported by Ganotakis (2012) for technology-based firms in the United Kingdom.

Results of estimation 3 show that the average (potential) experience of workers in a Swedish business establishment has a negative effect on business survival and the growth of businesses that remained in operation (controlling for sample selection). In addition, the marginal effect indicates that the growth of establishments in operation as of 2001 is negatively associated with the average age of their workers. The marginal effects corresponding to the potential experience of an establishment's workers are qualitatively similar to those corresponding to business age (i.e., years of operation), suggesting that older establishments and those with more experienced workers are associated with slower employment growth. On the other hand, establishments with more experienced workers have a lower probability of survival, whereas older businesses are more likely to remain in operation over time.

An explanation for these findings related to (potential) experience is that companies comprised of older workers might be more likely to adhere to the status quo and less apt to adopt new technologies (Verheul and van Mil, 2008; Meyer, 2011). Based on a study of the human capital of a company's founder, Ganotakis (2012) explains that more experienced individuals may be less likely to seek out the advice of others and have a lower proclivity to introduce "innovative products and practices." Other studies finding that businesses established by older entrepreneurs exhibit slower growth rates than the ventures undertaken by younger entrepreneurs suggest that experience and age have a negative effect on the ambition to grow (Peters et al., 1999; Lau and Busenitz, 2001; Bager and Schøtt, 2004; Autio, 2005; Verheul et al., 2010).

Table 2c. Human Capital effects on growth and survival, 2001 to 2006, Estimation 3 (n=467,034)

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.393**	-0.102**	-0.138**	-0.143**
	(0.005)	*(0.004)*	*(0.004)*	*(0.003)*
Size^2 (ln)	-0.047**	0.009**	0.013**	0.013**
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*
Age (ln)	0.391**	-0.092**	-0.128**	-0.135**
	(0.008)	*(0.006)*	*(0.006)*	*(0.005)*
Age^2 (ln)	-0.038**	0.022**	0.025**	0.026**
	(0.003)	*(0.001)*	*(0.002)*	*(0.002)*
*Size*Age* (ln)	0.032**	0.008**	0.005**	0.009**
	(0.002)	*(0.001)*	*(0.001)*	*(0.001)*
Experience (ln)	-0.116**	-0.094**	-0.083**	-0.086**
	(0.004)	*(0.003)*	*(0.003)*	*(0.003)*
Share Entry, industry	-3.861**	NA	NA	NA
	(0.052)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.157**	NA	NA
		(0.012)		
Wald Chi-Squared	5,555**	NA	NA	NA
R-squared	NA	0.043	NA	0.050

Note: Standard errors in parentheses (robust se for OLS); ** and * denote statistical significance at the 1-percent and 5-percent levels. The intercepts and sets of dummy variables that control for an establishment's industry and region of location are not shown in the table.

Moving to the skills-based occupational categories that account for the "types" of human capital that workers use in their jobs, we see in the regression results for estimation 4 that, relative to the omitted category of motor occupations, the shares of employees in the skills-based groups of management and administration, cognitive, and social occupations reduce the likelihood of business survival, while they have a positive effect on business growth. The positive effects on employment growth associated with these skills-based occupational categories are found in both the OLS results, which do not account for the influence of sample selection, and the marginal effects that are interpreted as the impacts of a variable on the growth of an establishment in operation as of 2001.

Our results can be explained by the fact that these types of skills can be used to develop strategies for growth and identify market opportunities (i.e., cognitive skills), organize an establishment's activities (i.e., management and administration skills), and communicate and interact with an establishment's customers and other businesses (i.e., social skills). Similarly, Ganotakis (2012, p. 499) suggests that management and marketing skills are important to business performance "as they can contribute to the formulation of strategies that are necessary for a firm to be able to successfully exploit a technological innovation in a marketplace." Interestingly, our findings also suggest that, relative to those who use motor skills, the percentages of workers in Swedish establishments who use management and administration, cognitive, and social skills reduce the likelihood of business survival. An explanation for these results, suggested by Gimeno et al. (1997) in a study of the human capital of entrepreneurs, is that these workers have higher thresholds for business success and if the establishment's performance does not meet the target these workers will move on to other opportunities.

