

# **Co-operative ties and the impact of external factors upon innovation in an industrial district: some insights from the North Staffordshire Table and Giftware sector**

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## **Abstract**

Drawing upon a sample of 118 firms, this paper explores the impact of co-operative ties and the role of institutions upon innovation in the UK ceramic table and giftware sector. We find that locational economies are important for aiding innovation, with firms in the North Staffordshire industrial district holding an inherent advantage vis-à-vis non district firms. However while close vertical ties enhance innovation, recent concerns have arisen that horizontal collaboration between district and Asian firms is having a detrimental impact upon innovative capacity within the district. Finally institutions also appear to play an important role in facilitating the innovation process.

**Keywords:** Innovation, Co-operation, Industrial districts, Institutions, Table and giftware.

**JEL Codes:** L67, O18 and R58

## **1. Introduction**

Amid concerns of globalisation and the threats posed by low cost competition, there is currently widespread acceptance in both academic and regional policy circles that the survival and future prosperity of Europe's old and traditional industrial districts is best attained through seeking a high road to development, one primarily based upon continuous innovation and higher value added activities (see Pyke and Sengenberger, 1992, Kaplinsky and Readman, 2001). Aligned to this view is that the innovation process itself can no longer be considered confined within the sole domain of the firm, but rather is enhanced through greater associative and co-operative ties between firms as well as with institutions which aid information and knowledge transfers (Lundvall, 1992, 1995). Such ties are also considered more likely to be fruitful where there is geographical proximity between firms in related industries such as in industrial districts or regional clusters, and this has led to an extensive literature on the concept of 'learning regions' and 'regional innovation systems' (see for instance, Cooke and Morgan, 1994, 1998; Morgan, 1997, 2004). Perhaps not surprisingly, these ideas have had a significant influence upon European industrial and regional policy. For instance, Bougrain and Haudeville (2002) note that innovation policies have increasingly tended to allocate funds towards promoting inter-firm co-operation rather than providing direct subsidies to individual firms. In the UK, such policies continue to permeate current thinking towards innovation (see, for instance, the recent Innovation Report by the UK government's Department for Innovation, Universities and Skills (DIUS, 2008)) and are particularly germane within a regional context, where there are specific industry clusters or industrial districts (see also Bailey and De Propris, 2009a and 2009b).

A particular case is the UK ceramics industry and the North Staffordshire industrial district, where much of the UK ceramics industry is located. The ceramics industry itself primarily comprises of electrical ware, tile manufacture, sanitary ware and table and giftware. While all of these ceramic sub-sectors are well represented within North Staffordshire, it is the table and giftware sector that is perhaps most synonymous with the district and which has borne the brunt of increasing global competition over the last decade (see Sacchetti and Tomlinson, 2009). In line with the academic literature on clusters, regional policy directives primarily from the West Midlands Regional Development Agency have thus focused upon creativity and raising innovative performance, advocating in particular that North Staffordshire's district firms be more open to forming co-operative ties both within and outside the district and also to other external sources of innovation such as institutions (see North Staffordshire Taskforce of the West Midlands RDA, 2003). A recently commissioned report by the consulting firm, SQW Consulting (2009) has also echoed similar sentiments.

Studies of innovation are a rarity in traditional industries such as ceramics, despite evidence that the sector has been highly innovative not only historically, but also in recent decades (Warren et al., 2000). For its continued survival in the UK and particularly the long term viability of the North Staffordshire district, both creative designs and products and smart processes within the industry are considered to be crucial. Thus identifying and gauging the impact of some of the (external) factors affecting innovative performance within the sector is of prime (regional) policy importance, while also contributing to the wider literature on regional innovation and development. In this paper, we therefore primarily explore the impact of co-operative ties upon innovation in the UK table and giftware sector; in doing so we also assess the impact of other external factors such as institutions and the district effect. A particularly salient issue is the nature and intensity of co-operative ties within the sector. For

instance, while it is widely acknowledged that the industry (and in particular, district firms) benefit from established supply chains, recent horizontal linkages formed between district firms and Far Eastern firms (to facilitate global outsourcing) have raised concerns that technical know-how and capabilities are being lost within the district (see Carroll et al., 2002). These issues are discussed in some detail in this paper.

In conducting our research, this paper employs a mixed methodological approach. First, we use survey data from 118 firms within the sector and employ multivariate analysis to assess the magnitude of co-operative ties, the role of institutions and the district effect upon firms' innovative performance. The sample is split between district and non-district firms. This not only mirrors the population of table and giftware firms in the UK as a whole, but it allows us to capture district specific effects and ascertain as to whether or not the impact of co-operation over innovation is unique to the North Staffordshire district. Secondly, we draw upon insights from a series of interviews conducted with Managing Directors of UK table and giftware firms plus related suppliers from within the district that explored co-operative ties and innovation. These insights are used to supplement our quantitative analysis.

The remainder of this paper is set out as follows. Section (2) provides a review of the literature in relation to co-operative ties and regional innovation systems. Section (3) provides some background information and context on the UK table and giftware industry and in particular the North Staffordshire district. Section (4) outlines the research methodology and details of the sample. In Section (5), we outline the model specification and provide details of variable construction and descriptive statistics. Section (6) discusses the quantitative results, in light of observations from the interviews, while finally Section (7) concludes.

## **2. Co-operative Networks, Geography and Innovation**

Whether through vertical ties or in some cases horizontal links, it is now generally perceived that firms can benefit through the exchange and co-ordination of resources and associated synergies in production, organisation and crucially knowledge transfer and this can improve innovative performance. In this regard, early research by Von Hippel (1976, 1988) demonstrated how end users played a crucial role in product innovation in industry, while Hakansson (1987) considered innovation and technical advance to be a product of network ties, particularly those involving both buyers and suppliers where competences are generally more complementary. As Tether (2002) has pointed out, close collaboration in supply chains facilitates knowledge transfer between users and suppliers and the adoption and adaptation of new standards within the industry, while feedback loops allow for the refinement of products and/or processes. Empirically, both Shan et al. (1994) and Ahuja (2000) have found in the US biotech and chemical industries respectively, that the number and range of co-operative ties that a firm establishes is positively correlated with their patent count. More widely in the management literature, the competitive advantage in innovative performance enjoyed by Japanese manufacturers during the 1970s and 1980s was also largely regarded as being based upon their own collaborative (and integrated) supply chain systems (see for instance, Gerlach, 1992; Smitka, 1991; Sako, 1994).

