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Intellectual capital in support of farm businesses' strategic management: a case study

Caterina Cavicchi, Emidia Vagnoni,

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Caterina Cavicchi
Department of Economics and Management, University of Ferrara, Ferrara, Italy, and
Emidia Vagnoni
University of Ferrara, Ferrara, Italy

Abstract

Purpose – The purpose of this paper is to shed light on the role of and relationships between human, structural and relational capital assets for strategic management in a farm business. In particular, it analyzes the interaction between human capital's creativity skills and the introduction of climate-smart technologies for the competitiveness of the firm.

Design/methodology/approach – An explorative case study was conducted on one of the largest Italian farm businesses to gain an understanding of the drivers of intellectual capital (IC) and of their implications for strategic management. Full-time employees' perception of the skills required to achieve strategic goals and their perception of whether they possessed these abilities were investigated to determine if an alignment was present. The skills were subsequently classified using the framework of Amabile (1988) into domain-relevant and creativity-relevant skills. Then, two linear regression models were used to investigate the effects of training on the acquisition of these two sets of skills.

Findings – The analysis confirmed the strategic role of interactions among human capital assets to effectively exploit the structural capital of the company. When investigating employees' perceptions, a gap emerged about informatics capabilities and knowledge of soils. As the company's investments in innovation are oriented to ICT technologies, the company could strengthen informatics training to enable its employees to implement effective innovation.

Originality/value – The paper contributes to the literature on IC by highlighting the role of interconnections of assets to align organizations with their strategic goals. Therefore, the provision of IC accounting contributes to the strategic management of human capital.

Keywords Intellectual capital, Strategy, Accounting, Farm business

Paper type Case study

1. Introduction

The literature has recognized the critical role of knowledge and, thus, intellectual capital (IC) in the enhancement of firms' strategy (Eisenhardt and Santos, 2002; Marr and Roos, 2005; Sveiby, 2001) and competitiveness (Grant, 1996). IC generally includes human, structural and relational capital (Meritum, 2002; Roos, 2005). Examining IC components, human resources contribute to organizational innovation through individual creativity (Amabile, 1988) which is dependent on domain-specific skills, creativity skills, an individual's intrinsic motivation and conditions of social environment (Amabile, 2012). Amabile (1988) stated that domain-relevant skills represent the "individual 'raw materials' for creative productivity" (p. 131), and include basic knowledge and technical skills in a given domain (e.g. expertise), while creativity-relevant skills represent a "cognitive style favorable to taking new perspectives on problems, an application of heuristics for the exploration of new cognitive pathways, and a working style conducive to persistent, energetic pursuit of one's work" (p. 131) (e.g. flexibility, social skills, risk orientation). Domain-relevant skills can be innate or acquired by formal and informal training in the domain; creativity-relevant skills depend on experience and training (Amabile, 1988). Transformations of IC, by way of the interaction of assets, as in the case of human capital

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into new products and services (Edvinsson and Sullivan, 1996) are the main source of value creation (Peppard and Rylander, 2001).

In agriculture as well as in other firms, the role of innovation has been discussed as pivotal (Edvinsson and Sullivan, 1996) to face the increasing uncertainty of the operating environment (Boehlje *et al.*, 1995; Diederen *et al.*, 2002; Boehlje *et al.*, 2011) and to allow its economic survival (Nieuwenhuis, 2002) through competitiveness (Subramaniam and Youndt, 2005). Despite this, evidence of the value provided by the interaction of different assets for strategical innovation in agricultural firms represents an under-investigated field; the majority of studies mainly address the effect of IC on farm businesses' productivity and financial performance (see e.g. Scafarto *et al.*, 2016; Lee and Mohammed, 2014). Moreover, there are few studies on the development of the human capital component of IC as a relevant asset (Hitt and Ireland, 2002) for innovation in the agricultural sector and these are mainly linked to training/schooling levels of farming operators, experience and social networking activities (see e.g. Huffman, 2001). The current literature on human capital (and of course IC) in agriculture also presents gaps concerning the strategical determination and assessment of competences needed to support the competitive advantage (Kozera, 2011). However, accounting studies on IC have been focused on the role of IC-based accounting techniques to improve management and reporting (Guthrie *et al.*, 2012; Mouritsen *et al.*, 2001). To this end, scholars have recently called for investigations into the contribution of IC resources to organizational strategy and performance (Lev, 2014; Vagnoni and Oppi, 2015), including sustainability (Cavicchi and Vagnoni, 2017) and value creation (Roos, 2005; Peppard and Rylander, 2001), focusing on the interconnectedness among the different categories of assets (Marr *et al.*, 2004; Habersam and Piber, 2003). Moreover, the interconnectedness of different IC assets should be studied focusing on how business activities transform IC and how this process can affect value creation (Cuganesan, 2005) or negatively impact on it (Cavicchi, 2017).

Indeed, the paper aims to address the above-cited multiple gaps in the literature and provide evidence of the strategic relevance of developing IC assets' interactions as a source of innovation for competitive advantage in an analyzed farm business. The case study is based on interviews and survey questionnaire methodologies. Interviews with the company's top and middle management shed light on the strategy of the company and on the IC assets relevant to the achievement of strategic goals. As some key human capital competences emerged as pivotal to drive the efficacy of the newly adopted technologies (structural capital), a questionnaire was given to the 20 full-time farming operators of the company in order to obtain auto-evaluation of their competences and detect the extent to which their competences were aligned with those needed for strategic goals. Moreover, the paper emphasizes the relevance of training in acquisition of individual innovation skills as a potential source of competitive advantage.

The paper is structured as follows. Section 2 outlines the role of IC and its link with organizational strategy; Section 3 contextualizes the role of IC in the agricultural sector, while in Section 4 competences that could drive competitive advantage in farm businesses are discussed. Section 5 introduces the setting and design of the study, while Section 6 presents the methodology. Section 7 presents and discusses the multiple results of the study. The results are discussed further in Section 8 to increase their interpretability. In Section 9, conclusions are drawn.

