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Internationalization amongst Professional Service Firms:  
A Study of UK Based Engineering Consultants**

**By**

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### **Abstract:**

This paper studies the antecedents of internationalization amongst professional service firms (PSFs). Using a unique panel of UK-based engineering consultancies over the 1994-2009 period, we show that more specialized PSFs are more likely to internationalize than firms with a broader scope of activities, and that domestic geographical diversification as well as diversification into more unrelated fields enhances the international competitiveness of PSFs. Specific human capital also fosters internationalization, and moreover, significantly intensifies the advantages of various forms of diversification. Business size, age, foreign ownership and management buy-outs also exert positive and



significant effects. The findings contribute to the literature on services internationalization and provide novel insights for the management of firms' geographical and industrial diversification.

**Keywords:** Internationalization ; diversification strategies ; human capital ; knowledge-intensive business services ; professional service firms (PSFs)

**Jel codes:** F23 ; L25 ; L84 ; M16

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## 1. INTRODUCTION

As globalization has provided new opportunities for companies operating in a wide variety of sectors, the resources and capabilities associated with internationalization have become a central concern of management. In recent years services in particular have experienced unprecedented access to foreign markets, thanks to the breakdown of trade barriers through deregulation and liberalization, the rapid diffusion of information communication technologies (ICTs) and the declining real cost of air travel (e.g., Miozzo and Soete, 2001; Ball, Lindsay and Rose, 2008; McNeill, 2009).

Yet, despite their domination of advanced economies, the internationalization of services has received scant scholarly attention. And various scholars have lamented the imbalance between the ever-increasing economic importance of services, and their academic neglect (e.g. Merchant and Gaur, 2008; Pla-Barber, Sanchez-Peinado and Madhok, 2010). Indeed, Merchant and Gaur (2008) consider that as scholars we are 'standing on very thin ice' in our collective understanding of how service firms internationalize.

Following von Nordenflycht's (2010, 2011) taxonomy, in this paper we focus on professional service firms (PSFs), which are characterized by high knowledge intensity, low capital intensity, and a professionalized workforce. PSFs are among the most dynamic firms in advanced economies (Wood, 2002; Tether and Tajar, 2008), and offer an ideal context for the analysis of knowledge-based competition that is becoming increasingly pivotal to business growth. We drawing upon human capital theory and the capabilities view of the firm to posit a set of hitherto unexplored hypotheses related to the extent of internationalization of PSFs. These hypotheses are tested using a unique dataset of UK-based engineering consultancies that spans over 15 years. Moreover, we utilize a novel empirical measure of industry relatedness that is inspired by the capability-based measure developed by Bryce and Winter (2009). This addresses the considerable challenge of measuring technological diversification in services, and brings further insight into the variation of service offerings amongst PSFs, as we consider not only the scope of these firms but also the relatedness or unrelatedness of their diversification.

Our analysis reveals the effect of a firm's human capital on its internationalization to be strongly contingent on its industrial scope, extent of unrelated diversification, and prior domestic regional coverage. To the best of our knowledge, this study provides the first evidence linking the international competitiveness of PSFs to their industrial diversification, domestic geographical diversification, human capital endowments, and other characteristics.

Our paper thus offers theoretical contributions to theories of internationalization anchored in human capital theory and the capabilities-based view of the firm (Johanson and Vahlne, 2009; Zander, 1997). We also offer empirical contributions to the literature on the internationalization of services, and more particularly of professional service firms (PSFs).

This paper is organized as follows. Section 2 draws insights from extant theories of human capital, diversification and learning within firms, linking these to internationalization to build a set of testable hypotheses. Section 3 introduces the data and discusses the empirical methodology. Section 4 presents the results, and Section 5 provides a discussion of the findings including the managerial implications. The last section concludes the paper.

## **2. THEORY AND HYPOTHESES DEVELOPMENT**

The international economics and business literature highlights a variety of reasons as to why firms internationalize their activities, including the exploitation of market power and reputation, the search for cost advantages and the adoption of risk-minimizing strategies (Kim, Hwang and Burgers, 1989; Jensen and Murphy, 1990). Unlike production-related advantages in manufacturing firms, a primary source of competitive advantage in internationalized PSFs stems from their ability to respond to particular client's demands with high-quality performance, whilst maintaining close contact with clients and keeping transaction costs low (Ochel, 2002; Brouthers and Brouthers, 2003). Internationalization provides opportunities to exploit these capabilities (Hitt et al., 2006). Beaverstock, Smith and Taylor (1999), for instance, found that London-based law firms were motivated to expand into foreign markets to gain access to a larger client base, combat competitive pressure from rival firms, and to establish strategic alliances through mergers and joint ventures. For all firms, however, there are trade-offs: working for foreign client entails high co-ordination costs and can over-stretch finite managerial resources (Ocasio, 1997).

### **2.1 Specialization and industrial cope**

When PSFs decide to internationalize, they are not only faced with a decision about the intensity of their current commitment but also its potential growth over time. Within the range of possible fields of activity, and conditional on largely exogenous demand patterns, firms have to decide what services they are willing and able to supply in foreign markets. They can either seek to apply their existing expertise or engage in new (more or less related) activities that are often developed as clients' needs evolve.

Although the latter strategy can be encouraged by clients' increasing interest in simplifying their buying of professional services, as evidenced by a growing preference for 'one-stop-shops', internationalizing by expanding the range of services offered can be costly – and more risky – due to 1) informational problems in the complex hierarchy of a multidivisional firm (Williamson, 1975); 2) problems of investment management and coordination across different activities (Tallman and Li, 1996); and/or 3) problems of organizational change (Sorenson, McEvily, Ren and Roy, 2006). For these reasons, conventional wisdom suggests firms are more likely to enter foreign markets by exploiting competences they have created in their home country, and adapting their output to new clients as required (Rugman, 1981). By specializing in particular activities in the domestic market firms can build intangible assets and, crucially, a reputation in that activity, which they can then leverage abroad (Cantwell, 1989). This is especially true in the context of professional services, where specialization has been found to help build reputation because of the importance of referrals and recommendations for gaining business within trust-based networks (Løwendahl, 1997; Glucker and Armbruster, 2003). We therefore hypothesize:

*Hypothesis 1a: A firm's degree of internationalization increases with its level of specialization (and decreases with increasing industrial scope).*

## **2.2 Domestic geographical diversification**

The role of domestic experience in internationalization has aroused some controversy. The conventional view is that domestic expansion is often an important antecedent to international expansion as firms draw on their past domestic experience to exploit opportunities in foreign markets, and to manage the complexities of the internationalization process (Rialp, Rialp, and Knight, 2005; Johanson and Vahlne, 2009). In this view, the accumulation of domestic experience gradually gives rise to unsolicited export opportunities, and leads to bolder commitments to foreign markets . Some researchers have, however, argued that greater domestic experience may hinder successful internationalization, because domestically oriented firms become so highly adapted to the idiosyncrasies of the domestic market that they lose the capacity to successfully adapt to foreign markets (Oviatt and McDougall, 1994; Autio, 2005; Sapienza, Autio, George, and Zahra, 2006). Thus, rather than being an advantage that can be leveraged for internationalization, extensive domestic experience becomes a source of rigidity and a competency trap (Levitt and March, 1988) that inhibits internationalization (Autio *et al.*, 2000).