The idea that innovation is an increasingly interactive process however, largely stems from the work of Lundvall (1992, 1995), who places a particular emphasis upon knowledge as a strategic resource and learning from others as a critical process for generating further knowledge and innovation. For Lundvall, engaging in interactive learning with partner firms and/or an array of other institutions is crucial if firms seek to be competitive in the global

economy (see also Lundvall and Johnson, 1994). Recent work in the strategic management literature has also emphasised the benefits of knowledge-transfer through inter-firm networking in offering firms a wider access to specialised knowledge and capabilities for innovation (see for instance, Dyer and Singh, (1998), Inkpen and Tsang (2005), Sammarra and Biggiero (2008)). The literature on knowledge transfer often distinguishes between codified knowledge that is in the public domain and easily transmitted between firms, and tacit knowledge in the form of know-how, skills and competencies and which is usually confined to a few actors. In this respect, tacit knowledge is often regarded as providing firms with an intangible competitive advantage, although it's hidden nature means that it is accessible to those closely involved within networks or located within specific locations, where it typically resides (see Hudson, 1999; Sacchetti, 2004) [1].

Over the past decade and a half, interactive learning and exploiting tacit knowledge flows have attracted particular interest in regional policy circles, where there has been a focus upon promoting 'learning regions' and/or 'innovative milieu' for generating economic growth (see Cooke and Morgan, 1994, 1998; Camagni, 1991; Maillat, 1995; Boekema et al., 2000). Behind the 'learning regions' concept is the idea that innovation is very much a social process involving the systemic exchange and enhancement of knowledge between firms and also related institutions within the region. Co-operative ties are thus regarded as a key facet to the success of such regions and innovative clusters are typically classified in relation to firms' accessibility to *'buyers, suppliers and partners, formal and informal networks; knowledge-centres such as universities, research institutes, contract research organisations and technology transfer agencies of consequence to the sectors in question; and a governance structure of private business associations, chambers of commerce and public economic development, training and promotion agencies and departments'* (Cooke et al., 1997; 484).

A crucial element is that relationships are associative i.e. that they involve a two-way, interchange between actors (Cooke and Morgan, 1998) and in this respect, geographical proximity is often as regarded as facilitating reciprocity, interaction and the nurturing of trust between firms, providing the foundations for a 'collective learning' environment from which new spin-off ideas and innovations can emerge. Recently, Morgan (2004) has re-emphasised the importance of physical proximity between firms in strengthening relational assets such as trust and co-operation for innovation and suggests that face to face communication remains the main medium for enhancing (tacit) knowledge flows.

From an empirical perspective, there is now a fairly substantive body of evidence which suggests that geographical proximity and regional co-operative ties are particularly important for innovation. In the first instance, influential work by Jaffe et.al (1993) found that US domestic patent citations have tended to be (disproportionately) localised within the same state as the originating patent and that these citations tend to come sooner (than citations outside the state). In a further international study, Jaffe and Trajtenberg (1999) uncover a similar pattern, with inventors more likely to cite patents originating from their own country than elsewhere. The authors suggest this is evidence that the diffusion of knowledge spillovers is predominantly at the local and regional level, and while they also find that localisation effects fade over time, this occurs only very slowly. More recently, Griffith et.al (2006) find that by investing in R&D facilities in the USA, UK affiliates are able to benefit from being geographically close to the latest US advances in new technology and innovation, thus highlighting the importance of proximity to take advantage of tacit knowledge flows and spillovers. Turning to specific co-operative ties it is, of course, worth recalling the earlier observations on the Italian industrial districts which explored the nature of the numerous vertical and in particular, horizontal ties existing between largely small and medium sized

firms (SMEs). The literature here has tended to emphasise the distinctive myriad of relationships between firms, who seem to simultaneously co-operate and compete with each other on different levels. In terms of co-operation, the co-sharing of information and resources between firms, and also their relationships with local research institutes and business consortia is widely perceived as being a key source of innovation and competitive advantage, while competition between the firms is seen as stimulating technical advance (see for instance, Becattini, 1990; Bellandi 2003). It is the unique interaction of both co-operation and competition with the districts, which leads to greater innovation (Lado et al., 1997).

In the UK, De Propris (2000, 2002) has explored co-operative ties among predominantly small and medium sized firms in the West Midlands manufacturing region. Using binary variables to capture co-operative ties between firms and to distinguish between ‘incremental’ (defined as changes to existing products/processes) and ‘radical’ (defined as new products/processes) innovations, she finds that firms engaging in co-operation with both client firms and suppliers are more likely to be product innovators, while those that co-operate closely with their supplies are also likely to engage in process innovation. De Propris’s studies clearly indicate the importance of collaboration along the supply chain within the West Midlands region, and interestingly here she discovers that ‘radical’ innovators are more likely to co-operate with both upstream and downstream partners while ‘incremental’ innovators tend to collaborate mainly with their suppliers. Freel and Harrison (2006) conduct a much larger regional survey exploring co-operative ties and innovation in small and medium sized manufacturing and service sector firms in Northern England and Scotland. Like De Propris, they also employ binary variables to capture co-operative ties and distinguish between ‘novel’ and ‘incremental’ innovation and ‘non-innovators’ [2]. They find in manufacturing, ‘novel’ product innovators are more likely to engage in co-operation with

buyer firms than ‘non-innovators’ while in process innovation, collaboration with suppliers is significantly in relation to ‘novel’ process innovations relative to both ‘incremental’ innovators and ‘non-innovators’. The authors report similar patterns in the service sector, although here supplier co-operation is also important in explaining ‘novel’ product innovation relative to ‘non-innovators’. Horizontal co-operation between firms was found to be insignificant in explaining innovative activity in the region. A further result reported in the study is that, in manufacturing, links with universities are positively correlated with ‘novel’ process innovations, suggesting a role for institutions in innovation.

Molina-Morales and Martinez-Fernandez (2006) adopt a more indirect approach by exploring the impact that ‘co-operative environments’ and ‘relational capital’ have upon innovation across 5 Valencian industrial districts. Using Likert scales, they construct variables designed to capture Marshall’s ‘industrial atmosphere’, such as the ‘shared vision’ of firms in the district, the ‘internal mobility’ of district managers and employees and ‘trusting co-operation’ between firms. These constructs attempt to measure the extent to which firms combine and exchange resources, the flow of tacit knowledge and the extent to which information networks exist within the districts. Such variables are not directly observable but are widely perceived as being historically significant ingredients to the competitiveness of industrial districts. In their own study, the authors find these relational capital variables are all significant in explaining the level of innovation in district firms.