2. IC development and its link with strategy

In order to be competitive, firms need to fully exploit IC resources to enact strategies; this, in turn, requires firms to be able to identify the performance drivers as well as their links and roles for value creation (Marr *et al.*, 2004). New approaches focus on value mapping techniques to identify key assets and their relations that can provide value creation as they drive the pursuit of organizational goals (see e.g. Marr *et al.*, 2004). Indeed, the literature has called for research on how these relationships work (Habersam and Piber, 2003) within a particular setting that has one strategy rather than conflicting ones related to different assets (Mouritsen, 2006) and, more generally, how IC behaves within organizations (Guthrie and Dumay, 2015; Mouritsen, 2006). The contribution of IC to value creation depends largely on transformation choices made by the organization on IC assets and it is contingent on the use of IC within business processes (Cuganesan, 2005). It follows that the goal for each organization's management and reporting system is to describe which combinations of tangible and intangible resources affect value creation (Lev and Daum, 2004; Mouritsen, 2006). Based on the above-cited premise, to what extent do the different assets (and their interconnectedness) of IC contribute to strategy and value creation in a farm business? To answer this question, trends in the current agricultural sector must first be described and discussed, and second, a review of the role of IC in this emerging context must be provided. The next section tries to meet these goals in order to outline the theoretical framework that has been used for the analysis of the case study.

3. Current uncertainty in the agricultural sector

The agricultural sector has faced a crisis for more than a decade mainly due to: the industrialization of agriculture; the liberalization of food and agricultural production markets and the rise of food empires in the food supply chain (Van der Ploeg, 2010). The industrialization of agriculture has been progressively based on artificial growth to the detriment of nature, locality and sustainability, requiring investment in technology that has high costs on the one hand and a reduction in margins that has to be recovered through scale production gains on the other hand (Van der Ploeg, 2010). This condition has emphasized the dependence of farm businesses on credit institutions and their advancing diversification into non-agricultural activities. In addition, with reference to agricultural sustainability, large-scale production is considerably inefficient in energy and water use (Van der Ploeg, 2010) and their overuse and misuse in agriculture led to environmental degradation and climate change effects (de Janvry, 2010). The liberalization of the markets led to a huge decrease in crop prices due to globalization processes. Finally, food empires, which expanded through credit availability and acquisitions (food industry and food delivery chains), have increasingly exercised downward pressure on prices paid to farmers and upward pressure on the prices consumers have to pay, in order to compensate their contracted debts (Van der Ploeg, 2010).

The environmental changes affecting agricultural systems were already present at the beginning of the 1990s; Symes (1992, p. 197) argued "at a time of declining government support, therefore, agricultural incomes are being squeezed by lower guaranteed farm prices, higher standards of product specification and increased input costs." Among the factors affecting the operating context of farm businesses, Symes (1992) identified the pressure of the distributors, price volatility of crops, increasing dependence of farm businesses on market specification and on suppliers' inputs, and the unequal system of incentives provided by the European Common Agricultural Policies, as the major causes of the decline in the agricultural sector in Europe. Symes (1992) reported the risks of the agricultural reforms, including the probable disappearance of middle-tier agricultural businesses, where rationalization and lack of successors to run the firm were the main problems facing the sector, and diversification in non-agricultural activities as a remedy was considered viable for the few.

With regard to agricultural sustainability, to date, new technologies are available to induce farmers to reduce the environmental impacts of their activities; however, the costs of these climate-smart technologies compared to uncertain benefits can constitute a barrier to innovations (Long *et al.*, 2016; de Wilt *et al.*, 2001), especially for small-size businesses (see e.g. Pedersen and Pedersen, 2006, and their adoption of precision farming technology).

Concerns related to the use of these technologies in the agricultural sector mainly referred to: the need to train operators and the need to design user-friendly solutions in response to the decreasing available time for farming; the correct functioning of these technologies when climate variations prevail; and the need to have in-time monitoring of soil conditions rather than forecasting based on historical production data (Pedersen and Pedersen, 2006). Climate change has made the results of agricultural activities more uncertain (Bindi and Olesen, 2011). Climate effects on systems' productivity include: an increase in water needs and a push toward efficient use of water because of higher temperatures; an early development and maturation cycle of crops while reducing yields; an increase in the presence of pests and variation in the efficacy of pesticides depending on changing environmental conditions; extreme meteorological events that can destroy yields; and variation in the chemical composition of soil and erosion, and variability in the efficacy of fertilizers (Olesen and Bindi, 2002). Farmers are increasingly urged on the one hand to develop innovation capabilities in order to compete in a market of high uncertainty (Diederen *et al.*, 2002), and on the other hand to adopt new mitigation and adaptation strategies in order to respond to the effects of climate change on agriculture (Bindi and Olesen, 2011; de Wilt *et al.*, 2001); however, both options require the development of competences (Knickel *et al.*, 2009) and thus, IC, to face uncertainty; these latter are well explained in the next section.

4. Competences in support of farm businesses

Based on the literature, this section provides details about competences that are considered relevant to farm businesses to create and support their competitive advantage in the current agricultural operating environment (please see Table I).

With regard to innovation capabilities for competitive advantage, Mc Fadden and Gorman (2016) proposed Kallio and Kola's (1999) model that is based on the characteristics farmers and farms should possess to be successful. These characteristics include: continuous evaluation of production, incomes and expenditures; constant development of cognitive and professional skills; positive work ethic; goal-oriented operation; utilization of recent information that is relevant for the individual farmer's own circumstances and the needs of the farm; favorable starting points for the enterprise (i.e. good condition of machinery, buildings, land) and an appropriate balance between pricing of product and investment in production; and cooperation with others in the supply chain. The shift from a subsided agricultural environment to a market-driven one is driving farmers to adopt the characteristics of entrepreneurship (McElwee, 2006) and develop business and managerial skills such as strategic planning, human resource management, cooperation and networking capacities, use of information technology, marketing and selling abilities, entrepreneurial