In the context of services, we believe that prior geographical domestic expansion is likely to aid rather than hinder internationalization. Services, and especially knowledge

intensive and professional services, are typically undertaken with the client and service provider working closely together, such that services are often 'co-produced' by the partnership (Bettencourt, Ostrom, Brown and Roundtree, 2002). Indeed, services, which are typically intangible, heterogeneous (i.e., they often involve high levels of customization and specialization), and perishable (i.e., they cannot be stocked or stored), are often characterized by inseparability and simultaneity of the production, delivery and use (Boddewyn *et al.*, 1986). Growing the business implies serving more local customers with a wider array of service offerings, thereby broadening the scope of the business, or serving clients of a given set of services at greater physical distance from the firms' existing offices. Both strategies imply learning, although along different dimensions. The former implies learning about technologies, markets and customers, whilst the latter typically involves setting up regional offices, and expanding geographically into a larger number of regions within the domestic market; in doing so, the firm can learn how to set-up and run remote or satellite offices and operate in regional markets that may vary significantly. We consider that this will be a valuable learning experience for expansion into international markets where firms will face additional difficulties such as different local customs, demands and preferences, different institutional logics, and possibly different ways of organizing (Lord and Ranft, 2000). On this basis, we hypothesize that:

*Hypothesis 1b: A firm's degree of internationalization increases with its prior geographical diversification in domestic markets.*

### **2.3 Unrelated diversification**

Product-life-cycle theory (Vernon, 1966) and more recent neo-technology models (Greenhalgh, 1990) have laid the basis for an extensive stream of literature on industrial diversification and knowledge accumulation. Particularly in manufacturing, production often moves from high-cost locations in industrialized economies to low-cost locations in developing countries, and scholarly work has shown that multinationality is associated with significant learning in subsidiaries as well as knowledge spillovers to host economies (Cantwell, 1989; Almeida, 1996). For professional services, the patterns of competition and learning may be somewhat different. Firms based in high-cost locations will find it difficult to compete with local rivals in basic activities. They may instead hold an advantage when more complex or unusual services are required. This can entail the ability to bring together less immediately related types of expertise. Provided that a firm is able to overcome the initial costs associated with diversifying into less related activities, the additional learning from governance and coordination experience is likely to provide more unique knowledge-base

about technologies and contexts, such that it enhances the firm's ability to exploit its resources in more complex or unusual situations. Moreover, Zhou (2010) has recently shown that despite the synergistic benefits of related diversification, coordination costs usually increase with industrial scope at a higher rate for more related than for less related diversification. We therefore hypothesize that:

*Hypothesis 1c: A firm's degree of internationalization increases with its prior diversification into unrelated industrial activities.*

## **2.4 Specific human capital**

Turning next to the importance of capabilities and resources for internationalization, what a firm does and the resources it possesses largely determine what it can accomplish in the future (Nelson and Winter, 1982; Wernerfelt, 1984). Firms with stronger intangible assets and capabilities can exploit these to derive competitive advantages, and moreover the sustainability of these competitive advantages will require the resources and capabilities be non-replicable and non-substitutable, so they cannot be copied by rival firms, thereby eroding the foundations of their competitive advantage.

In the context of professional services, skilled human capital has been identified as the fundamental resource of these firms (Erramilli and Rao, 1993; von Nordenflycht, 2010). As Hitt *et al.* (2006) observe, professional services generally create value in the form of information and advice through the selection, development and use of human capital. Not only is human capital the key to their knowledge and expertise - the fundamental products of these firms - but it is also the cornerstone of their reputation and relational (or social) capital, the other key resources of PSFs. Teece (2003, p. 903), for example, states that: "while reputational capital is certainly not unique to PSFs, it is frequently their most important asset. This is because other methods of selling – for instance advertising – are usually quite ineffective." In other words, the services are embodied in the people who provide them, and internationalization allows firms to build on and extend their reputation in the domestic market to overseas markets, where internationalized firms are often perceived as having higher quality (Aharoni, 2000, p. 127-128).

We follow Becker (1993) and identify the people with the technical skills and knowledge specific to the engineering consulting industry - which our data focuses on - as holding *specific human capital*. This is distinct from more general human capital which is useful in all industries. It follows that there are a number of reasons why higher specific human capital is likely to be associated with greater internationalization amongst PSFs. First,



operating in foreign markets is likely to require learning about those foreign markets, their customs and regulations. Maintaining high levels of specific human capital helps firms understand these contexts, as well as enhance and protect their reputation, a critical resource for PSFs. For instance, British civil and structural engineers with chartered status belong to the prestigious and internationally renowned Institutions of Civil and Structural Engineers. Greater specific human capital also enables firms to bring something extra, relative to the local competitors, and therefore helps to overcome the liability of foreignness (Zaheer, 1995) and to build relational capital.

Moreover, firms are known to sometimes go abroad in order to learn about different markets, or the application of technologies in unusual contexts. Strong specific human capital will enhance this learning, which can then be used to enhance the firm's competitive resources and capabilities (Cantwell and Piscitello, 2000; Zahra, Ireland and Hitt, 2000). We therefore posit that:

*Hypothesis 2: A firm's degree of internationalization increases with its endowment of specific human capital.*

## **2.5 Interactions between diversification and specific human capital**

Overall, specific human capital is positively associated with absorptive capacity both in knowledge-based (Rialp *et al.*, 2005; Sapienza *et al.*, 2006) and organizational-learning (Di Gregorio, Musteen, and Thomas, 2008) frameworks. It follows that there are likely to be several complementarities for international engagement between the extent to which the firm is diversified and its level of specific human capital. We briefly discuss these likely interaction effects below.

First, firms that specialize in a small number or range of activities engage, by definition, in more homogeneous tasks and similar repeated experiences or routines. The development of such routines often encourages a finer division of labor, and allows the substitution – crucially without significantly diminishing task performance and by extension reputation – of more for less highly-educated or trained labor (Metcalf, James and Mina, 2005). On the other hand, learning across a broad range of activities is likely to be enhanced (or inhibited) by maintaining higher (or lower) levels of specific human capital. If this learning helps firms create new knowledge and leverage capabilities, then it is likely to enhance their international competitiveness. Hence, we hypothesize:

*Hypothesis 3a: Higher specific human capital will enhance the extent of internationalization as the scope of the firm increases.*

Second, within the context of professional services, where close client relations are important, the ability to serve regional markets, which vary in scale and other dimensions, is likely to imply different regional office sizes and other variations in local arrangements. Firms may expand in a franchise type fashion, replicating routines and establishing very similar offices and practices in the various domestic regions (Winter and Szulanski, 2001), including where possible the substitution of more for less specialized and highly educated labor. However, doing this will reduce the firm's opportunity to learn from the variation that exists within its domestic market. Instead, firms that maintain higher levels of specific human capital will enhance their capacity to learn from this variation, will enhance their ability to exchange knowledge within multi-office settings and to co-ordinate project teams at a distance, and will enhance their ability to leverage this knowledge within international markets. Hence, we hypothesize:

*Hypothesis 3b: Higher specific human capital will enhance the positive effect of a firm's prior domestic geographical diversification on its degree of internationalization.*

Finally, a high level of specific human capital is likely to be particularly valuable when the firm engages in a set of relatively unrelated activities. At the extreme, a firm that engages in a set of unrelated activities may operate as a conglomerate of separate businesses. In so doing, it is likely to focus on optimizing each business independent of the others, and this may well involve substituting more for less highly specialized or educated labor. Alternatively, by maintaining a high level of specific human capital, a firm engaged in relatively unrelated activities can enhance its ability to communicate and learn across these various activities, to exchange knowledge between them and possibly to combine activities, generating distinctive capabilities that can be leveraged in international markets. Hence, we hypothesize:

*Hypothesis 3c: Higher specific human capital will enhance the positive effect of a firm's prior unrelated diversification on its degree of internationalization.*

### **3. DATA AND METHODS**

#### **3.1 Data and sample**

To investigate the internationalization of PSFs, this study exploits a novel dataset of UK-based engineering consultancy firms. Engineering consulting has, in recent years, shown

exceptionally high rates of growth both within the UK and internationally. The UK's Annual Business Survey (ABS), which is conducted by the Office for National Statistics to monitor the 'health' of various sectors, shows that business population in the 3-digit sector, within which these firms operate (i.e. SIC 74.2), grew by 38% between 1995 and 2007, and that the sector's gross value added increased by 94% after adjusting for inflation (compared with just 1.4% for UK manufacturing). Based on the most recent *Structural Business Statistics* (SBS) available from Eurostat, nearly a quarter (23%) of the sector's output went to international markets, with British firms amongst the most internationalized in the EU. Notably, this includes a strong orientation towards more distant markets, with sales outside the EU exceeding those within the EU by nearly 3 times. These indicators reflect the UK's strong international competitiveness in the sector.

The data for the study has been drawn primarily from *New Civil Engineer's* (NCE) 'Consultants File'. NCE is the weekly magazine of the Institution of Civil Engineers (ICE), the UK's chartered body for civil engineering. For its 'Consultants File', NCE gathers annual information on individual civil and structural engineering consulting firms based in the UK, including the total number of staff employed in the UK and abroad, the proportion of technical staff working in the UK and abroad, total sales, geographical areas of work (i.e., UK and world regions), and areas of engineering expertise (i.e. up to 39 areas of expertise or activity). Although inclusion in the 'Consultants File' is voluntary and potentially biased towards larger engineering consultancies, we believe that this is unlikely to be problematic for our analysis given that, based on calculations using Eurostat data for the broader sector (i.e. SIC74.2), the sector's output is highly concentrated in larger firms with at least 50 employees.

To compile the dataset, we took each year's 'Consultants File' and linked the firms reported therein for the period 1979-2009. However, some crucial information such as the number of overseas technical staff was only collected from 1994, so we restricted our analysis to the 16-year period spanning from 1994 to 2009. Our main empirical analysis (Section 4) draws on 2,623 valid firm-year observations which relate to 236 individual firms.

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Table 1 goes about here  
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To enhance the dataset, additional firm-level information was gathered from the Internet (mainly company websites) and complementary data sources such as *Financial Analysis Made Easy* (FAME), which provides access to company accounts, and *Zephyr*,

which provides information on mergers and acquisition. Both of these datasets are maintained by Bureau van Dijk. This additional data covers the location of firm headquarters, foreign ownership, ownership changes (e.g. M&As, management buyouts), and other firm life events such as closure. Table 1 provides detailed definitions of the variables used in the analysis, whilst Table 2 provides some descriptive statistics and the correlation matrix.

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Table 2a goes about here

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Table 2b goes about here  
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**3.2 Dependent variable**

Traditional measures of internationalization are generally uni-dimensional (Hitt, Hoskisson and Kim, 1997; Lu and Beamish, 2004; Hitt *et al.*, 2006). That is, they account for either the degree (e.g., foreign sales as a proportion of total sales – Hitt *et al.*, 1997; Di Gregorio *et al.*, 2008) or the scope (e.g., number of international markets involved in – Tallman and Li, 1996) of internationalization, but not both. Following UNCTAD (1995)<sup>i</sup> and others (e.g., Sanders and Carpenter, 1998; Lu and Beamish, 2004; Qian *et al.*, 2008), we employ a multi-dimensional approach by combining two components of internationalization: the depth (commitments to foreign markets) and the breadth (scope of international expansion) of internationalization. We measure depth of internationalization using information on the proportion of technical staff based in foreign countries,<sup>ii</sup> whilst we measure breadth using the number of foreign regional markets that the firm is engaged in, relative to the maximum possible number of foreign regional markets available. These depth and breadth aspects are moderately correlated (correlation coefficient 0.62), with a satisfactory internal consistency score (Cronbach’s alpha=0.6).<sup>iii</sup> Our measure of internationalization combines these two elements by taking the average of these two percentage figures, and therefore ranges between 0 and 1, with 1 indicating the highest possible level of internationalization.

**3.3 Industrial scope and relatedness in diversification**

This study considers two specific underlying dimensions of PSFs’ service offerings. The first is the scope of diversification, which is a simple count of the number of different

activities that the firm engaged in (e.g., roads, bridges, pipelines, fire engineering, earthquake engineering, etc.). Given that the data structure concerning industrial activities varies over time (i.e. some activities appear in all years, whilst others emerge and others disappear), to ensure comparability across years, we calculated the total number of disciplines a firm was engaged in as a proportion of the maximum number of disciplines existing in any given year. We label this dimension ‘industrial scope’: specialized firms have a narrow scope, whilst diversified firms have a broad scope.

However, the extent of industrial diversification can also depend on the ‘closeness’ of each of these activities to one another (Montgomery and Wernerfelt, 1988; Rumelt, 1974). In order to measure the direction of services diversification (i.e. related vs. unrelated), we therefore largely followed Bryce and Winter’s (2009) approach to developing a relatedness index. More specifically, we constructed a co-occurrence matrix based on the frequencies with which any two disciplines appeared within the same firm in any given year.<sup>iv</sup> As combinations of activities may appear more or less often than by chance (i.e., random co-occurrences), we controlled for the expected frequencies of co-occurrence and normalized the raw counts against the random hypothesis, a procedure originally suggested by Teece, Rumelt, Dosi and Winter (1994).

Further adjustment is necessary to mitigate the bias that smaller portfolios are likely to reflect stronger relationships between a pair of activities than larger portfolios: highly diversified firms may engage in activities that are only weakly linked to other activities in their portfolio.<sup>v</sup> To allow the size of portfolios to be adequately adjusted for and better reflect the relatedness of the dyads, we operationalized this adjustment by means of a Newman (2001) weighting procedure, with weights being applied to the co-occurrence matrices on the basis of the following formula:

$$w_{ij} = \sum_p \frac{1}{N_p - 1}$$

where  $w_{ij}$  is the weight between node  $i$  and node  $j$ ,  $p$  is the firms where two activities are observed to co-appear and  $N_p$  is the number of disciplines observed within the same firm.

Ultimately, our measure of the second dimension of service diversification – the unrelatedness index, is derived from the average distances between each pair of activities within a firm’s portfolio. This is low when firms only engage in highly related activities (i.e., frequently occurring combinations); it is high when they engage in highly unrelated activities (i.e., rarely occurring combinations).

Together, industrial scope and the unrelatedness index capture substantial variation in organizational behavior with respect to firms' activities, as Figure 1 illustrates. These measures recognize that firms involved in a large number of activities or business segments (i.e. a higher value on industrial scope) may score lower in terms of unrelatedness than firms that concentrate their resources in a small number of generally unrelated activities.

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Figure 1 goes about here  
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### 3.4 Other independent variables

Beyond industrial scope and the relatedness of diversification, we also measure the extent of the firms' **domestic geographical diversification** by calculating the proportion of UK regions in which the firm was active relative to the maximum number of regions. There are ten regions in total, including Scotland, Wales, Northern Ireland and eight English regions. This yields a measure ranging between 0.1 and 1. Although this measure does not capture the relative importance of each regional market (as in, Qian *et al.*, 2008), it is adequate for our purposes, which is to measure how firms expand physically, and to infer how they learn from this experience. This learning, we argue, will be greater with an increased number of regions served.