In summary, the importance of geography and co-operative ties between firms as a source of innovation is widely documented. While co-operative network ties can and do have an impact upon innovation irrespective of location, it is the regional studies literature which has tended

to highlight the importance of geographical proximity for such collaborations to flourish (Morgan, 2004). With this in mind, we now turn to our case study.

### **3. The UK table and giftware sector**

#### ***3.1 Background***

The table and giftware sector consists of the manufacture of ceramic household and ornamental articles, including tableware, kitchen ware, ornamental and giftware. These products are manufactured in earthenware, bone china, stoneware, porcelain and vitreous china. With an annual output of £268 million in 2007, the sector accounts for approximately a third of total output within the UK ceramics industry (Office of National Statistics, 2007). While the industry is predominantly small-scale in nature - with a large number of small independent producers - there are a few, larger and more prominent firms.

These larger firms are primarily based in and around Stoke-on-Trent, North Staffordshire, which is where the UK ceramics industry is mainly concentrated. The North Staffordshire area has deep historical roots and associations with the ceramics industry and is affectionately known as 'The Potteries' (see Whipp, 1990). This old 'industrial district' region has a long and proud international reputation in the design and manufacture of high quality ceramics, with prominent table and giftware firms (and famous brands) such as Wedgwood (established 1759), Minton (1793), Aynsley (1775) and Spode (1780) originating from the region. Today, the district accounts for approximately 32% of all UK ceramics firms (around 350 ceramics related businesses are believed to operate in the region) and 60% of total UK ceramics employment (Advantage West Midlands, 16/10/09). The district is also the base to a number of industry related institutions including The British Ceramic Confederation (BCC), The Association for Ceramic Training and Development (ACTD), The British Ceramic Plant and

Machinery Manufacturer's Association, CERAM Research and the Ceramic Industry Forum (CIF). While some leading companies have and continue to operate outside the district (examples include Royal Crown Derby and Denby), these companies also retain close links with the district, primarily through the associated industry institutions and the supplier-base such as manufacturers of kilns, pottery plant and machinery (including pressings and mouldings) and clay, glaze and colour producers.

### ***3.2 Recent trends and global outsourcing***

Recent trading conditions within the sector have been difficult, with domestic sales of ceramic household and ornamental wares falling by 39.6% between 2003 and 2006 (Keynote, 2008). UK firms have, in particular, been adversely affected by rising international competition (from predominantly low cost East Asian manufacturers) in both the domestic market and in their traditional export markets. Indeed, while the table and giftware sector has over a long period earned the UK a significant export surplus, its trade balance has been in continual deficit since 2004 (Keynote, 2008). The initial impact of this competition was upon the high volume, low value added end of the sector, although recently the more lucrative medium to upper end of the sector has been affected (see Day et al., 2000). The response of larger and medium sized tableware manufacturers has in recent years been to move their operations to East Asia and/or outsource production to East Asian producers.

Outsourcing within the industry and the district, in particular, is not new. Indeed, table and giftware firms have for a long time outsourced production within the district. While outsourcing can inhibit the growth of individual firms into wider activities, in general and from a resource based perspective it has provided table and giftware firms with greater flexibility in dealing with fluctuating demands in the industry, while allowing them to

concentrate their own resources on their core activities. Historically, such horizontal collaboration between district firms has also facilitated inter-organisational learning and has allowed the district as a whole to retain its core competencies, while maintaining employment and critical mass (see Carroll et al., 2002). However, the recent outsourcing of production to the Far East is widely regarded as having a detrimental impact upon the UK industry with a number of high profile company insolvencies, factory closures and large scale redundancies occurring, particularly within the North Staffordshire district. Ceramics related employment within the district, for instance, has fallen from approximately 21,800 to around 7,200 in the decade to 2006 (see Sacchetti and Tomlinson, 2009). Such a dramatic fall in employment has had an adverse effect upon the district's capabilities and in particular the skills-base, with displaced workers often being reluctant to remain in (or return to) the sector, given the uncertainty surrounding future employment prospects (Ceramic Innovations, 2003, p.16).

### ***3.3 Innovation within the sector***

Despite the pessimism, some district firms have been able to thrive in what has been a turbulent period. Most notable are the hotel-ware companies, such as Churchill, Dudson and Steelite who have nurtured on-going and long term service contracts with their clientele, and high quality decorative giftware producers, such as Emma Bridgewater and Moorcroft, who are able to charge premium prices for their craft. Increasingly, however, the future of the industry and the district is seen as being at the bespoke end of the market, with an emphasis upon creativity, innovation and high value added activities.

While previous academic studies have tended not to associate traditional sectors such as ceramics with innovation, it is the case that over the last forty years the UK ceramics industry has itself witnessed significant technical change. Some of the main innovations are

documented by Warren et al., (2000). On the process side, they have included greater mechanisation to control and improve the consistency of raw materials, the introduction of single fire technology and new forms of organisation within the workplace []. There have also been notable improvements to clays and glazes and in design techniques to enhance product development. These changes have been seen as delivering faster throughput times, raising efficiency and improving product quality within the industry and until recently, have helped to negate some of the negative impacts of globalisation.

In exploring the sources of innovation within the sector, Warren et al. (2000) emphasise the specific role played by the industry's institutions, particularly CERAM research which provides consultancy, testing and technical support across the whole ceramics industry. The authors suggest that CERAM research has been instrumental in pulling together innovative ideas, promoting collaborative ties between firms and securing and managing external funding for research and development within the sector. We might also include here reference to the 'Hothouse Project', a largely publicly funded ceramic shape and pattern design centre located within the district and which is equipped with the latest 3D printing and prototype technology along with CAD and CAM tools. This centre of excellence aids firms in bringing new designs to markets more quickly, and serves firms across the whole sector, with firms being able to take advantage of the centre's facilities and expertise (for a set fee), without incurring the high sunk costs associated with investing in specific technologies (see Sacchetti and Tomlinson, 2009).

Within policy quarters, there has understandably been an increased interest in promoting the external sources of innovation within the sector, particularly the fostering of closer network ties and co-operation between firms within the sector (see for instance, North Staffordshire

Taskforce (2003, Section 2.9) and more recently, SQW Consulting, 2009)). Many of these policy directives have been guided by the literature on 'learning regions' and/or regional innovation systems (see Section 2). However, while (horizontal and vertical) co-operation to some extent has always existed within the district and industry more widely, the nature of recent collaborations involving (district) firms and producers in the Far East in relation to global outsourcing raises concerns as to their long term impact upon the development of the district (see Section 3.2).