Table I. Competences and skills to face the emerging agricultural environment

Competences/skills	Sources
Know-how and expertise related to the company's core activity (e.g. building and machinery' maintenance, knowledge on soils, climate' effects and biodiversity, regulations, information systems' technologies), and farming techniques for sustainable agriculture (e.g. water management)	Soulignac *et al.* (2012), Mc Fadden and Gorman (2016), Kallio and Kola (1999), Olesen and Bindi (2002), Steenwerth *et al.* (2014), Long *et al.* (2016), Pogutz and Winn (2016), Pedersen and Pedersen (2006)
Individual capacities such as problem solving, decision making and flexibility, interactions with colleagues and other actors in the value chain, innovative attitude	Soulignac *et al.* (2012), McElwee *et al.* (2006), Mc Fadden and Gorman (2016), Kallio and Kola (1999), Boehlje *et al.* (1995), Nieuwenhuis (2002), Gellynck *et al.* (2015)
Market-related skills such as strategic planning, human resources management and marketing	Soulignac *et al.* (2012), McElwee *et al.* (2006)

qualities and values and expertise with technical competences (McElwee *et al.*, 2006). Farmers are asked to develop problem-solving and decision-making abilities to meet the dynamic context characterized by fast progress in technology (McElwee, 2006) as well as flexibility (Boehlje *et al.*, 1995) and interactions with different actors such as colleagues, suppliers or society at large (Läpple *et al.*, 2015; Knickel *et al.*, 2009). Innovation in this setting is configured as a learning process (Knickel *et al.*, 2009; Nieuwenhuis, 2002) and requires the farmer to be attentive to market orientations and to adopt innovative behavior to respond to the complex environment (Gellynck *et al.*, 2015). The characteristics of innovative farmers include: a personal attitude to learning; understanding of the changes in the agricultural sector and its market trends in order to set competitive strategies; a willingness to improve technical and production processes of their farms; and a problem-solving attitude in their networking with suppliers and colleagues, or in their consultation of sectoral journals and available databases (Nieuwenhuis, 2002). In order to be competitive and sustainable in this new agricultural habitat, farms should mobilize knowledge and know-how; then, knowledge capital for agriculture focuses on (Soulignac *et al.*, 2012): knowledge of grounds, climate and biodiversity and knowledge of regulations characterizing the operating environment; soft skills such as interaction with colleagues and other actors; know-how encompassing the capacity to observe crops and bio-aggressors, adaptation repair, maintenance, driving of agricultural machines and building maintenance; use of IT tools; and commercial/relational skills if direct selling is applied.

The required competences for knowledge of sustainability include irrigation and nutrients management, mixed crops techniques, early planting combined with short-term and long-term cultivars depending on environmental conditions, specialization, conservation tillage (Olesen and Bindi, 2002), optimal combining of land-use practices and carbon storage through multifunctional farming, risk management, water management (Steenwerth *et al.*, 2014) and capacity to deal with technological innovations for climate-smart agriculture (Long *et al.*, 2016; Pogutz and Winn, 2016). In agriculture, these skills can be acquired through direct experience, education and social networking; these skills are aimed at preparing farmers to deal with long-term climate change (Steenwerth *et al.*, 2014).

The opportunity to develop the competences of human capital by means of strategical management is critical to a firm's performance, including agricultural firms, as human capital in agricultural firms can contribute to innovation for competitive advantage (Boehlje *et al.*, 2011) and innovation itself can bring new approaches to agricultural development to overcome problems characterizing the agricultural context (de Janvry, 2010). Among competences, although technical skills serve the market's need for product sophistication, they are not expected to drive competitiveness; by contrast, personal skills, creativity and innovation, strategic thinking and marketing competences are considered more suitable for competitive advantage acquisition in the context of farm businesses (Boehlje *et al.*, 1995). Farm businesses that assume an entrepreneurial behavior are more successful in adopting technical innovations (Diederen *et al.*, 2002). When technological innovation is needed to drive the business through a competitive position, not only are human capital's basic skills of interaction with technology required to make the innovation work, but learning and management competences are required for the technology to be used in strategy planning and deployment. This is the case in the company being analyzed where the adoption of innovative technologies for precision farming was seen as strategical for the competitive advantage of the firm as well as human resources' ability to use these innovations effectively.

5. The setting and design of the study

The chosen case study was one of the biggest farm businesses in Italy. For privacy reasons, in this paper, the authors address the company as Alpha. The company started in London, UK, in the late 1800s with one subscriber and a starting capital of £300,000, handling in a short time, more than 7,000 hectares of land, to carry out land reclamation in North Italy. After the company was licensed by Royal Decree to operate in the Kingdom of Italy, and in the first half of the 1990s, the Bank of Italy became the largest shareholder of Alpha. In 2014, a holding formed by a group of private investors took a majority of shares with the objective of transforming the company into a European agricultural business of excellence. The actual Industrial Plan of Alpha (2015–2019)[1] allocates an investment of more than EURO 30m for the actual property as follows:

- strategic placement through shift from wholesale-oriented management to consumer-oriented business products;
- using innovative cultivation techniques such as the production of super-stretch olive cultivation for the production of extra virgin oil with high mechanization;
- integration with organized large-scale retail distribution (OLRD);
- the distribution and marketing of high-quality branded products directed at high-end retail stores;
- development of an Italian integrated zoo technical chain;
- development of bioenergy through the exploitation of crop residues;
- creation of the first Italian university campus for experimentation and innovation in the farming field; and
- precision agriculture through: partnerships and supply of more than 20 operating machines managed by customized software realized considering the needs of the farm; satellite earth mapping and geo-referencing according to soil's morphological characteristics to improve cultivation techniques; and technical improvement of irrigation systems to maximize efficiency in the use of water.

The magnitude of undergoing investment in technical and market innovations makes this company an interesting case for the exploration of the interaction between structural, human and relational capital assets for strategy formulation and value creation (Peppard and Rylander, 2001; Marr *et al.*, 2004). The role of relational capital and its interactions with human and structural capital for competitive advantage was mainly related to external partners furnishing new structural capital to Alpha; for reasons of secrecy, this component has not been investigated. However, other aspects of relational capital such as interaction with suppliers and learning by interaction with colleagues are examined in the paper.

6. Methodology

This case study analysis (Yin, 2013) is based on a two-step model, including both interviews and questionnaire survey, and is explained in detail as follows.

6.1 Step 1: the interviews

The interview process involved the CEO of the company and five of the heads of the company's strategical areas in order to detect the strategical priorities of the firm. All the semi-structured interviews were conducted in their workplace; the interview with the CEO of the company lasted 90 min while the interviews with the heads of five strategical areas lasted about 30 min each. The participants agreed to the recording and transcribing of the interviews. Field notes were also taken to help memorize key themes for the discussion. The protocol of the interviews focused on the firm's long-term goals and the key actions and drivers or critical success factors needed to achieve the firm's objectives. This allowed the authors to design a strategy map of the company and to detect the potential role of IC (mainly human and structural and their interaction) in driving the achievement of the detected goals. As competences emerged as essential for the firm's strategic goals, the authors adopted the framework of Amabile (1988, 2012) of domain-relevant skills and creativity-relevant skills (please see Table II); these were largely coherent with the literature on competitiveness and sustainability in the agricultural sector as previously discussed in the paper, and were used to design the questionnaire for further research.