To proxy for the level of **specific human capital** in the firm, we use the proportion of UK technical staff in the firm over the size of its workforce (c.f. Wolf, 1977).

### 3.5 Control variables

We control for the impact of the firm's **past internationalization** activities (which highlights the persistence of internationalization) by including the lagged internationalization variable (Hitt *et al.*, 2006). To proxy for a reputation effect, we include the **age of the business**. Here, age is derived from the firm's self-reported year of establishment (which is usually reported on company websites).<sup>vi</sup> To allow for a potential nonlinear effect of business age, we include its quadratic. To control for **size and efficiency**, we use the number of employees based in the UK and labour productivity (i.e. inflation-adjusted turnover per employee) respectively.

We also control for the broad **type of disciplines** the firm has engaged in. Following consultation with experienced experts within the engineering consulting industry, we have classified the 39 areas of expertise into 4 sub-groups, based on the nature of the knowledge deployed: 1) fundamentals (i.e. fundamental building and structural engineering activities, such as building services, general civil and structural design, and foundations); 2) complex systems, such as harbours, ports and docks, airports, and offshore oil and gas pipelines; 3) specialist areas, such as fire and earthquake engineering; and 4) non-technical areas, such as health and safety, management consulting, and legal advice.

To control for the impact of **foreign ownership**, we include a dummy variable to indicate if the firm's ultimate owner is a foreign enterprise. 'Critical incidents', such as changes in ownership or management, can exert an important influence on the propensity of firms to internationalize (Bell, McNaughton and Young, 2001). To control for the impact of such events, we include dummy variables for **mergers and acquisitions, management buy-outs, and closures**.

We also control for the **location of the firm's headquarters**. PSFs are known to be sensitive to regional clustering (Martinez-Argüelles and Rubiera-Morollón, 2006), and London is a world city and a hub for various professional services (see Hitt *et al.*, 2006 for similar observations in relation to New York). We therefore anticipate that firms headquartered in London will be more deeply engaged in international market than those headquartered elsewhere. Also notable is Northern Ireland, which is separated from the rest of the UK by the Irish Sea, but shares a border with the Republic of Ireland, which counts as an international market. Due to the relative ease of serving the Republic from Northern Ireland, firms headquartered there are likely to have a higher level of internationalization than otherwise similar firms headquartered in the rest of the UK. Finally, we included **year dummies** to control for time effects.

### 3.6 Estimation method

Given that our dependent variable of internationalization consists of proportional values bounded between zero to unity, we follow Papke and Wooldridge (1996) and use a quasi-maximum likelihood estimation (QMLE, with a logistic mean function) to estimate fractional response models of internationalization using our pooled panel sample.<sup>vii</sup> This method, which has previously been employed in similar settings by Wagner (2001) and Hanley (2009), ensures the estimate of the dependent variable and thus its predicted values are bounded between 0 and 1. It also accommodates non-linear relationships between the

explanatory variables and the dependent variable, which is useful when the marginal effect of an explanatory variable is expected to diminish. We implemented this using the STATA statistical package. .

Specifically, we consider the following model for the conditional expectation of the fractional response variable 'INTLN':

$$E[\text{INTLN}_i | x_i] = G(\beta_0 + \beta_1 \text{INTLN}_{i-1} + \beta_2 \ln \text{Indscp}_{i-1} + \beta_3 \ln (\text{Indscp}_{i-1})^2 + \beta_4 \ln \text{Unrelated}_{i-1} + \beta_5 \ln (\text{Unrelated}_{i-1})^2 + \beta_6 \ln \text{Regdiv}_{i-1} + \beta_7 \ln \text{Humcap}_{i-1} + \beta_8 \text{M\&A}_{i-1} + \beta_9 \text{Acquired}_{i-1} + \beta_{10} \text{MBO}_{i-1} + \beta_{11} \text{Displns}_{i-1} + \beta_{12} \ln \text{Prod}_{i-1} + \beta_{13} \ln \text{Age}_{i-1} + \beta_{14} \ln (\text{Age}_{i-1})^2 + \beta_{15} \ln \text{Size}_{i-1} + \beta_{16} \text{Foreign}_{i-1} + \beta_{17} \text{Closure}_i + \beta_{18} \text{Region}_i + \beta_{19} \text{Time}_i), \quad i=1, \dots, N(1)$$

Here, INTLN is our dependent variable internationalization, which ranges from 0 to 1; INTLN<sub>*t-1*</sub> denotes its previous value at time *t-1*; all other continuous variables are included in natural log forms, viz. *Indscp* for the level of industrial scope, *Unrelated* for the level of unrelated diversification, *Regdiv* for the degree of geographic diversification, *Humcap* for the level of specific human capital, *Prod* for labor productivity. Other control variables are also included, such as *M&A*, *Acquired*, *MBO*, *Displns* (discipline types), *Foreign* (foreign ownership) and *Closure*, as well as regional and time dummies. To control for potential endogeneity of explanatory variables, we estimate INTLN on the previous values of these variables by lagging them by one year (except for closure, region and year)<sup>viii</sup>.  $G(\bullet)$  is the

logistic function such that  $G(z) = \frac{\exp(z)}{1 + \exp(z)}$ , which means that  $G(\bullet)$  falls within the (0, 1)

interval. Here, based on the formulation put forward by McCullagh and Nelder (1991), and to obtain consistent estimates of  $\beta$ , Papke and Wooldridge propose the maximization of log likelihood using the Bernoulli quasi-likelihood function, which is given by:

$$l_i(\beta) = y_i \log[G(x_i\beta)] + (1 - y_i) \log[1 - G(x_i\beta)] \quad (2)$$

#### 4. RESULTS

The estimated models are presented in Table 3. Model 1 is the baseline model, which includes the main effects and control variables; Models 2, 3 and 4 introduce interactions between specific human capital and, respectively, industrial scope, related-unrelated diversification and domestic regional diversification



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Table 3 goes about here  
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The models show that the extent of a firm's current internationalization is highly related to its past levels of internationalization. Indeed, the lagged dependent variable is, unsurprisingly, the most important predictor of a firm's current level of international engagement, and the level of internationalization amongst PSFs is therefore shown to be highly persistent.

In relation to the impact of industrial scope, Model 1 shows that the broader the scope of the firm's activities, the lower the extent of its internationalization. There is no statistically significant quadratic effect of this factor. The results therefore support Hypothesis 1a, which anticipated that more specialized firms would be more internationalized than firms with a broader scope (all else equal).

The coefficient on UK regional diversification is also significant and positive.<sup>ix</sup> This indicates that the greater a firm's prior domestic regional diversification, the greater its internationalization will be. This provides support for Hypothesis 1b.

In relation to the impact of related and unrelated industrial diversification, we find that unrelated diversification shows a positive and highly significant effect on the extent of internationalization. Meanwhile, the squared term of this variable is also highly significant but negative, which indicates that diversification into less related activities has a highly positive yet diminishing effect on the extent of international engagement. Overall, the results support Hypothesis 1c which anticipated that prior diversification into less related business activities would increase engagement in international markets (see Figure 2).