#### **4. Research methodology**

While the primary focus of our research is to measure the impact of co-operative ties upon innovation within the North Staffordshire district, it is also important to assess whether any such correlation(s) are unique to the district or are applicable to the industry more widely. The research therefore drew upon a sample of table and giftware producers, both from within the North Staffordshire district and also across the UK. A mixed methodological approach was employed, using a combination of interviews and questionnaires to gather data and valuable insights about the sector.

At the onset of our research in the Spring of 2008, a small number of interviews were conducted with managing directors of table and giftware firms located within the North Staffordshire district. These interviewees were approached through our own personal contacts within the industry, although care was taken to ensure they were representative of table and giftware firms within the district (in terms of size and product scope). An unstructured interview approach was taken, and the interviewees provided us with some useful background information about industry issues - in particular about co-operation and the

nature of innovation within the sector - and this guided the construction of the questionnaire. Following the questionnaire and the statistical analysis of the data (see Section 5), further interviews were conducted with 15 firms within the district and who had indicated (on the questionnaire) a willingness to participate further in our research. These interviews explored a number of issues relating to the development and future of the district and the industry, and also focused upon interpreting and discussing the implications of our empirical results (see below).

The postal questionnaire was distributed to the Managing Directors of 331 ceramics firms in the UK table and giftware sector in September 2008. The sample frame was drawn from The Ceramics Industry Forum's membership directory and supplemented with smaller independent table and giftware producers listed on Yell.com, using a random stratified sampling process to select firms. These were selected in proportion to the size distribution of firms within the sector, as recorded by the Office for National Statistics (see Appendix: Table A1) [4]. In total, 128 district and 203 non-district firms were contacted and in order to induce a higher response rate, a £1 donation was promised to a recognised charity for each completed and returned questionnaire received. A reminder was sent out three weeks after the initial mail-out and the final reminder was mailed two weeks later. The questionnaire included questions on the firm's business background, firm size and revenues, their R&D and innovation activities as well as their co-operative and network ties. The innovation and co-operation questions covered a range of activities and the responses were measured using a structured set of Likert scales (see Table 1). In total, there were 118 valid responses from UK table and giftware producers (a 35.6 % response rate), with responses from 54 (42%) district and 64 (31.5%) non-district firms. This gave a sampling error of 5.4% at the 95% confidence interval, which is within the acceptable limits for survey research (see Oerlemans et Al.,

2006). Finally, the sample was a fairly close reflection of the size distribution of the population of firms in the sector (for further details, see Appendix: Table A1).

## **5. Model Specification and Variable Construction**

### ***5.1 Model Specification***

In line with other studies, we employed a standard innovation production function, which was supplemented with appropriate independent predictors (see Geroski, 1990, De Propris, 2002, Freel and Harrison, 2006, Molina-Morales and Martinez-Fernandez, 2006):

$$\text{Innovation} = \beta_0 + \beta_1 \text{ Firm Size} + \beta_2 \text{ R\&D} + \beta_3 \text{ District Affiliation} + \beta_4 \text{ Vertical Co-operation} + \beta_5 \text{ Horizontal Co-operation} + \beta_6 \text{ Institutional Support} + \beta_7 \text{ Vertical Co-operation} \times \text{District Affiliation} + \beta_8 \text{ Horizontal Co-operation} \times \text{District Affiliation} \quad (1)$$

In short, the model includes a set of internal (control) variables, a dummy variable to capture the district effect and augmented with constructs to measure the impact of external sources, namely measures of vertical and horizontal co-operation and institutional support. Multiplicative dummies to assess the impact of co-operative ties specifically within the North Staffordshire district are also included. Summarised information on these variables is listed in Table (1) and considered in further detail below.

### ***5.2 Dependent Variable: Innovation***

The measure of innovation employed is a composite measure of both the number of product and process innovations recorded within the firm over the previous three years. This construct was used by Molina-Morales and Martinez-Fernandez (2006) and is based upon measures of firm innovation discussed in Tsai and Ghoshal (1998). The construct provides an overall

indication of the level of innovation - capturing both the scale and multi-dimensional nature of innovation - within each firm. It was compiled using Principal Components Analysis and Cronbach's alpha ( $\alpha$ ) was run to validate the aggregation of items.

### ***5.3 Independent Variables:***

#### ***5.3.1 District Affiliation***

Following, Signorini (1994), a dummy variable was used to account for firms whose main location was in the North Staffordshire industrial district. This captures the impact of district membership and agglomeration effects upon levels of innovation. In line with the literature on industrial districts and, in particular in relation to learning regions and innovative milieu, it is expected that district membership has a positive impact upon levels of innovation.

#### ***5.3.2 Co-operation variables: Vertical and Horizontal Co-operation***

Unlike previous studies which use a simple binary variable to indicate whether co-operation between firms occurs or not, we measure co-operation in its wider context across a range of activities and employ a 5 point Likert scale, where 1 = No co-operation to 5 = Very high level of co-operation. Such an approach has the advantage of allowing us to capture more information on the nature and scale of co-operative relations between firms. Respondents were asked the extent to which their firm engaged in co-operation with their *i). main buyer/client firms ii). main supplier firms and iii). main competitor firms* using the items listed in Table (1) and which are based upon a set of studies into co-operative behaviour between firms by Schmitz, H (1999, 2000), Knorringa (1999) and Nadvi (1999).

1. *Vertical Co-operation:* Initial experimentation appeared to reveal a degree of multi-collinearity between both buyer and supplier co-operation. In order to overcome this, both

these constructs were therefore amalgamated into a Vertical co-operation construct, again using principal components analysis. Following the earlier discussion in Section (2), it is expected that higher levels of co-operation along the value chain will be positively associated with levels of innovation.

*2. Horizontal Co-operation:* Following the literature on industrial districts, innovative milieu and learning networks (see Section (2)), it might be anticipated that higher levels of horizontal co-operation lead to higher levels of innovation (both product and process) in the firm. The counter hypothesis is a negative relationship between horizontal co-operation and the level of recorded innovation, since (horizontal) alliances can lead to the avoidance of waste and duplication of effort (see Hitt et al. (1997)). A further issue here, and particularly pertinent given our earlier observations (see Section 3.2) about recent trends in the table and giftware sector, is the impact of horizontal collaboration with Far Eastern producers upon the innovative capability of district firms (see Carroll et al. 2002).