6.2 Step 2: questionnaire survey

As key human capital competences emerged from interviews with top and middle management as pivotal to drive the efficacy of the newly adopted technologies (structural capital), the questionnaire was given to 20 full-time farming operators in order to obtain auto-evaluation of their competences and detect the extent to which their competences were aligned with those that were considered essential for the firm to pursue its organizational goals. In addition to full-time employees, the company hires seasonal operators and workers to perform tasks characterized by a low degree of specialization. Seasonal workers experience a high rate of turnover from one year to another; consequently, we did not assess their contribution to the stock of IC the company had matured over time[2].

The 20 full-time operators were asked to assess on a seven-point Likert scale:

(1) Which competences they believed were fundamental to the firm's pursuit of organizational goals?

(2) To what extent they perceived themselves to possess these competences?

(3) To what extent they perceived they had acquired these competences through training activities provided by the company?

Other secondary questions concerned each operator's rate of attendance at courses, the type of attended courses, the kind of diploma they possess, their experience in the agricultural field and so on.

Subsequently, as top management particularly underlined the role of training and education for the acquisition of the key competences, employees were asked to rate how essential training was to their development. In the literature, education and training in agriculture were depicted as pivotal to the intent and behavior to adopt innovations (Läpple *et al.*, 2015; Toma *et al.*, 2016). Indeed, more educated farmers are more aware of available innovations and are more able to effectively process information about them (Läpple *et al.*, 2015). When the technology is new and perceived as profitable, schooling increases the probability of adoption of innovation (Huffman, 2001). Then, the classification made above considering the framework of Amabile (1988) was adopted to conduct further analysis of the data obtained from survey participants, in order to perform more in-depth analysis.

Domain-relevant skills	Creativity-relevant skills
Knowledge of soil's properties (KS)	Flexibility (FLEX)
Ability to understand climatic influences on cultivation (AUCI)	Ability to provide alternative solutions to work problems (problem solving and decision making) (APSP)
Ability to effectively manage the irrigation system (EMIS)	Ability to adapt to changes due to innovation in tools and work practices (AACI)
Knowledge of regulations (KR)	Ability to interact with colleagues (AIWC)
Ability to maneuver agricultural machinery (AMAM)	Ability to interact with other farming operators belonging to different firms (AIWFO)
Ability to use agricultural ICT technologies (AUICT)	Motivating human resources (when required by the covered role) (MHR)
Expertise (EXP)	

Table II. Domain-relevant and creativity-relevant skills in Alpha

First, correlations through Spearman's ρ test were done between the two sets of variables (Sheskin, 2003) to test relations between domain-relevant and creativity-relevant skills and analyze their complementarity. Second, correlations within each set of variables were performed in order to assess if the variables pertaining to each set of competences could be aggregated in a composite index (two sets of competences, two different composite indexes). This process would allow testing if training provided by the company to the 20 operators: affected the acquisition of domain-relevant skills, and affected the acquisition of creativity-relevant skills. To this end, given the studied sample, we verified for each set of competences: that if there were pairs of items with correlations that were too high, one of the two items of the pair was removed (OECD, 2008); and the presence of negative correlations between items of each set to exclude competences that were negatively correlated with others, as not part of the same construct. Following these rules, the "ability to conduct minor maintenance on agricultural machinery" was then excluded for the creation of the additive index of domain-relevant skills as it was negatively correlated with the other variables in the set; it was clear that it could not be a part of the same construct[3]. As the application of factor analysis to a small sample is controversial (Beavers *et al.*, 2013), we used Cronbach's α to assess if the scales of the variables for each of the considered sets were able to measure the same construct. As argued by Cronbach (1951, p. 332), Cronbach's α represents "an upper bound to the concentration in the test of the first factor among the items. For reasonably long tests not divisible into a few factorially-distinct subtests, alpha is very little greater than the exact proportion of variance due to the first factor." Although Cronbach's α cannot prove unidimensionality of data, it can be reasonably used to prove internal reliability of the used scales for each composite index to be created. For the composite index of creativity skills the Cronbach α was equal to 0.807 (standardized value of 0.816), while for the one of domain-relevant skills the α was equal to 0.818 (standardized value of 0.834); both values were acceptable. We then decided to proceed with the creation of the composite indexes. The literature prescribes steps to create a composite index: normalize data and perform the aggregation (Torelli *et al.*, 2013). To this end, Min-Max normalization has been used in this paper (Larose and Larose, 2015), and additive function has been performed to construct each of the composite indexes. As suggested in the literature (Babbie, 2013), an equal weight (w) was assigned to the variables of the domain-relevant skills index and to the variables of the creativity-relevant skills index.

Linear regression analysis was performed through IBM SPSS software (Field, 2013), testing the following relations:

H1. Training had a positive effect on the acquisition of creativity-relevant skills (regression model no. 1), in formula $Y = XB + \varepsilon$, vector resulting from the N equations:

$$y_i = b_0 + b_1 x_i + \varepsilon_i,\ i = 1,\ \ldots,\ N,$$

where y is the composite index for creativity-relevant skills for each of the observations, equal to:

$$w\ x\ (\text{FLEX} + \text{APSP} + \text{AACI} + \text{AIWC} + \text{AIWFO} + \text{MHR});$$

x represents the relevance of training provided by the company for each observation; b_0 is the intercept of the model; b_1 is the gradient; and ε the error term.

H2. Training had a positive effect on the acquisition of domain-relevant skills (regression model no. 2), in formula $\Omega = XB + \varepsilon$, vector resulting from the N equations:

$$\omega_i = b_0 + b_1 x_i + \varepsilon_i,\ i = 1,\ \ldots,\ N,$$

where ω is the composite index for domain-relevant skills for each of the observations, equal to:

$$w\ x\ (KS+AUCI+EMIS+KR+AMAM+AUICT+EXP);$$

x represents the relevance of training provided by the company for each observation; b_0 is the intercept of the model; b_1 is the gradient; and ε the error term.

In order to verify the goodness of the obtained regression models, the analysis of assumptions on residuals was also provided; indeed, the assumptions concerned (Crown, 1998) normality of residuals distribution tested by the Shapiro–Wilk test (Sen and Srivastava, 2012), absence of autocorrelation tested by Durbin–Watson test (Sen and Srivastava, 2012), homoscedasticity tested by Levene's test (Martin and Bridgmon, 2012) and residuals are distributed with a mean of zero (Crown, 1998).