We also find that that the level of specific human capital plays a significant and positive role in influencing the extent of a firm's internationalization, corroborating Hypothesis 2.<sup>x</sup>

To examine whether the level of specific human capital moderates the relationships between the diversification strategies and the extent of internationalization, we also estimated models with interaction terms. Specifically, we interacted specific human capital with industrial scope (Model 2, Hypothesis 3a), with domestic regional diversification (Model 3, Hypothesis 3b), and with unrelated diversification (Model 4, Hypothesis 3c).

Significant interaction effects were found in all three models. To illustrate the extent to which higher (and lower) levels of specific human capital moderate the effects of diversification on international competitiveness, these interaction effects have been plotted in the hypothetical diagrams in Figure 2. These diagrams reveal that specific human capital significantly moderate the negative influence that industrial scope exerts on the firm's international engagement, such that firms with a broader scope and high level of specific human capital tend to be considerably more internationalized than those with an equally broad scope but low level of specific human capital. This supports Hypothesis 3a. Meanwhile, for each level of prior domestic regional diversification, international engagement is higher (lower) amongst firm with higher (lower) endowments of specific human capital. This supports Hypothesis 3b. Finally, for each level of unrelated diversification, international engagement is higher (lower) amongst firms with higher (lower) specific human capital. This supports Hypothesis 3c.

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Figure 2 goes about here  
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In relation to the controls, we find that the parameter estimate for firm age is positive and significant, and that its squared term is also significant but negative. This indicates that firm age has a positive but diminishing marginal effect on internationalization, and indeed we find that the age effect becomes insignificant after 58 years. Larger firms also tend to have greater engagement in international markets, which likely reflects their greater resource portfolios and capacity for international activities (Hitt et al, 2006). Productivity, however, has no significant effect. As anticipated, firms headquartered in London and Northern Ireland are, on average, more internationalized than firms headquartered in other UK regions.

With respect to the different types of engineering disciplines, we only find a significant negative effect for 'non-technical areas'. This includes activities such as health and safety and legal advice. This is understandable given that these activities are not technically based and therefore have more variable jurisdictions and therefore location-dependent. Unsurprisingly, foreign ownership also has a positive and significant effect, indicating that foreign owned firms operating in the UK are on average more internationalized than their UK-owned counterparts. With the exception of Management Buy-Outs, changes in ownership (i.e., mergers and acquisitions, or being acquired) had little impact on the firm's international competitiveness. In line with expectations, Management Buy-Outs, which are associated with a rejuvenation of the management team and a willingness to take greater risks and bolder

strategies (Wright, Hoskisson and Busenitz, 2000; Hitt *et al.* 2006), are positively related to internationalization. Closure, meanwhile, had an unsurprising negative impact on the firm's international expansion.

## 5. DISCUSSION

In this paper we set out to investigate the links between diversification, human capital and internationalization among professional service firms (PSFs), which are amongst the most dynamic and fast growing firms in advanced economies. Drawing upon human capital theory and the capabilities-based view of the firm, we posited a set of hitherto unexplored hypotheses related to internationalization among PSFs, which we then tested using a unique longitudinal dataset of UK-based engineering consultancies. Our findings demonstrate the direct significance of specific human capital, diversification in scope, domestic regional coverage, and engaging in more unrelated activities (i.e., less frequently combinations of activities), but also revealed the link between specific human capital and a firm's internationalization to be strongly contingent on its industrial scope, extent of unrelated diversification, and prior domestic regional coverage. For each level of these diversification behaviors, firms with higher levels of specific human capital achieved greater internationalization. This indicates that specific human capital enhances the capacity of firms to learn from diversification, and to apply this knowledge, to benefit their international activities.

In general, professional service firms create value for clients at home and abroad by synthesizing and transforming tacit and explicit knowledge that is obtained from a variety of sources and partners (Hipp, 1999). This knowledge then becomes embodied in highly skilled and qualified people (as individuals and teams), and in internal codified knowledge. We find that firms specializing in a small number of activities typically have a stronger international orientation than those that engaged in a wide range of activities. This can be explained by the need for firms that have chosen to restrict themselves to a small set of activities to seek out opportunities abroad where they can capitalize on this relatively narrow base of technical expertise. Less specialized firms, that is those with greater scope, may emphasize market knowledge over technical knowledge. This will lead them to first seek further opportunities in the domestic market. We also find no evidence that prior domestic experience hinders internationalization; indeed, we find the opposite.

Our most original finding concerns the substantial, yet diminishing, impact on the extent of engagement in international markets and diversification into more unrelated (i.e.,

less frequently co-occurring) activities. In the context of manufacturing, the widely-held view is that product diversification and internationalization are complementary growth strategies (e.g., Cantwell, 1995; Zander, 1997). Hitt *et al.* (1997) argue that prior product diversification gives firms experience with managing complex multiple product markets which can be effectively exploited in international markets. Our results suggest something more complex may arise in professional services such as engineering consulting. First, relatedness (or unrelatedness) reflects the extent to which different activities are commonly (or rarely) found within a firm's portfolio of activities. This may well depend on the ease (or difficulty) of learning when diversifying from one activity to another. Thus if activities are commonly combined together amongst UK firms, then it is likely that the same combinations will be more commonplace in other local and foreign competitors in overseas markets. By engaging in a set of less commonly co-occurring activities, and therefore having the capacity to create more unusual resources (which is further enhanced by maintaining relatively high levels of specific human capital), a professional service firm can increase the uniqueness of its offer, which may well enhance its ability to win work in overseas markets. This also implies smaller, more specific markets, and this will also encourage the firm to seek out international opportunities where it can apply its 'unusual combinations' of knowledge. The more unrelated, and therefore uncommon the combination of activities, the more unique the potential offer. However, engaging in a set of unrelated activities also increases the costs associated with managing and coordinating the firm. Following Chandler (1962), unrelated product diversification typically leads to the adoption of a multidivisional structure, and in highly diversified firms with many largely unrelated activities, individual business units may become increasingly autonomous and distant. This may bring advantages but also increase costs, as such a structure diminishes the opportunities to learn across activities, and to compile unusual service offers from multiple activities. Achieving synergies or complementarities between activities may become increasingly difficult as the portfolio expands, but the rewards for doing so may also be high, as such synergies are inherently hard to imitate. The key may therefore lie in growing the business by engaging in a wider portfolio of activities that are both related and unrelated, thereby maintaining corporate coherence (see Bengtsson, 2000 and Gabrielsson and Gabrielsson, 2004, for similar evidence). We believe that these patterns are interesting and should be the subject of further research.

Our finding that domestic geographical diversification is positively related to the extent of international engagement contributes to the ongoing debate on the controversial role of geographical expansion in domestic markets (c.f. discussion in Section 2.2). The development of a more geographically dispersed business, which often requires the establishment of a domestic network of regional offices, involves developing the ability to co-

ordinate the operations of a more devolved business, whilst further advantages of domestic regional diversification can be obtained through economies of scope if the capabilities developed in the various offices can be combined from time to time to provide more unique service offerings (Johanson and Vahlne, 2009). Overall, this learning to expand the business within the domestic market appears valuable when it comes to opening the business internationally, where similar organizational issues are coupled with additional hazards.

Our analysis also shows that engineering consultants typically increase their commitment to international markets in an incremental fashion (Hitt *et al.*, 2006). This probably reflects the time needed to establish reputational and relational capital amongst local decision makers, and to accumulate knowledge about local markets, thereby overcome the liability of foreignness. Related to this, we find that the age of the business enhances internationalization up until almost 60 years of age (with a declining marginal effect). This indicates that amongst older firms, reputation and relational assets are increasingly tied to the firm, rather than to specific individuals within it.