For both constructs, the mean of all the relevant items for each firm was calculated, with Cronbach's alpha again being run to validate the aggregation process.

### ***5.3.3 Institutional Support***

This construct attempts to capture the impact of external support provided by the ceramics industry institutions and also academic institutions upon innovation. As already noted, the majority of these institutions are based within the North Staffordshire district, although their industry links are much wider. The items are listed in Table (1) and are guided by the roles such institutions play within industrial and regional development (Maillat 1995, Helmsing,

2001). In line with the literature, it is posited that such institutions have a positive impact upon the level of innovation.

#### **5.3.4 Control variables**

Previous studies have suggested that internal resources are positively related to firm innovation (see, for instance, Cohen and Levinthal, 1990, Symeonidis, 1996, Freel, 2003) and so in order to control for this, the model also included measures of Firm size and Research and Development (R&D) expenditure. Table (1) provides details of the construction of these control variables. In line with previous studies, both variables are segmented into categorical scales, with Firm Size measured in terms of the number of employees and R&D expenditure expressed as a proportion of sales turnover. Both variables are expected to be positively associated with firm innovation.

**INSERT TABLE (1) HERE**

#### **5.3.5 Descriptive Statistics**

Table (2) provides details of the descriptive statistics. The bivariate correlations indicate significant correlation between some of the independent co-operation variables. However, while sensitivity between independent variables can give rise to estimation problems, the reported (low) variance inflation factors suggest that multi-collinearity (in the sample) was not a problem. For the construct variables, Cronbach's alpha ( $\alpha$ ) is also reported. This is important in assessing *convergent validity* i.e. whether the items used in specific constructs are related (or share a high proportion of variance in common). In all cases, Cronbach's alpha was greater than the accepted minimum level of 0.70, thus satisfying the criteria for internal consistency and reliability (Hair et al., 2007). Tests for *discriminant validity* were also

conducted by comparing the variance-extracted estimates for pairs of constructs with the square of their respective correlation coefficient (see Hair et al, 2007). This captures the extent to which a construct is unique and captures phenomena other measures do not i.e. that it is distinct (Campbell and Fiske, 1959). The test statistics supported the hypothesis that discriminant validity was present [5]. Finally, *face validity* - the theoretical justification for using particular scale items – was satisfied by utilising previous used multi-scale items and being guided by the literature on innovation, co-operation and industrial districts. Following these tests, the factor scores for each construct were calculated in SPSS, each with a standardized mean of 0 and a standard deviation of 1, and in accordance with Hair et al (2007) these were used in the ensuing regression analysis.

**INSERT TABLE (2) HERE**

## **6.0 Results and Discussion**

### ***6.1. Regression Results***

The estimation of equation (1) followed Molina-Morales and Martinez-Fernandez (2006) and took the form of a hierarchical regression model. First innovation was regressed on the control variables, with the predictor variables being subsequently added and finally the multiplicative dummy variables being included. The regression results are presented in Table (3). The first point to note is that the model appears a reasonable predictor of the level of innovation within the sector. The adjusted  $R^2$  statistics are relatively high in comparison to previous studies and generally improve with the addition of the predictor variables, while the reported Akaike information criterion falls with the addition of such variables. This would suggest that the augmented models are preferred.

As expected, both Firm size and R&D expenditure are positive and highly significant in models (1) through to (6), thus indicating the importance of internal resources for raising the level of innovation within the sector. The positive and significant impact of the dummy variable for district affiliation in models (1) to (5), indicates that firms located within the North Staffordshire district benefit from their close proximity and other advantages associated with industrial agglomeration (see Section 2). This supports the view that old traditional districts (and industries) can act as conduits for industrial change and innovation (Warren et al., 2000). The dummy variable captures a range of intrinsic characteristics within the district that provide these firms with advantages in relation to innovation. There are some clues in identifying these most distinguishing characteristics in regressions (2) to (6), where the variables capturing the direct impact of external sources of innovation are included. First, the introduction of vertical co-operation appears to have, albeit at 10%, a positive and significant impact upon innovation across the whole sector (models (2) and (3)). This is perhaps not surprising given that the influence of the value chain in promoting innovative activity has been widely documented (Tether, 2002). The introduction of horizontal co-operation though does not appear to have any significant impact across the whole sample (models (4) to (7)). What is particularly interesting however, is that when these co-operation constructs are applied only to district firms (through multiplicative dummies), both vertical and horizontal ties appear to have a highly significant impact (models (5) and (6)). Moreover, the dummy variable for district membership becomes insignificant. This implies that where district firms engage in collaboration there is a significant impact upon their innovative performance relative to non-district firms. This is, of course, in line with previous theoretical and empirical observations relating to the importance of co-operative behaviour within industrial districts and regional clusters (see Section 2).

Within the district, we can therefore concur that stronger vertical ties - across a range of activities - have a positive impact upon levels of innovation. In this respect, upstream co-operation with suppliers over the uses of different clays and glazes and downstream co-operation with buyers/retailers (for instance, at trade fairs) over new designs can often enhance levels of product improvement. Similarly, co-operation over delivery times, technology, labour training (e.g. through the ACTD) and production organisation along the value chain also play an important role in generating positive feedback effects and synergies between firms and raising levels of process innovation. Turning towards horizontal co-operation however, this appears to have a (significant) negative impact on the district firms' levels of innovation. One likely interpretation here is that through combining resources, co-operating firms are avoiding duplication in their (joint) innovative activities, which is reflected in a lower level of recorded innovation (see Hitt et al. (1997)). There is however an alternative explanation. As mentioned earlier, district firms have increasingly been collaborating with Far Eastern partners in relation to global outsourcing (for instance in China and Indonesia). In the medium to longer term, the impact may reduce their own capabilities and competencies, thus adversely affecting their innovative potential and this is captured by the significantly, negative coefficient. Unfortunately, our data on the nature and extent of co-operative activities between firms does not distinguish between collaborative ties within and outside the district and/or with firms beyond the UK. However, given our earlier observations relating to global outsourcing within the district, this inference is certainly plausible and is a live issue. We return to this in Section (6.2).

Finally, turning to the role of institutions, models (4) to (6) reveal that external support for R&D related activities from industry and academic related institutions have a positive and significant impact upon the level of innovation across the whole industry. As noted in Section

(4), the UK ceramics industry has a recognised and established group of supporting institutions and facilities that actively play a role in assisting firms with regards to innovation in the sector and their impact appears to have been captured in our sample.