7. Results

7.1 Results of interviews and the strategy map of Alpha

From the interviews with top and middle management, it was possible to draw the strategy map of Alpha (Figure 1) detailing goals and drivers of IC.

Two main goals emerged as strategically relevant for the firm. First, the company aimed at increasing the quality of the production, focusing on the possibility to interact with suppliers and improving the know-how of employees through basic technical knowledge (e.g. on regulations for the selling of the product on OLRD's channels, especially concerning the issue of quality and chemical treatment of crops). The second goal was related to the introduction of precision farming as a source of better internal control and improved planning ability. The investment in these new technologies was related to the acquisition of combine harvesters with GPS and humidity sensors for the mapping of soils: these innovations would enable the firm to map the characteristics of the soil through harvesting operations or periodic soil pickups, in order to plan cultivation activities such as seeding, fertilizing and irrigation on the basis of historical production and humidity data.

From the perspective of top and middle management, the major advantage in the use of combine harvesters was related to improved efficiency and long-term sustainability because an optimal combination of growing techniques could be achieved by using production data forecasting, which would reduce waste of natural resources. This information along with daily information on agricultural activities would then be included in newly developed software that would serve as employees' support for daily decision making. Management's view on the strategical development of the company was highly coherent with the literature,

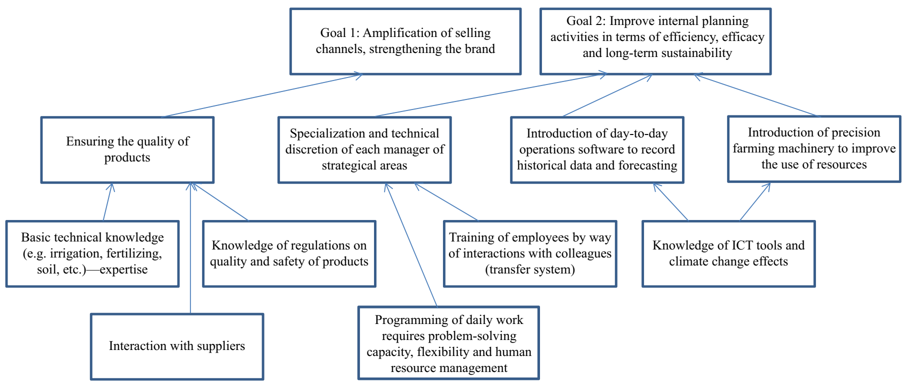

Figure 1.
Strategical map of Alpha (goals and drivers of intellectual capital)

which urged farm businesses to develop both innovation and sustainability competences to be competitive in the current agricultural environment (Diederen *et al.*, 2002; Bindi and Olesen, 2011; de Wilt *et al.*, 2001; Knickel *et al.*, 2009), and shed light on the interconnectedness of IC assets for the company's sustainability (Cavicchi and Vagnoni, 2017). As the middle management pointed out, the benefit associated with these technologies could be achieved if changes in weather conditions were not inconsistent and they did not change frequently; inconsistent changes in weather conditions would make forecasting the optimal cultivation conditions very difficult. When asked about the IC drivers affecting achievement of the strategic goals, top management signaled training, because the majority of the organization's core activities required deployment of different employees' abilities.

With reference to the first goal (improving the quality of product), the major competences that were required in employees consisted of basic agricultural knowledge (the domain-relevant skills as defined by Amabile, 1988), knowledge of regulations affecting the presence of the firm in OLRD's channels (such as quantity of allowed fertilizer) and the capacity to interact with suppliers to obtain good raw materials to be used in the production chain. While for the second goal, knowledge of ICT tools was the predominant competence: the combine harvesters would provide employees with new information that had to be interpreted in order to make decisions within their daily planning. This also required employees to develop knowledge on climate effects in order to put their experience to the service of new technologies, as climate variations could affect the forecasts derived from the combine harvesters. The employees' expertise would enable them to interpret data from new technologies (e.g. combine harvesters) and they could integrate these forecasts with field knowledge. In this way, creativity skills (Amabile, 1988), such as flexibility in response to climate change, decision-making abilities and innovativeness could be developed within the company.

Moreover, talking with the heads responsible for each strategical area, it emerged that coordination with subordinates was needed because the size and geographical dispersion of the sites to be handled required a large number of employees able to manage different crops; in this case, management expressed the idea of reinforcing the already developed supervised training in order to increase the specialization of employees and their knowledge of different products in order to make them able to autonomously plan agricultural activities within the firm's sites when required. Then, from the interviews, it was clear that knowledge development was considered central to allow the IC drivers to interact with each other in order to produce strategic value for the firm.

To this end, it was interesting for the authors to test the effectiveness of the training provided by the company to improve employees' abilities to deal with the innovations previously introduced.

7.2 Training and acquisition of innovative behavior

7.2.1 Correlations' results. In Table III, Spearman's ρ correlations between domain-relevant and creativity-relevant skills are provided.

The correlation analysis showed that the ability to provide alternative solutions to work problems was positively correlated with knowledge of soil's properties, ability to understand climatic influences on cultivation, knowledge of agricultural regulations and the ability to effectively manage the irrigation system (significant at the 0.01 level). This is explained by the fact that a new operating context in which sustainability and productivity targets were increasing was emerging for the investigated firm, and the capability to develop domain-relevant skills such as knowledge of climate, soils and regulations was considered strategic to the firm's survival over time by the firm's top and middle management. Moreover, the investment of the company in increasing the efficiency of the