Table 2d. Human Capital effects on growth and survival, 2001 to 2006, Estimation 4 (n=467,034)

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.428**	-0.094**	-0.142**	-0.147**
	(0.006)	*(0.004)*	*(0.005)*	*(0.004)*
*Size*² (ln)	-0.054**	0.008**	0.014**	0.014**
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*
Age (ln)	0.371**	-0.079**	-0.120	-0.130**
	(0.008)	*(0.006)*	*(0.006)*	*(0.005)*
*Age*² (ln)	-0.041**	0.015**	0.019**	0.021**
	(0.003)	*(0.001)*	*(0.001)*	*(0.002)*
*Size*Age* (ln)	0.038**	0.009**	0.004**	0.010**
	(0.002)	*(0.001)*	*(0.001)*	*(0.001)*
Cognitive	-0.053**	0.025**	0.031**	0.033**
	(0.008)	*(0.005)*	*(0.005)*	*(0.005)*
Mgmt. & Admin.	-0.053**	0.081**	0.087**	0.079**
	(0.008)	*(0.004)*	*(0.004)*	*(0.005)*
Social	-0.082**	0.055**	0.064**	0.063**
	(0.007)	*(0.004)*	*(0.005)*	*(0.004)*
Share Entry, industry	-3.738**	NA	NA	NA
	(0.052)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0001)			
Sample Selection Lambda	NA	0.0192**	NA	NA
		(0.012)		
Wald Chi-Squared	4,361**	NA	NA	NA
R-squared	NA	0.038	NA	0.048

Note: Standard errors in parentheses (robust se for OLS); ** and * denote statistical significance at the 1-percent and 5-percent levels. The intercepts and sets of dummy variables that control for an establishment's industry and region of location are not shown in the table.

The final sets of regression results, which include all of the human capital variables, more or less confirm the results found when examining the measures of human capital separately. That is, educational attainment has a positive effect on survival, while the other human capital variables are negatively associated with survival. Furthermore, the marginal effects that account for the influence of sample selection

suggest that the average experience of workers in an establishment has a negative effect on the growth of Swedish businesses, and the shares of workers in management and administration, cognitive, and social occupations have a positive effect on growth (relative to an omitted category of motor occupations).

However, a difference between the earlier results and those from estimation 5 is that, whereas educational attainment had a positive effect on growth between 2001 and 2010 in the analysis that did not account for the occupations employed by the establishment, the marginal effect (and OLS result) associated with educational attainment is not statistically significant in the regression (examining growth between 2001 and 2010) that accounts for the types of occupations employed by the establishment. In addition, the marginal effect (and OLS result) associated with the educational attainment of workers is negative in the regression using data from 2001 to 2006 that controls for the skills (i.e., occupations) of workers in the establishment.

Table 2e. Human Capital effects on growth and survival, 2001 to 2006, Estimation 5 (n=467,034)

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.412**	-0.115**	-0.156**	-0.161**
	(0.006)	*(0.004)*	*(0.004)*	*(0.004)*
Size^2 (ln)	-0.051**	0.012**	0.017**	0.016**
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*
Age (ln)	0.382**	-0.080**	-0.118**	-0.126**
	(0.008)	*(0.005)*	*(0.006)*	*(0.005)*
Age^2 (ln)	-0.036**	0.020**	0.024**	0.024**
	(0.003)	*(0.001)*	*(0.001)*	*(0.002)*
*Size*Age* (ln)	0.034**	0.006**	0.003**	0.008**
	(0.002)	*(0.001)*	*(0.001)*	*(0.001)*
Education	0.055**	-0.008	-0.013*	-0.013**
	(0.008)	*(0.004)*	*(0.004)*	*(0.004)*
Experience (ln)	-0.115**	-0.099**	-0.088**	-0.090**
	(0.004)	*(0.003)*	*(0.003)*	*(0.003)*
Cognitive	-0.064**	0.029**	0.035**	0.037**
	(0.009)	*(0.005)*	*(0.005)*	*(0.005)*
Mgmt. & Admin.	-0.039**	0.097**	0.101**	0.094**
	(0.007)	*(0.004)*	*(0.004)*	*(0.005)*
Social	-0.086**	0.049**	0.058**	0.058**
	(0.007)	*(0.004)*	*(0.004)*	*(0.004)*
Share Entry, industry	-3.842**	NA	NA	NA
	(0.052)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.170**	NA	NA
		(0.012)		
Wald Chi-Squared	6,087**	NA	NA	NA
R-squared	NA	0.044	NA	0.052