**INSERT TABLE (3) HERE**

## **6.2 Further Discussion and Insights from Interviews**

The regression results from models (1) to (6) raise some interesting issues. There are, of course, obvious parallels between the results presented here and the earlier regional studies of UK manufacturers conducted by De Propriis (2002) and Freel and Harrison (2006). However and as we noted earlier, while these (and other) studies found that inter-firm co-operation (as denoted by a binary variable) along the value chain raised a firm's probability of being an innovator, the multi-scalar and multi-dimensional approach with regard to measuring the variables of interest adopted in this paper, allow us to go further and comment upon the *nature* and *intensity* of such ties for innovation. In short, the results presented in Table (3) suggest that where district firms engage in *higher levels of co-operation* with partner firms over a *range of activities*, there is a significant impact upon *levels of innovation*. This is a non-trivial insight, since previous quantitative studies have merely emphasised the existence (and sometimes number) of co-operative ties as being important for innovation, yet have shed little light on the nature of such ties. What is therefore clear from this study is that the nature of the dyad between partner firms in the district industry is particularly important for innovation.

In terms of vertical co-operation, the strength of the industry's supply chain has long been documented in regional and industry quarters (see North Staffordshire Taskforce Report,

2003; SQW, 2009), and its importance for innovation was also emphasised in the interviews that we conducted. In this respect, both formal and informal types of co-operation appear to exist within the district. For the smaller micro-firms, informal vertical co-operation generally takes the form of technical advice and guidance provided by suppliers for example on the consistency of clay or appropriate firing temperatures. This source of advice can be invaluable where the firm is not sufficiently large enough to employ specialists in all aspects of production. In general, there tends to be a rapport between the smaller manufacturing firms and the clay, glaze, colour and other material suppliers as each recognizes their mutual interdependence. Being co-located in the same district also facilitates a close network of contacts through which technical issues can be solved jointly or through the previous experience of a related or similar firm. Tacit know-how is an important feature of the district (and industry) at this level, especially where firms communicate verbally rather than through technical peer-reviewed academic papers as in other industries such as bio-technology.

For larger firms, there is evidence of more formal vertical co-operation often placed in a legal framework or via working agreements. These tend to range from premium-priced tableware manufacturers having exclusive product design deals with key retail outlets; to glaze suppliers committed to continuous process innovation with the main manufacturers within the district. In both cases, this outcome is a response to the on-going pressures of cost reductions generated by globalisation and low-cost foreign imports. In the former case, the ceramics manufacturer can reduce its own price elasticity of demand through adding value in the branding and design of surface patterns and/or ceramic body shapes; and in the latter case the supplier can offer environmental benefits and cost reductions by firing at lower temperatures through innovation work jointly with the pottery manufacturer. Both firms acknowledge the

respective products are operating in niche markets but consider this approach the best way to add value at the various stages of the supply chain.

Turning to horizontal co-operation there are fewer and much less obvious examples on a firm-to-firm basis within the district. From our sample, just under a third (29.7%) of all district firms engaged in horizontal co-operation within the district (see Table (4)). In essence, firms in the table and giftware sector have tended to view one another as ‘fellow travellers’ and do not collude with one another in an anti-competitive manner. While (horizontal) outsourcing has and still occurs within the district (see Carroll et.al, 2002), much of the horizontal innovation between district firms now tends to be through third-party organizations such as the British Ceramics Confederation (BCC) and CERAM Research. Such co-operation can involve the joint promotion of the industry, through industry fairs organised within the district and also through mutual research collaborations (see also Warren et.al 2000). There are however, a couple of examples of horizontal co-operation that are indicative of the nature of collaboration that occurs within the district. In this regard, Furlong Mills Limited is a jointly owned operation, whose main shareholders include the major (district based) tableware manufacturers, Dudson (Holdings) Limited, Portmeirion and Churchill China. Furlong Mills is a leading supplier of processed material to the ceramics industry with a product range that includes silica, feldspar and composite ceramic fluxes processed to the bespoke requirements of the customer. The company is based in Burslem, in the north of the district, and it has facilities for crushing, grinding, blending and drying material as well as being accessed by a customer base beyond the three main shareholders. The operation benefits the three main shareholders in two main ways. Firstly, the shareholding firms have local access to the process and product innovations of a leading ceramics material supplier (generating economies of agglomeration); and secondly, because

the set-up has a wider customer-base than the three main shareholders then there is the potential for greater utilization of the plant and machinery within the district (facilitating economies of scale).

Occasionally district firms specifically pool resources to jointly develop new technology and processes: such arrangements are typically referred to as 'buddying' within the district. In this respect, a relatively recent (and particularly noteworthy) example of 'buddying', which also involved collaboration with industry suppliers and was facilitated through CERAM Research, has been the development of new pressure casting machinery and techniques for the table and giftware sector. Pressure casting is designed to reduce the problems of air compression in the mould and casting process. While the technique has been used in industrial ceramics, similar techniques have been difficult to employ in the table and giftware sector where more complex and variable multi-part moulds are required. Collaboration here has led to the development of more durable synthetic and porous moulds and a reduction in casting times, thus improving production efficiency. The new techniques (originating from within the district) are regarded as setting a new world standard, which allow for greater flexibility in production runs while the new moulds themselves have a finer, tightly controlled pore structure that improves ware surface quality.

As we have already noted, one particular issue of contention in recent years has been the impact of increasing horizontal ties with firms from outside the district, in particular outsourcing arrangements with Far Eastern producers. This could be detrimental to innovative activity within the district, particularly when skills and competencies (particularly those relating to displaced workers) are transferred to the Far East (see also Ceramic Innovations, 2003). While only 18.5% of all district firms in our sample engage in international co-operation, it is notable that such activities are predominantly undertaken by

the larger manufacturers (55.5%), who are also (by definition) the largest employers (see Table (4)). Such firms have announced a number of large scale redundancies in recent years as their production plans have shifted to the Far East and this can create an air of despondency and inevitability within the district, particularly with regard to employment prospects (see Sacchetti and Tomlinson, 2009). Our interviewees revealed concerns that as result of global outsourcing by larger manufacturers, the district was now suffering a skills shortage particularly with regards to gilders, dishmakers, lithographers, spongers and semi-automotive holloware operators. Indirectly, the loss of such skills can have adverse impact upon innovative capacity within the district, as firms become less able to access/utilise employees with traditional crafts. It is possible that the negative co-efficient on the horizontal co-operation variable in Table (3) may be capturing these effects.