	Motivating human resources	Flexibility	Ability to adapt to changes due to innovation in tools and work practices	Ability to provide alternative solutions to work problems	Ability to interact with colleagues	Ability to interact with other farming operators belonging to different firms
Knowledge of soil's properties						
Correlation coefficient	0.218	0.385*	0.354	0.689**	0.225	0.337
Sig. (1-tailed)	0.177	0.047	0.063	0.000	0.170	0.073
Ability to understand climatic influences on cultivation						
Correlation coefficient	0.384*	0.463*	0.486*	0.701**	0.204	0.329
Sig. (1-tailed)	0.047	0.020	0.015	0.000	0.194	0.078
Knowledge of regulations						
Correlation coefficient	0.363	0.548**	0.380*	0.654**	0.184	0.356
Sig. (1-tailed)	0.058	0.006	0.049	0.001	0.219	0.062
Ability to effectively manage the irrigation system						
Correlation coefficient	0.519**	0.570**	0.395*	0.609**	0.349	0.511*
Sig. (1-tailed)	0.009	0.004	0.043	0.002	0.066	0.011
Ability to maneuver agricultural machinery						
Correlation coefficient	0.201	0.340	0.522**	0.363	0.271	0.617**
Sig. (1-tailed)	0.197	0.072	0.009	0.058	0.124	0.002
Ability to conduct minor maintenance on agricultural machinery						
Correlation coefficient	−0.156	0.021	0.440*	0.099	0.141	0.277
Sig. (1-tailed)	0.256	0.466	0.026	0.339	0.277	0.118
Ability to use agricultural ICT technologies						
Correlation coefficient	0.052	0.319	0.741**	0.238	0.408*	0.297
Sig. (1-tailed)	0.414	0.085	0.000	0.156	0.037	0.101
Expertise						
Correlation coefficient	0.484*	0.460*	0.231	0.192	−0.005	0.106
Sig. (1-tailed)	0.015	0.021	0.163	0.208	0.491	0.329

Notes: *,**Correlation is significant at 0.05 and 0.01 levels (1-tailed), respectively

Table III. Correlations between domain-relevant and creativity-relevant skills

irrigation system would not be possible if these domain-specific abilities were not properly developed by the organization.

The ability to adapt to changes in response to innovation in tools and work practices was positively associated with the ability to use agricultural ICT tools and to maneuver agricultural machinery (significant at the 0.01 level); this indicates that the increase in the firm's employees' basic competences to deal with combine harvesters' innovation for soil mapping also increased the employees' ability to adopt to new practices. Moreover, the ability to adapt to innovation was also positively correlated with the ability of employees' to interpret climatic variations, as required by new structural investments made by the company, as well as to knowledge of regulations (especially the ones concerning the selling of products in the OLRD segments) and other basic maintenance competences (significant at the 0.05 level).

Employees' flexibility was correlated with expertise, knowledge of soils and regulations and knowledge of climate variations that provide employees' with the ability to adapt to the new organizational context (significant at the 0.05 level). In fact, the increasing importance of climatic conditions to the agricultural sector requires focus on the effects that these climatic events can have on crops and their cultivation; climatic events affect agricultural activities such as seeding, irrigation and harvesting, and generally, this knowledge can be acquired through experience in the sector. Flexibility was also correlated with the ability to use the irrigation system, which is generally highly dependent on climate conditions, and knowledge of regulations that might lead to new requirements to be adopted (significant at the 0.01 level).

The ability to interact with colleagues and with other farming operators were the only two items which registered a small number of correlations within domain-relevant skills, suggesting that these abilities are personal and generally not linked with training or other ways adopted by the firm to develop employees' capabilities. The ability to interact with colleagues was only correlated with use of agricultural ICT technologies, as new investments made by the firm were mainly related to the introduction of combine harvesters which are based on GPS and ICT systems for the mapping of the soil (significant at the 0.05 level); thus, relational capital in this sense could be considered useful to strengthen the firm's capacity to use the introduced innovations effectively. Interaction with other farming operators was correlated with the ability to use the irrigation system and the ability to maneuver agricultural machinery (respectively significant at the 0.05 level and the 0.01 level); in this case, the ability to interact with others can lead to the development of basic knowledge because, in agriculture, relationships within the sector are considered one of the major sources of information and learning for farmers.

Finally, motivating human resources was positively correlated with: (a) employees' expertise (significant at the 0.05 level), as the employees with higher technical knowledge of work are generally more able to encourage and orient employees with less capabilities in performing the task that are required to them; (b) the ability to efficiently use the irrigation system (significant at the 0.01 level) and to understand climatic variations (significant at the 0.05 level), denoting that these basic competences are needed if employees in higher positions need to show others how the work should be performed and, in consequence, motivate others to do the task. Point (b) was interesting because motivating human resources is very important in the performance of the tasks that are functional to the strategic priorities of the firm (i.e. the interpretation of climate conditions and investment in irrigation systems as cited in the industrial plan).

7.2.2 Results of regressions. The first regression model the authors developed assessed the effects of training on the acquisition of creativity-relevant skills. As can be seen in Table IV, training was considered essential to the acquisition of creativity skills. Indeed, training accounted for 54.3 percent of the variation in creativity competences. The F ratio of the output of the ANOVA from Table V was equal to 21.389, significant at the 0.001 level (the value in the column Sig. is less than 0.001), confirming the goodness of fit of the model.

Table IV. Goodness of fit for the model summary of regression no. 1

R	R^2	Adjusted R^2	SE of the estimate
0.737	0.543	0.518	0.1802708

Note: Model summary of linear regression no. 1 (creativity-relevant skills as dependent variable)

Table V. ANOVA with creativity-relevant skills as dependent variable

Model	Sum of squares	df	Mean square	F	Sig.
Regression	0.695	1	0.695	21.389	0.000
Residual	0.585	18	0.032		
Total	1.280	19			

Table VI provides the values of the coefficients of the regression model. The t-test[4] to determine whether b_0 (the intercept of the model) and b_1 (the gradient of the regression) differ from zero shows that only the value of the test for b_1 is significant at the 0.05 level (the p-value of the test is 0.000); this means that the model has an intercept equal to zero and a gradient that differs from zero (the gradient is equal to 0.616); in order to better explain the value of the intercept, when the organization does not provide training to employees, creativity skills equal zero.

This result showed that training was relevant for the surveyed employees to improve their creativity skills such as planning, flexibility, decision-making abilities, motivation of personnel and interaction with colleagues. Indeed, in line with organization's strategic priorities, education is needed to develop capabilities supportive of innovation, which are more complex to obtain compared to basic technical competences.

The assumptions on residuals were tested in order to verify the solidity of the model.

Considering the assumption of normality of residuals distribution, a Shapiro–Wilk test for small samples was conducted: the p-value was equal to 0.313, which is higher than the level of significance (0.05), confirming the normality of the distribution of residuals[5].

With reference to the assumption of homoscedasticity (equality of error variance), Levene's test was conducted: the p-value was equal to 0.239, which is higher than the level of significance (0.05), confirming the null hypothesis of equality of error variance[6].