## **6. CONCLUSIONS**

David Maister, an expert in managing professional service firms, identifies three benefits that clients seek from these firms: 'expertise, experience, and efficiency' (Maister, 2003, p 21). Specific human capital holds the key to at least the first two of these, and is critical to the core assets of PSFs: their domain knowledge, ability to learn, relationships with clients and other experts, and reputation. Strong and specific human capital also holds the key to the international competitiveness of these firms; for overall, PSFs endowed with higher levels of specific human capital are better able to respond to their clients' needs for specialist knowledge and prior experience. It also enhances the firm's ability to learn from direct experience (i.e, learning-by-doing) and from the environment (i.e., it enhances absorptive capacity – Cohen and Levinthal, 1990), and it is also likely to enhance and protect the firm's reputation, to help it build relational capital, and to navigate the complexities of unfamiliar overseas markets, thereby helping to overcome the liability of foreignness (Zaheer, 1995).

In our study we also investigated the contingent effects of firms' specific human capital on their internationalization, and found the internationalization of PSFs to be strongly contingent on firms' industrial scope, extent of unrelated diversification, and domestic regional coverage. With these findings, the paper contributes to theories of internationalization anchored in human capital theory and the capabilities-based view of the firm (Johanson and Vahlne, 2009; Zander, 1997). We also offer empirical contributions to the

literature on internationalization of services, and more particularly of professional service firms (PSFs). Despite the dominance of services in advanced economies, this is an area of prior academic neglect. Finally, by adapting and utilizing a novel empirical measure of relatedness inspired by Bryce and Winter (2009), we offer methodological refinements with a capabilities-based measure of diversification. We drew upon various data sources to construct an extensive panel which tracks the evolution of significant UK-based engineering consultancies over 15 years. This enhances the robustness of our findings in a field which is still dominated by cross-sectional studies.<sup>xi</sup>

Our findings also suggests important lessons for managers and policy makers seeking to understand the dynamics of PSFs. The significance of specific human capital is perhaps unsurprising given the nature of PSFs (von Nordenflycht, 2010), but it does highlight that whilst all of these firms may be considered as knowledge- (as opposed to capital-) intensive, their knowledge intensity varies significantly. Our findings that specific human capital moderates the effects of diversification on internationalization suggests that with the exception of highly specialized firms, PSFs that seek to compete internationally should not skimp on specific human capital, but should instead actively consider how to learn through diversification in scope, by expanding geographically in the domestic market, and by engaging in more unrelated activities.

Our most novel contribution concerns the impact of unrelated diversification on internationalization. There appears to be a strong impact of a moderately diversified portfolio and 'a little' unrelated diversification, whilst additional unrelated diversification further increases internationalization but with a diminishing marginal effect. The managerial implications are intriguing: if managers aim to internationalize their firm, they should carefully balance organizational scope and unrelated diversification, thereby benefiting from the capacity to learn from and to put together unusual combinations of activities. But they should not step too far too quickly into unrelated activities, as this implies higher costs of both learning and coordination. Clearly the 'pay-off' from engaging in more or less related activities, and the threshold of such engagement, are interesting questions for future research.

We also find that firms tend to increase their engagement in international markets gradually over time,. This suggests that substantial players take time to emerge, and that short term economic conditions may have long-term consequences for the survival and development of businesses in this sector. Policymakers should therefore consider how to sustain the sector through 'hard times' that are not of its own making.

As with all empirical studies, ours has limitations. Firstly, we do not consider the role of external relationships and/or relational assets in driving PSFs' internationalization. This is something for which we have no empirical evidence on a systematic basis. Secondly, our study does not take into account the role of different patterns and sequences of geographical and industrial diversification. Future research on the international activities among PSFs may shed further light on these issues by focusing on the temporal sequence of diversification and internationalization amongst different 'types' of firms (e.g., small companies first entering international markets versus the behavior of larger, established players).

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**TABLE 1: DEFINITIONS AND SOURCES OF VARIABLES**

<b>Variable</b>	<b>Definitions</b>	<b>Source</b>
Internationalization	Composite index based on % of overseas technical staff and no. of foreign markets involved in year t	NCE
Industrial scope	Level of total industrial diversification as the % of the no. of market segments in which a firm operates over the maximum no. of segments in year t	NCE
Unrelatedness index	The average distance amongst all market segments in which a firm operates in year t	NCE
UK regional diversification	% of no. of UK regions in which a firm operates over the total no. of UK regions in year t	NCE
Specific human capital	% of UK technical staff over total staff	NCE
GO regions	Dummy variable =1 if registration office located in a particular region	FAME
Ownership change	3 Dummy variables for merger and acquisition (M&A), being acquired, and management buyout (MBO) respectively in year t	Zephyr
Corporate discipline	4 Dummy variables for sub-groups of industrial disciplines of engineering consulting firms in year t, viz. foundation work, complex systems engineering, specialist areas and non-technical areas respectively	NCE
Labor productivity	Real turnover in £' millions per employee in UK in year t, deflated using Producer Price Index (PPIs), normalised to 2005 prices	NCE
Business Age	Age of business in years since its original establishment	NCE
Size	Total number of staff employed in the UK in year t	NCE
Foreign ownership	Dummy variable =1 if the ultimate global owner is a non-UK company in year t	FAME
Closure	Firm closure due to dissolution or M&As	FAME

**TABLE 2A: DESCRIPTIVE STATISTICS AND CORRELATIONS OF VARIABLES**

Variables		media			1	2	3	4	5	6	7
		mean	n	s.d.							
Internationalization	1	0.170	0.081	0.208							
Industrial scope	2	0.435	0.382	0.243	0.625*						
Unrelatedness index	3	0.783	0.748	0.364	0.674*	0.767*					
UK regional diversification	4	0.722	0.800	0.264	0.432*	0.458*	0.378*				
Specific human capital	5	0.770	0.809	0.146	-0.693*	-	-	-			
London	6	0.254	0	0.435	0.201*	0.067	0.071	0.113*	-0.170*		
Northern Ireland	7	0.021	0	0.143	-0.072	-0.024	-0.067	-	0.039	-0.085*	
M&A	8	0.061	0	0.240	0.231*	0.331*	0.258*	0.186*	-0.079*	0.030	-0.037
Acquired	9	0.022	0	0.148	0.042	0.054	0.059	0.045	0.004	0.024	0.014
MBO	10	0.004	0	0.062	0.025	0.017	0.019	0.030	-0.011	0.007	-0.009
Foundation	11	0.917	1	0.276	0.030	0.347*	0.055	-0.037	0.021	-0.018	0.044
Complex systems	12	0.990	1	0.101	0.059	0.144*	0.149*	0.057	-0.012	-0.045	0.015
Specialist areas	13	0.296	0	0.457	0.316*	0.512*	0.518*	0.245*	-0.171*	0.010	-0.025
Non-technical areas	14	0.851	1	0.357	0.137*	0.365*	0.313*	0.156*	-0.040	-0.014	0.002
labor productivity	15	0.054	0.049	0.024	0.471*	0.169*	0.295*	0.125*	-0.484*	0.117*	-0.055
Age	16	45.6	32	52.3	0.300*	0.327*	0.276*	0.214*	-0.129*	0.162*	-0.031
Size	17	434.5	81	1189	0.484*	0.541*	0.430*	0.298*	-0.267*	0.073	-0.043
Foreign ownership	18	0.080	0	0.272	0.307*	0.196*	0.240*	0.145*	-0.192*	-0.095*	-0.034
Closure	19	0.022	0	0.146	0.002	0.021	0.024	0.006	-0.001	0.033	0.015