**INSERT TABLE (4) HERE**

Finally, our interviews also broached the role of institutions in the table and giftware sector. Our regression results (Table 3) indicate that stronger ties with institutions are likely to enhance innovative activity, an intuitive result in line with theory and previous industry analysis (see Warren et.al, 2000). We have already mentioned the types of institutions that exist within the district (see Section 3.1), but it is worth briefly providing some further detail on the nature of their main roles in facilitating innovative activity. In particular, our interviewees acknowledged the role served by CERAM Research, which was established in 1920 and is now a global leader in materials analysis including research, development and quality testing aimed at improving the manufacturing yield of ceramics materials. In this respect, one of the most effective examples of institutional co-operation on innovation is the network of organizations known as Powdermatrix, which was initiated and is managed by CERAM. Powdermatrix is a knowledge transfer network consisting of over 200 firms (both

within and outside the district), research institutions and organizations involved in particulate engineering. The key strength of the network is that although it focuses primarily upon advanced ceramics, powder metal, hard metal and magnetics industries it has been able to attract other sectors such as pharmaceuticals and food. This allows the participating firms to gain access to almost every expert in materials technology and thereby gain valuable institutional support in developing new product and process innovations.

In addition, BCC who represent the ceramics industry as a whole, collaborate across areas of innovation such as chemical compliance and emissions reduction, which tie-in with central government policy on environmental management. Also, the Ceramics Industry Forum (CIF) launched in 2000 as a non-profit organization to help firms in the ceramics industry with process improvement, design, marketing and human resources has helped create best practice across the sector in many areas of cost reductions and strategic planning in line with policy aimed at developing the skills and knowledge base of UK manufacturing.

## **7.0 Concluding Comments**

In recent years, the ceramics industry has been the focus of various policy directives to foster greater inter-firm networking. Such directives are often seen as enabling firms to raise their performance particularly in the area of innovation, where firms can benefit from the exchange of information and resources, inter-organisational learning and synergies in production (see Huggins, 2001, Bailey and De Propris, 2009a and b). This is particularly pertinent for old industrial districts, such as North Staffordshire, whose table and giftware sector has struggled to cope with rising international competition.

In this paper, using survey data and drawing upon insights from a series of interviews, we have explored the impact of external sources upon innovation in the UK table and giftware sector. We have found that locational economies are still important in this old, traditional industry for innovation and in this respect, table and giftware firms located within the North Staffordshire industrial district still retain an inherent advantage vis-à-vis non (UK) district firms. In particular, these advantages appear related to strong co-operative ties along the value chain, which is perhaps reflective of the established supply chain within the sector. From a policy perspective, it would thus appear that the (further) promotion of good management and co-ordination of activities along the supply chain is particularly likely to be beneficial for the sector. In this respect, recent work on the socialisation of the value chain might be worth exploring in improving the dyad between firms and their suppliers. This might include new initiatives such as developing more open communication systems along the chain; facilitating greater reciprocity in discussion and joint problem solving to build relational capital and enhance long term relationships (see Cousins et.al 2006).

At a horizontal level, co-operative ties also appear significant in explaining innovation, although here there are (justifiable) concerns that increasing moves towards global outsourcing (and collaborative ties with partners in the Far East) is possibly reducing innovative capacity within the district. Such concerns might be allayed somewhat by promoting greater networking within the district, possibly with facilitating roles being played by the industry institutions. Indeed, the institutions themselves appear to play a positive and highly significant role in aiding product and process innovation within the sector. Recent proposals for a new innovation centre located within the North Staffordshire district, with the aim of linking the existing areas of innovation, knowledge transfer and developing the skills-

base, along with Research and Development (R&D) across firms and related actors are therefore worth exploring (see SQW, 2009).

Overall, the future for the table and giftware sector and the district, in particular, lies in producing (relatively) low volume but (definitely) high quality ceramic products. Innovations and the related creative output coupled with a long-standing reputation for excellence is likely to be the way forward for ceramics firms in the district both individually and collectively.

## **Endnotes**

[1]. It is often argued that networks need not be geographically proximate for (tacit) knowledge to flow between firms; indeed what is often important is the proximity of organisational views and the sharing of values between participants; Sacchetti and Sugden (2009) refer to this as ‘mental proximity’.

[2]. As with De Propriis’s (2002) ‘radical’ innovation, ‘novel’ innovations refer to innovations new to the industry, while ‘incremental’ refers to innovations new the firm (Freel and Harrison, 2006). By their nature, ‘novel’ (or ‘radical’) innovations give firms a first mover advantage within the industry.

[3]. The industry became more capital intensive following the Clean Air Act of 1957, which effectively removed the bottle kilns from the district’s landscape: by the early 1970s, over 2,000 bottle kilns had disappeared (see Gay and Smyth, 1974).

[4]. This notional measure of the population is provided by the UK National Office of Statistics (2008), which provides information on the number and proportion of UK firms within a given sector by employment sized bands (1-49, 50-249, greater than 250). See Appendix, Table A1.

[5]. Full details of these tests and calculations are included for the editor and referees: further details are available on request from the authors.

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**Table 1 – The Variables Used**

<b>Variables</b>	<b>Method used to construct the variables</b>
Innovation	<p>(a). Number of new product lines introduced            (b). Number of changes/improvements to existing product lines            (c). Number of new equipment/technology introduced in the production process            (d). New input materials introduced in the production process            (e). Number of organisational changes/improvements made in the production processes</p> <p>(Scale 1-7; where 1 = Zero, 2 = to 1-5, 3 = 6-10, 4 = 11-15, 5 = 15-25, 6 = 26-50, 7 = greater than 50)</p>
Firm Size	<p>Number of employees            (Scale 1-7; where 1 = less than 10, 2 = 10-49, 3 = 50-99, 4 = 100-250, 5 = 250-499, 6 = 500-999, 7 = greater 1000)</p>
R&D expenditure	<p>% of turnover spent on R&amp;D            (Scale 1-5; where 1 = 1-5%, 2 = 6-10%, 3 = 11-20%, 4 = 21-30%, 5 = Greater than 30%)</p>
District Affiliation	<p>Value = 1, if firm located within North Staffordshire district            0, otherwise</p>
Vertical Co-operation	<p>(a). Improving quality of inputs and final product            (b). New Product designs            (c). Improving delivery times            (d). Marketing and Distribution of products            (e). Labour training            (f). Production organisation            (g). Technological upgrading            (h). Exchange of information/experiences</p> <p>Scale 1-5, where 1 = no co-operation and 5 = Very high level of co-operation</p>
Horizontal Co-operation	<p>(a). New Product Designs            (b). Marketing and Distribution of products            (c). Labour training            (d). Production organisation            (e). Outsourcing production            (f). Technological upgrading            (g). Exchange of information/experiences</p> <p>Scale 1-5, where 1 = no co-operation and 5 = Very high level of co-operation</p>