With reference to the assumption of the absence of autocorrelation, the Durbin–Watson test was conducted: as the statistic value was equal to 2.329, the absence of spatial autocorrelation between residuals of observed values was confirmed[7].

Finally, the mean of the residual's distribution was calculated and found to be equal to zero.

As all the assumptions on residuals were respected, the goodness of fit of the model was confirmed. With reference to the second hypothesis, training was able to explain only 24.2 percent of the variation of domain-relevant skills (Table VII).

The F ratio of the output of the ANOVA from Table VIII was equal to 5.762, significant at the 0.05 level (the value in the column "Sig." is less than 0.05), confirming only a sufficient fit.

Unstandardized coefficients		Standardized coefficients		
B	SE	β	t	Sig.
Intercept: 0.134	0.105		1.278	0.217
Gradient: 0.616	0.133	0.737	4.625	0.000

Table VI. Coefficients of the linear regression model no. 1

R	R^2	Adjusted R^2	SE of the estimate
0.492	0.242	0.200	0.2039824

Note: Model summary of regression no. 2 (domain-relevant skills as dependent variable)

Table VII. Goodness of fit for the model summary of regression no. 2

Model	Sum of squares	df	Mean square	F	Sig.
Regression	0.240	1	0.240	5.762	0.027
Residual	0.749	18	0.042		
Total	0.989	19			

Table VIII. ANOVA with domain-relevant skills as dependent variable

From Table IX, it is possible to identify the coefficients of the regression model.

The authors conducted the *t*-test to determine whether b_0 (the intercept of the model) and b_1 (the gradient of the regression) differ from zero. The output showed that the value of the test for b_1 was significant at the 0.05 level and was equal to 0.362; this means that when training increases by one unit, the acquisition of competences increases by a unit multiplied by 0.362. The value for b_0 was significant at the 0.01 level and was equal to 0.381; this means that when training is absent, domain-relevant skills are equal to 0.381.

However, the testing for assumptions on residuals led the authors to reject the model, as the assumption of normality of residuals distribution was not confirmed. Indeed, considering the assumption of normality of residuals distribution, the Shapiro–Wilk test provided a *p*-value equal to 0.001, which led to a rejection of the normality of data distribution. In any case, Levene's test provided a *p*-value of 0.180, which was higher than the level of significance (0.05), confirming homoscedasticity; the Durbin–Watson test provided a value of the test statistic equal to 2.473 confirming the absence of autocorrelation of residuals. However, as the assumption of normality of residuals distribution was not confirmed, the model was not solid; this means that the relation between domain-relevant skills and training provided by the company has to be rejected, and that acquisition of domain-relevant skills in the analyzed case study did not come from training that stemmed from employees' permanence in the firm.

Indeed, of the surveyed employees of the firm, 55 percent already possessed a higher school diploma or an agricultural qualification (15 percent) that was perceived to be coherent with their occupation in the agricultural sector (mean equal to 3.9), meaning they had already acquired basic competences to do the work. Moreover, 70 percent of the employees had been working in the agricultural sector for more than 20 years, and only five employees for more than 20 years in the analyzed company; this probably means they therefore had matured domain-relevant skills through their basic schooling or through previous work experience in other companies. Further research could investigate how the combination of training and experience matured over time could be a source of domain-relevant skills. Likewise, more complex models could also estimate the effects of experience in the agricultural sector on the ability of employees to develop creativity skills, as in this paper this analysis has not been performed.

In conclusion, the linear regression confirmed that training was pivotal to the development of innovative capabilities of employees (Läpple *et al.*, 2015; Toma *et al.*, 2016) in the form of creativity-relevant skills (Amabile, 1988). However, a linear relation between training stemming from the company and the acquisition of domain-relevant skills was not proved.

7.3 Firm's strategy and employees' perceptions of possessed skills

Figure 2 presents an outline of employees' auto-assessment of competences needed for competitive advantage comparing the mean value of competences that were perceived as strategic for the success of the business and the mean value of perceived possessed competences.

As can be seen, all the competences were perceived as important for the success of Alpha, as the average value (a.v.) of each competence is higher than the a.v. of each variable measured on a seven-point Likert scale. Except for "dealing with ICT" and "knowledge of soil,"

Table IX.
Coefficients of the regression model 2

Unstandardized coefficients		Standardized coefficients		
B	SE	*β*	*t*	Sig.
Intercept: 0.381	0.119		3.207	0.005
Gradient: 0.362	0.151	0.492	2.400	0.027

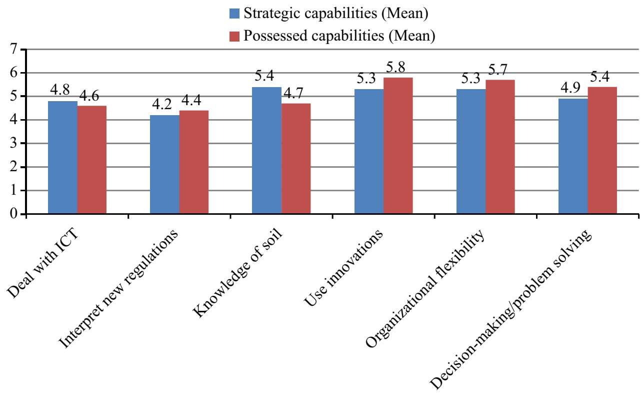

Figure 2. Employees' strategic vs possessed competences

employees thought they possessed all the strategic capabilities contributing to the competitive advantage of the firm. However, there was a small gap between employees' perceptions of the relevance of such competences and their effective possession of the skills for the competences "deal with ICT" and "knowledge of soil." The company's investment in innovation comprised the introduction of machines (combine harvesters) that utilize ICT technology to optimize agricultural planning based on forecasts exploiting knowledge of the soil's properties. As a major practical implication for the company's planning, the results of the self-assessment indicated that Alpha could eventually strengthen informatics training in order to enable its employees to effectively use these innovations. As a consequence, the greater comprehensiveness of data provided by combine harvesters (the structural capital of the firm) could lead to better planning of agricultural activities within the daily routine of each employee because of their increasingly developed knowledge of soil.

8. Discussion

From the case study, it emerged that human capital, defined as the skills of full-time employees of the investigated company, was functional to exploit the company's investment in structural capital, while relational capital was the major source of this structural innovation and a potential contributor to the company to enter new market segments. The interactions among different IC assets (Habersam and Piber, 2003; Marr *et al.*, 2004) represented the major source of value creation for the analyzed case study (Roos, 2005; Peppard and Rylander, 2001; Lev and Daum, 2004).