Note: Standard errors in parentheses (robust se for OLS); ** and * denote statistical significance at the 1-percent and 5-percent levels. The intercepts and sets of dummy variables that control for an establishment's industry and region of location are not shown in the table.

Overall, we find that the skills-based groups of management and administration, cognitive, and social occupations appear to reduce the likelihood of establishment survival (compared to the skills-based category of motor occupations) due to the high threshold for business performance, yet they enhance the employment growth of establishments that do survive because of their abilities to develop new strategies, organize activities, and communicate with others. Our findings related to the primary importance of business-related skills to establishment growth are similar to the results reported by Almus and Nerlinger (1999), Colombo et al. (2004), and Ganotakis (2012). The fact that the skills-based measures of

human capital influence the growth of Swedish businesses whereas educational attainment and overall experience generally do not is consistent with other studies (Almus and Nerlinger, 1999; Ganotakis, 2012) that did not uncover significant impacts on business performance associated with these conventional measures of human capital.

Although a comprehensive treatment of how the impacts of human capital on business performance vary by industry is beyond the scope of the current paper, we found some interesting differences when focusing on establishments in the agricultural, manufacturing, and services sectors. The industry dummy variables generally have a significant effect in the regression models.[3] Our results show that service-based businesses follow the general pattern reported above, which is consistent with other studies analyzing human capital and firm performance in the services sector (Backman, 2014).

Establishments in the manufacturing and agricultural sectors, however, differ in some respects compared to the pattern revealed for all businesses. The main difference is the effect ascribed to the share of employees with at least a bachelor's degree (*Education*). For all establishments, we find that the percentage of workers in an establishment with a bachelor's degree increases a company's chance of survival, but it does not have a consistent effect on business growth. For establishments in the manufacturing and agricultural sectors, this measure of educational attainment has a negative influence on business survival and growth.

Our finding of differential impacts of human capital on business growth by sector of the economy is consistent with the results from previous studies (Sumner and Leiby, 1987; Weiss, 1999; Crook et al., 2011). An explanation for this finding comes from the different ways in which human capital is deployed within an industry. The influence of human capital may be more pronounced in knowledge-intensive industries where the ability to adopt and adapt to external changes, information, and knowledge is more important.

4. Summary and conclusions

This study examined the effects of human capital on the survival and employment growth of a large sample of Swedish business establishments. Human capital is represented by the conventional measures related to educational attainment and experience, which indicate the amount of human capital possessed by workers, as well as occupational-based variables that indicate the types of skills used by employees to perform their jobs. Our empirical approach involved a Heckman two-stage model of business survival and the growth of businesses that remained in operation over time, with an emphasis on the marginal effects that capture the impacts of human capital on the growth of a "typical" establishment that was open in 2001.

Regression results presented in the paper show that educational attainment, defined as the percentage of workers in an establishment with a bachelor's degree, increases a company's chance of survival, but it does not have a consistent effect on the growth of Swedish businesses. A second key finding uncovered in our analysis is that the average experience (i.e., age) of workers in an establishment has a negative effect on its survival and employment growth over time. Occupational-based indicators of human capital that capture the skills used by workers suggest that, compared to people who use motor skills while performing their jobs, those with management and administration, cognitive, and social occupations enhance the employment growth of establishments.