Notes: Pearson correlation coefficients (Bonferroni-adjusted); \* significant at the 1% level



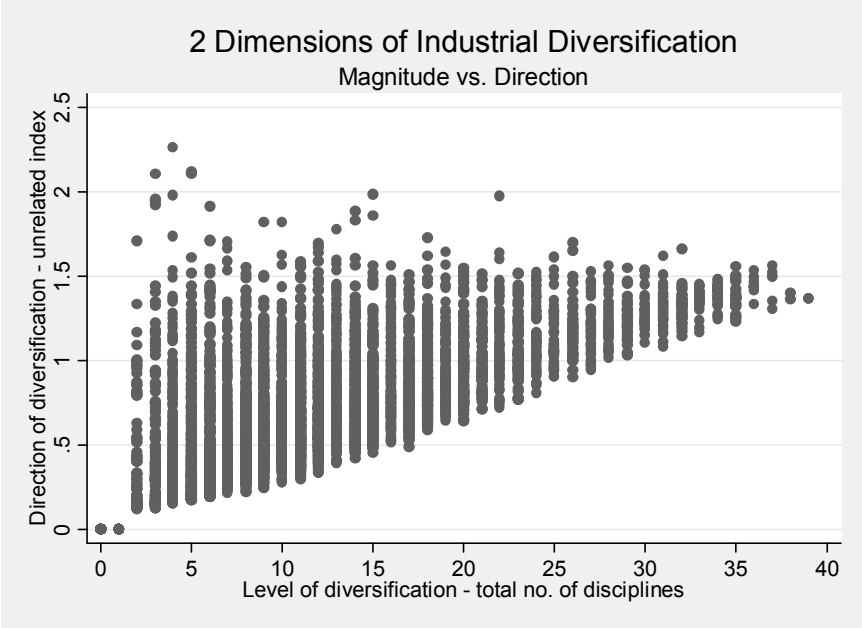


**TABLE 2B: CORRELATIONS OF VARIABLES (CONTINUED)**

Variables	8	9	10	11	12	13	14	15	16	17	18	
M&A	8											
Acquired	9	-0.017										
MBO	10	-0.016	-0.009									
Foundation	11	0.077	0.008	-0.026								
Complex systems	12	0.026	-0.010	0.006	0.038							
Specialist areas	13	0.210*	0.031	0.001	0.177*	0.058						
Non-technical areas	14	0.089*	0.006	0.026	0.149*	0.116*	0.183*					
labor productivity	15				-							
		0.094*	0.016	0.027	0.085*	-0.036	0.165*	-0.029				
Age	16	0.107*	-0.009	0.018	0.081*	0.031	0.196*	0.107*	0.109*			
Size	17	0.372*	0.001	-0.001	0.081*	0.033	0.323*	0.121*	0.188*	0.199*		
Foreign ownership	18	0.164*	0.192*	-0.018	-0.033	0.002	0.125*	0.014	0.246*	0.085*	0.158*	
Closure	19	0.006	0.630*	0.033	0.007	-0.037	0.024	0.004	0.005	-0.016	-0.012	0.129*

Notes: See Table 2a

**FIGURE 1: TWO DIMENSIONS OF DIVERSIFICATION: INDUSTRIAL SCOPE AND UNRELATEDNESS INDEX**



**TABLE 3: FRACTIONAL RESPONSE MODEL OF INTERNATIONALIZATION OF UK-BASED ENGINEERING CONSULTING FIRMS, 1994-2009**

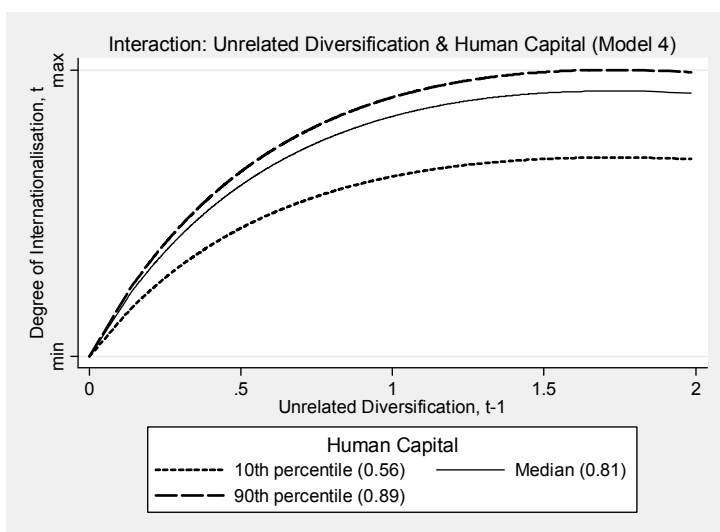
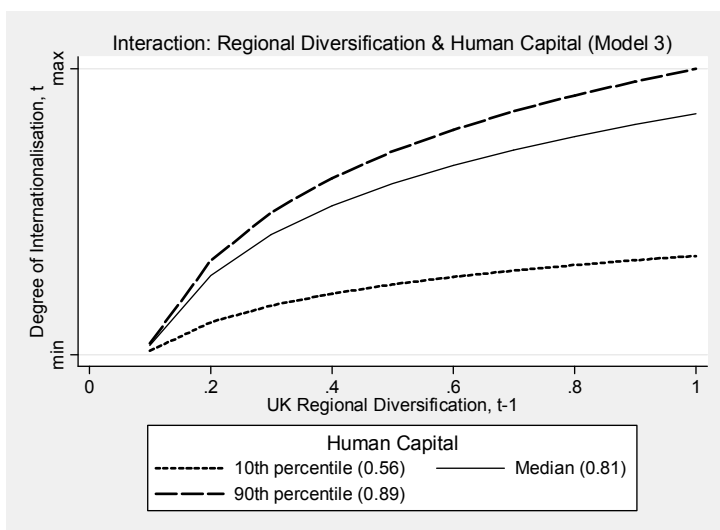
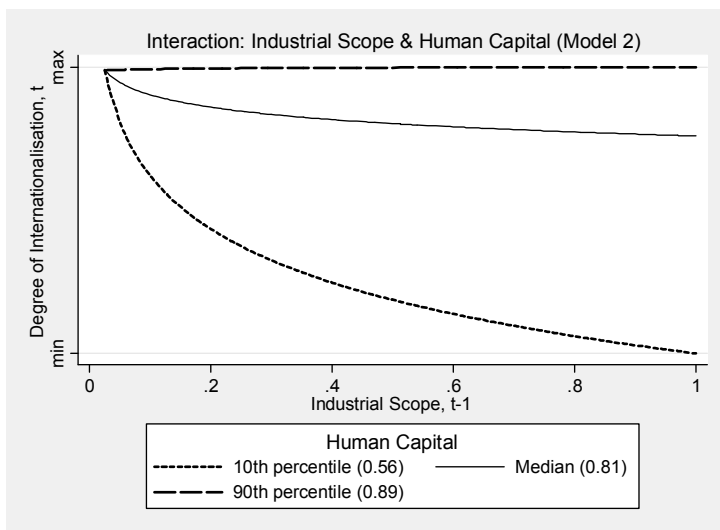
Dependent variable:		Model 1		Model 2		Model 3		Model 4	
Internationalization			Robust		Robust		Robust		Robust
Independent variable		$\hat{\beta}$	SE	$\hat{\beta}$	SE	$\hat{\beta}$	SE	$\hat{\beta}$	SE
Internationalization	$(t-1)$	5.559***	0.182	5.528***	0.179	5.464***	0.181	5.511***	0.178
<i>ln</i> industrial scope	$(t-1)$	-0.270**	0.134	-1.036**	0.464	-0.234*	0.136	-0.252*	0.131
H1a									
<i>ln</i> industrial scope <sup>2</sup>	$(t-1)$	0.009	0.052	0.028	0.249	0.007	0.053	0.009	0.051
<i>ln</i> UK regional diversification	$(t-1)$	0.339***	0.068	0.377***	0.066	-0.616**	0.264	0.366***	0.061
H1b									
<i>ln</i> unrelated diversification	$(t-1)$	4.548***	0.681	4.030***	0.697	4.075***	0.696	-6.925**	3.472
H1c									
<i>ln</i> unrelated diversification <sup>2</sup>	$(t-1)$	-	0.507	-2.448***	0.519	-2.490***	0.517	3.130	2.505
<i>ln</i> specific human capital	$(t-1)$	2.867***							
H2		1.114***	0.263	2.101***	0.340	1.490***	0.262	-7.494***	2.073
<i>Interaction: Diversification &amp; Specific human capital</i>									
<i>ln</i> industrial scope X <i>ln</i> human capital	$(t-1)$	-	-	<b>1.627*</b>	<b>0.836</b>	-	-	-	-
H3a									
<i>ln</i> industrial scope <sup>2</sup> X <i>ln</i> human capital	$(t-1)$	-	-	<b>0.046</b>	<b>0.435</b>	-	-	-	-
<i>ln</i> UK regional diversification X <i>ln</i> human capital	$(t-1)$	-	-	-	-	<b>1.810***</b>	<b>0.455</b>	-	-
H3b									
<i>ln</i> unrelated diversification X <i>ln</i> human capital	$(t-1)$	-	-	-	-	-	-	<b>19.008***</b>	<b>6.242</b>
H3c									
<i>ln</i> unrelated diversification <sup>2</sup> X <i>ln</i> human capital	$(t-1)$	-	-	-	-	-	-	<b>-9.474**</b>	<b>4.575</b>
London		0.217***	0.039	0.207***	0.039	0.202***	0.039	0.215***	0.038
Northern Ireland		0.520***	0.133	0.545***	0.131	0.580***	0.135	0.554***	0.126