The results showed that domain-relevant skills along with creativity-relevant skills (Amabile, 1988) were considered the right luggage that the employee must possess in order to allow the competitive advantage of the business, in a context of high uncertainty (Diederen *et al.*, 2002; Bindi and Olesen, 2011; de Wilt *et al.*, 2001; Knickel *et al.*, 2009). The paper also addresses the call of Cavicchi and Vagnoni (2017) to study the interconnectedness of IC assets for sustainability deployment; indeed, the combine harvesters introduced as structural capital would contribute to a reduction in waste of natural resources while increasing the planning capacity of the company in response to climate change. Not only were creativity-relevant skills enhanced by training which was periodically provided by the company through specialization courses, but also by relationships that the organization strengthened within internal and external environments. As a matter of example, links with suppliers of agricultural machinery and with software developers were developed over time with the aim of improving daily planning activity through forecasting for productivity data based on mapping of the soils and on developing a capability to interpret climate variations, as these latter can affect the results of the forecasts.

In the case study, a self-assessment of skills was also performed by the company's full-time employees; as a practical implication, this assessment can be implemented to enable companies to find out whether their employees' skills are aligned with strategic goals (Kozera, 2011). The intention of the company to continue training activities for employees was evident from the interviews held with top and middle management. Apart from periodic courses that were attended by employees in specific disciplines, middle management started to educate the workforce through supervised learning activities in order to increase employees' flexibility.

9. Conclusion

This study represented an attempt to investigate the role of IC within organizations (Guthrie and Dumay, 2015; Mouritsen, 2006), investigating the combinations of corporate resources, and tangible and intangible factors that affect value creation (Lev and Daum, 2004). From the study, it emerged that the development of human capital was considered essential to the effective use of the structural innovations introduced by the firm. Employees' self-assessment was also performed and combined with the firm's future strategical development of human capital competences, in line with the call of scholars to use IC accounting for strategic purposes in the agricultural sector (Kozera, 2011), and to contribute to management and reporting activities (Guthrie *et al.*, 2012; Mouritsen *et al.*, 2001).

Regression analysis showed that training was already contributing to the development of employees' creativity skills (Amabile, 1988), and from interviews held with top and middle management, it was clear that employees' education was considered relevant to effectively exploit the firm's innovative potential. In line with previous studies (Huffman, 2001; Läpple *et al.*, 2015; Toma *et al.*, 2016), farmers' capability to adopt and exploit innovation was dependent on the level of education provided by the company's training sessions. By contrast, a linear regression of the effects of training on the acquisition of domain-relevant skills was not solid, and a deeper examination of the data suggested that domain competences can be acquired from a combination of training and experience matured over time. Thus, further research should construct regression models on the basis of these results. Moreover, experience matured in the agricultural field can also be tested in combination with training for the acquisition of creativity-relevant skills, as in this case study the analysis was not performed.

Limitations of the study are linked to the testing of unidimensionality for the definition of composite indexes.

However, given the scarcity of studies in the field, the paper contributes to the literature by investigating the relation between training and the development of the human capital skills that are required for innovation and sustainability (and thus, competitiveness) in the agricultural sector (Diederen *et al.*, 2002; Bindi and Olesen, 2011; de Wilt *et al.*, 2001; Knickel *et al.*, 2009). With reference to sustainability, the paper also responds to the call for research investigating the connectivity of different IC assets for the sustainable development of organizations (Cavicchi and Vagnoni, 2017) in the agricultural setting, as it was clear that the combine harvesters could be fully exploited if employees were empowered and this would benefit the company through increased efficiency and reduced waste of natural resources.

Notes

1. www.consob.it
2. Turnover represents a relevant issue in the current management of farm businesses: as a matter of fact, the labor force in the agricultural sector in 2013 comprised 22.2 m people; among them, approximately 9 m were full-time employees, which means less than one full-time equivalent job

per farm. Moreover, in the period 2005–2015, more than 3 m full-time jobs were lost (25 percent) (European Commission, 2017). Indeed, progressive mechanization of bigger farms and increases in technical innovation and the achievement of economies of scales have contributed to replace human labor with capital so that the human labor in agriculture decreased by about 5.2 percent from 2005 to 2010 (EU Agricultural Economics Brief, 2013).

3. Please consider that Italian agricultural legislation requires that even small maintenance tasks have to be certified by the authority that verifies compliance with the rules on health and safety in a work environment. Thus, small maintenance tasks in agricultural firms are performed by external professionals who are qualified to perform the maintenance and can issue a conformity certification for the task. Moreover, the evolution in components of agricultural technologies, from mechanic to electronic elements, requires professionals' external competences to perform these activities.

4. In the *t*-test, the null hypothesis is that the intercept and the gradient equal zero (the *t*-test is conducted on each of the model's parameters). If the *p*-value of the *t*-test is less than the level of significance, the null hypothesis should be rejected as the parameters significantly differ from zero.

5. In the Shapiro–Wilk test, the null hypothesis of the test refers to a normally distributed population. Thus, if the *p*-value is less than the α level of significance (0.05), then the null hypothesis is rejected, and there is evidence that the data are not from a normally distributed population. By contrast, if the *p*-value is greater than α, then the null hypothesis (i.e. the data came from a normally distributed population) cannot be rejected.

6. If Levene's test is significant at $p < 0.05$, the variances are significantly different. Thus, the assumption of homogeneity of variances is violated (the null hypothesis has to be rejected in favor of the alternative one). By contrast, if Levene's test is non-significant with $p > 0.05$ then the variances are roughly equal (the null hypothesis is then accepted).

7. Critical values of the test statistics (*d*) for a sample $n = 20$ and for one key explicative variable, with a level of significance of 0.05, are $d_L = 1.20$ (the lower critical value) and $d_U = 1.41$ (the upper critical value). As the value of the obtained test statistic was equal to 2.329 (higher that the upper value $d_U = 1.4$), we accepted the null hypothesis of the absence of autocorrelation of residuals. The test indeed prescribes that: if $d < d_L$, the null hypothesis of the absence of autocorrelation should be rejected; if $d > d_U$ the null hypothesis should be accepted; if $d_L < d < d_U$ the test is inconclusive.

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Corresponding author
Emidia Vagnoni can be contacted at: vgnmde@unife.it