These results are similar to those found in other studies about the impacts of specific skills (e.g., management and administration) and more general measures of human capital (e.g., education and experience) on business performance. The findings also have important policy implications regarding the importance of skills and knowledge to the outcomes of individuals and overall economies. At a multi-national scale, the OECD has several major initiatives (e.g., OECD Skills Strategy, OECD Skills Outlook) focusing on the skills of its member countries. In a recent report, the OECD Secretary-General proclaimed that "what people know and what they do with what they know has a major impact on their life choices" (OECD 2013, p. 3). Our results show that the skills people use in their jobs, even more so than an individual's level of formal education, can enhance the growth of businesses.

Although the analysis focuses specifically on establishments located in Sweden and our empirical design and approach to measuring human capital differ from other firm growth studies, some of the main

[3] Regression results specific to the agricultural, manufacturing, and services-based businesses are available from the authors upon request.

ideas from our results may apply to businesses operating in other places. That is, the human capital embodied in a company's workforce affects the performance of businesses, yet the nature of these effects depend on how human capital is measured—whether it is education, experience, skills, or another aspect of human capital such as culture and background. Conducting a study similar to ours elsewhere, however, might be hampered by the unavailability of data matching workers and their occupations to businesses and their characteristics (e.g., firm size, industry, etc.). Given the importance of individual skills to economic outcomes found in other countries, it is possible that the skills of workers affect the growth of companies outside of Sweden as well.

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Appendix: Results using data from 2001 to 2010.

Table 3. Effects of Human Capital on the Growth and Survival of Swedish Establishments, 2001 to 2010

Estmation A1:

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.417**	-0.080**	-0.133**	-0.138**
	(0.006)	(0.006)	(0.006)	(0.004)
Size^2 (ln)	-0.049**	0.001	0.007**	0.007**
	(0.001)	(0.001)	(0.001)	(0.001)
Age (ln)	0.325**	-0.117**	-0.158**	-0.164**
	(0.008)	(0.008)	(0.008)	(0.007)
Age^2 (ln)	-0.042**	0.016**	0.021**	0.021**
	(0.003)	(0.002)	(0.002)	(0.002)
*Size*Age* (ln)	0.047**	0.013**	0.007**	0.011**
	(0.002)	(0.001)	(0.001)	(0.002)
Share Entry, industry	-3.463**	NA	NA	NA
	(0.053)			
Average Establishment Size, industry	-0.008**	NA	NA	NA
	(0.003)			
Sample Selection Lambda	NA	0.189**	NA	NA
		(0.017)		
Wald Chi-Squared	2,838**	NA	NA	NA
R-squared	NA	0.060	NA	0.058

Estmation A2:

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.419**	-0.080**	-0.132**	-0.137**
	(0.006)	(0.006)	(0.006)	(0.004)
Size^2 (ln)	-0.049**	0.001	0.007**	0.007**
	(0.001)	(0.001)	(0.001)	(0.001)
Age (ln)	0.325**	-0.117**	-0.158**	-0.164**
	(0.008)	(0.008)	(0.008)	(0.007)
Age^2 (ln)	-0.042**	0.016**	0.021**	0.021**
	(0.003)	(0.002)	(0.002)	(0.002)
*Size*Age* (ln)	0.047**	0.013**	0.006**	0.011**
	(0.002)	(0.001)	(0.001)	(0.002)
Education	0.033*	0.025**	0.021**	0.021**
	(0.008)	(0.006)	(0.006)	(0.006)
Share Entry, industry	-3.477**	NA	NA	NA
	(0.053)			
Average Establishment Size, industry	-0.008**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.186**	NA	NA
		(0.016)		
Wald Chi-Squared	2,860**	NA	NA	NA
R-squared	NA	0.060	NA	0.058

Estmation A3:

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.393**	-0.113**	-0.148**	-0.153**
	(0.006)	(0.006)	(0.006)	(0.004)
Size^2 (ln)	-0.042**	0.006**	0.010**	0.010**
	(0.001)	(0.001)	(0.001)	(0.001)
Age (ln)	0.348**	-0.126**	-0.157**	-0.161**
	(0.008)	(0.008)	(0.008)	(0.007)
Age^2 (ln)	-0.033**	0.024**	0.027**	0.027**
	(0.003)	(0.002)	(0.002)	(0.002)
*Size*Age* (ln)	0.039**	0.009**	0.005**	0.009**
	(0.002)	(0.001)	(0.001)	(0.002)
Experience (ln)	-0.235**	-0.144**	-0.122**	-0.127**
	(0.004)	(0.004)	(0.004)	(0.004)
Share Entry, industry	-3.656**	NA	NA	NA
	(0.054)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.136**	NA	NA
		(0.016)		
Wald Chi-Squared	5,194**	NA	NA	NA
R-squared	NA	0.065	NA	0.063