Institutional Support

- (a). You have received support for R&D activities from industry and academic institutions*
- (b). Your firm has received benefits from research activities carried out by industry and academic institutions.*
- (c) In seeking support for your business you are willing to liaise with industry and academic institutions*

*Scale 1-5, where 1 = strongly disagree and 5 = strongly agree*

**Table 2: Cronbach's alpha and Bivariate correlations (to two decimal places)**

	Mean	S.D.	Cronbach's Alpha	VIF	1	2	3	4	5	6	7
Innovation	2.87	1.10	0.82	N/A	1						
Firm Size	1.70	1.43	N/A	1.52	0.55***	1					
R&D Expenditure	1.97	1.15	N/A	1.19	0.09	-0.16*	1				
District affiliation	0.46	0.50	N/A	1.35	0.36***	0.45***	-0.173*	1			
Institutional Support	2.84	1.00	0.82	1.27	0.33***	0.29***	0.211*	0.126	1		
Vertical Co-operation	1.74	0.65	0.92	1.32	0.43***	0.46***	0.149*	0.354***	0.29***	1	
Horizontal Cooperation	2.34	0.85	0.85	1.06	-0.06	-0.09	0.125	-0.178*	0.075	0.102	1

$\alpha$  = Cronbach's alpha for all multiple-item variables

VIF – Variance Inflation Factor

\*\*\* Pearson's Correlation is significant at the 0.01 level (2-tailed).

\*\* Pearson's Correlation is significant at the 0.05 level (2-tailed).

\* Pearson's Correlation is significant at the 0.10 level (2-tailed).

**Table 3 Multivariate Analysis: Dependent Variable - Innovation**

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	1.683*** (0.210)	1.817*** (0.24)	1.882*** (0.24)	1.983*** (0.246)	1.977*** (0.244)	1.965*** (0.262)
Firm Size	0.385*** (0.065)	0.348*** (0.068)	0.348*** (0.068)	0.318*** (0.070)	0.301*** (0.070)	0.311*** (0.092)
R&D Expenditure	0.200*** (0.075)	0.167** (0.076)	0.168** (0.077)	0.142* (0.078)	0.135* (0.078)	0.110* (0.065)
District Affiliation	0.400** (0.195)	0.340* (0.196)	0.331* (0.20)	0.328* (0.198)	0.367* (0.198)	0.377 (0.247)
Vertical Co-operation		0.189* (0.114)	0.193* (0.115)	0.169 (0.115)	0.045 (0.137)	0.035 (0.119)
Horizontal Co-operation			-0.026 (0.090)	-0.042 (0.090)	-0.059 (0.089)	0.088 (0.097)
Institutional Support				0.169* (0.099)	0.166* (0.098)	0.187* (0.107)
Vertical Co-operation * District Affiliation					0.358* (0.218)	0.468*** (0.163)
Horizontal Co-operation*District Affiliation						-0.482** (0.205)
Adjusted R <sup>2</sup>	0.34	0.37	0.37	0.36	0.37	0.40
F-statistic	21.07***	16.73***	13.29***	11.76***	10.62***	10.53***

Akaike info criterion	2.74	2.75	2.66	2.65	2.64	2.60
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\*\*\* p<0.01; \*\* p<0.05; \* p < 0.10, Non-standardized regression coefficients (*errors in brackets*)

**Table 4 Proportion of District Firms Engaging in Horizontal Co-operation**

	All District Firms	Large Firms (i.e. greater than 250 employees)	Small and Medium Sized Firms (1-249 employees)
District Horizontal Co-operation	29.7%	55.5%	24.4%
National Horizontal Co-operation	14.8%	11.1%	15.5%
International Horizontal Co-operation	18.5%	55.5%	8.9%

Source: Author's Survey

### **Appendix: Table A1 – Sample and Population of Firms**

<b>Number of Employees</b>	<b>Table and Giftware Sector</b>	
	Sample	Population
<b>0-9</b>	70.3%	75.5%
<b>10-49</b>	16.1%	14.2%
<b>50-249</b>	5.1%	4.2%
<b>&gt;250</b>	8.5%	4.1%
<b>Total</b>	100 %	100 %

Sources: UK Office for National Statistics (2008).

The notional measure of the population is provided by the UK National Office of Statistics (2008), which provides information on the number and proportion of UK firms within a given sector by employment sized bands (1-49, 50-249, greater than 250).

**Additional Note for Editor/Referees: Tests for Discriminant Validity (see Footnote 5)**

**Cronbach's alpha and Bivariate correlations (to two decimal places)**

	Cronbach's Alpha	V.E.	1	2	3	4
Innovation	0.82	0.59	1	0.11	0.18	0.004
Institutional Support	0.82	0.59	0.33***	1	0.21	0.008
Vertical Co-operation	0.92	0.68	0.43***	0.46***	1	0.01
Horizontal Cooperation	0.85	0.61	-0.06	-0.09	0.102	1

**$\alpha$  = Cronbach's alpha for all multiple-item variables**

\*\*\* Pearson's Correlation is significant at the 0.01 level (2-tailed).

\*\* Pearson's Correlation is significant at the 0.05 level (2-tailed).

\* Pearson's Correlation is significant at the 0.10 level (2-tailed).

V.E. – Variance Extracted for each factor constructed

Notes:

For discriminant validity, a comparison is made between the variance extracted estimates (V.E.) for each factor with the squared interconstruct correlations associated with that factor (Hair et.al, 2007). According to Hair et.al (2007: 778) 'The variance estimates should be greater than the squared correlation estimate – the logic being that a latent construct should explain its item measures better than it explains another construct. Passing this test provides good evidence of discriminant validity'.

In the Table, the variance-extracted estimates are greater than the corresponding interconstruct squared correlation estimates (which are above the diagonal and are in red). The tests thus support the presence of discriminant validity.