Merger & Acquisition <sub>(t-1)</sub>	0.043	0.058	0.025	0.057	0.027	0.057	0.022	0.057
Being acquired <sub>(t-1)</sub>	0.004	0.184	-0.002	0.174	0.000	0.179	-0.013	0.169
Management Buyout <sub>(t-1)</sub>	0.467***	0.160	0.467***	0.148	0.438***	0.159	0.430***	0.165
<i>Corporate disciplines</i>								
Fundamentals <sub>(t-1)</sub>	0.112	0.087	0.135	0.092	0.065	0.089	0.156*	0.090
Complex systems <sub>(t-1)</sub>	-0.231	0.357	-0.224	0.334	-0.256	0.355	-0.241	0.354
Specialist areas <sub>(t-1)</sub>	-0.016	0.046	-0.036	0.046	-0.028	0.046	-0.028	0.045
Non-technical areas <sub>(t-1)</sub>	-0.127**	0.064	-0.118*	0.065	-0.117*	0.065	-0.135**	0.064
<i>ln</i> labor productivity <sub>(t-1)</sub>	0.048	0.050	0.059	0.050	0.039	0.049	0.042	0.049
<i>ln</i> age <sub>(t-1)</sub>	0.406**	0.187	0.350*	0.189	0.327*	0.191	0.342*	0.190
<i>ln</i> age <sup>2</sup> <sub>(t-1)</sub>	-0.050**	0.024	-0.043*	0.024	-0.041*	0.024	-0.041*	0.024
<i>ln</i> size <sub>(t-1)</sub>	0.100***	0.023	0.098***	0.023	0.108***	0.023	0.106***	0.023
Foreign ownership <sub>(t-1)</sub>	0.111**	0.053	0.072	0.054	0.120**	0.053	0.091*	0.054
Closure	-0.277**	0.108	-0.288***	0.105	-0.282***	0.105	-0.288***	0.106
Year dummies	Yes		Yes		Yes		Yes	
Constant	-		-		-		-	
	6.404***	0.612	-6.578***	0.607	-6.235***	0.620	-1.277	1.315
Observations	2,380		2,380		2,380		2,380	
Log pseudo-likelihood	-569.2		-568.0		-568.1		-567.4	

Notes: A 'fractional logit' model is estimated, based on the pooled quasi-maximum likelihood estimation (QMLE) with a logistic mean function.

\*\*\*Significant at 1%, \*\* significant at 5%, \*significant at 10% level. For variable definitions, see Table 1.

**FIGURE 2: EFFECTS ON INTERNATIONALIZATION OF THE INTERACTIONS OF SPECIFIC HUMAN CAPITAL AND VARIOUS DIVERSIFICATION MEASURES, UK-BASED ENGINEERING CONSULTING FIRMS, 1994-2009**



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<sup>i</sup> Such a composite index was initially introduced in UNCTAD (1995) to measure multinationality, taking the form of an average of three ratios, viz. foreign employment per total employment, overseas sales per total sales and overseas assets per total assets of the firm.

<sup>ii</sup> Kim *et al.* (1989) also used foreign staff ratio to proxy for internationalization. We believe this measure provides a more intensive and persistent form of internationalization compared with direct exports and foreign sales, since setting up foreign operations with a significant number of personnel implies a higher level of commitment to these overseas markets.

<sup>iii</sup> This is acceptable, given that only two components are combined.

<sup>iv</sup> The fact that our measure is constructed for each year separately instead of systematically across firms throughout the whole period is one departure from Bryce and Winter (2009). This was necessary to accommodate variability in the classification of engineering activities reported in the various 'Consultants Files'.

<sup>v</sup> Bryce and Winter addressed this problem by weighting the frequency matrices using the extent to which the pair of activities were both significant to the overall economic output of the firm. Unlike Bryce and Winter we do not have information on output attributable to each activity, which explains the different strategy we use to weight the importance of dyads.

<sup>vi</sup> Quite frequently this is considerably older than its date of incorporation as a limited or public limited company, which is recorded in company accounts datasets such as *FAME*.

<sup>vii</sup> In a more recent development, Papke and Wooldridge (2008) have proposed a panel data version of this estimator and tested this using a balanced panel dataset. However, as they point out, this estimator is currently difficult to extend to unbalanced panel data as in our case.

<sup>viii</sup> To check the robustness of the lag structure specified, we have also allowed independent variables to be lagged up to 2 or 3 years when estimating Equation (1) and the results from these alternative lag structures are broadly comparable to those using a one-year lag in Table 3 (these additional results are not reported here but are available upon request). Thus this generally confirms the adequacy of one-year lags in reflecting the underlying data structure.

<sup>ix</sup> We also tested the quadratic form of regional diversification; however, no non-linear effect was found and thus the square term was removed from the model.

<sup>x</sup> We also tested whether this relationship is non-linear by including the squared term for human capital, but as this was not statistically significant it was removed from the model.

<sup>xi</sup> The dearth of longitudinal studies has been highlighted as a significant weakness in international business research (Autio, 2005; Keupp and Gassmann, 2009).