Estmation A4:

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.433**	-0.094**	-0.149**	-0.154**
	(0.006)	(0.007)	(0.007)	(0.004)
Size^2 (ln)	-0.053**	0.004**	0.010**	0.010**
	(0.001)	(0.001)	(0.001)	(0.001)
Age (ln)	0.317**	-0.109**	-0.149**	-0.156**
	(0.008)	(0.008)	(0.008)	(0.007)
Age^2 (ln)	-0.040**	0.014**	0.019**	0.019**
	(0.003)	(0.002)	(0.002)	(0.002)
*Size*Age* (ln)	0.049**	0.011**	0.005***	0.010**
	(0.002)	(0.001)	(0.001)	(0.002)
Cognitive	-0.061**	0.043**	0.051**	0.053**
	(0.009)	(0.006)	(0.007)	(0.007)
Mgmt. & Admin.	-0.063**	0.104**	0.112**	0.104**
	(0.008)	(0.006)	(0.006)	(0.006)
Social	-0.064**	0.037**	0.045**	0.045**
	(0.007)	(0.005)	(0.005)	(0.005)
Share Entry, industry	-3.427**	NA	NA	NA
	(0.054)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.191**	NA	NA
		(0.016)		
Wald Chi-Squared	3,128**	NA	NA	NA
R-squared	NA	0.062	NA	0.060

Estmation A5:

Variable	First-Stage *Survival*	Second-Stage *Growth* (ln)	Marginal Effect	OLS Regression
Size (ln)	0.399**	-0.128**	-0.166**	-0.170**
	(0.006)	(0.006)	(0.006)	(0.005)
Size^2 (ln)	-0.045**	0.009**	0.014**	0.013**
	(0.001)	(0.001)	(0.001)	(0.001)
Age (ln)	0.340**	-0.115**	-0.148**	-0.152**
	(0.008)	(0.008)	(0.008)	(0.007)
Age^2 (ln)	-0.031**	0.022	0.026**	0.026**
	(0.003)	(0.002)	(0.002)	(0.002)
*Size*Age* (ln)	0.040**	0.007**	0.003**	0.007**
	(0.002)	(0.001)	(0.001)	(0.002)
Education	0.038**	0.001	-0.003	-0.003
	(0.008)	(0.006)	(0.006)	(0.006)
Experience (ln)	-0.235**	-0.153**	-0.130**	-0.134**
	(0.004)	(0.004)	(0.004)	(0.004)
Cognitive	-0.064**	0.046**	0.052**	0.054**
	(0.009)	(0.007)	(0.007)	(0.007)
Mgmt. & Admin.	-0.028**	0.129**	0.132**	0.124**
	(0.008)	(0.006)	(0.006)	(0.006)
Social	-0.074**	0.031**	0.038**	0.037**
	(0.008)	(0.005)	(0.005)	(0.005)
Share Entry, industry	-3.629**	NA	NA	NA
	(0.054)			
Average Establishment Size, industry	-0.007**	NA	NA	NA
	(0.0003)			
Sample Selection Lambda	NA	0.143**	NA	NA
		(0.016)		
Wald Chi-Squared	5,690**	NA	NA	NA
R-squared	NA	0.068	NA	0.072

*Notes. Standard errors are shown in parentheses; robust standard errors in the case of the OLS regression. ** and * denote statistical significance at the 1-percent and 5-percent levels. The regression models also include intercepts and two sets of dummy variables, not shown in the table, that control for an establishment's industry and region of location. Of the original sample of 467,034 establishments in 2001, 208,437 of the businesses were in operation as of 2010.*