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# The role of adverse economic environment and human capital on collaboration within agri-food supply chains

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## Abstract

*This paper examines the role of adverse economic conditions and human capital on different types of collaboration within agri-food supply chains. Data was collected from the Greek agricultural sector, covering periods of economic hardship. The results reveal that the impact of adverse economic conditions on the collaborative constructs of goal congruence, decision synchronization, incentive alignment, resource sharing and joint knowledge creation is nonlinear, specifically an inverted U for all of them. For collaboration constructs of information sharing and collaborative communication, the results reveal that under adverse economic conditions, the farmers do not collaborate. We also show that aspects of human capital such as age, education and farming experience affect collaboration. Our contribution lies in investigating the potential non-linear relationship between adverse economic conditions and various types of collaboration. Therefore, this study provides several managerial implications and insight for policymakers, while filling a crucial gap in the literature due to the limited existing studies that consider the impact of adverse economic conditions on agri-food supply chains.*

**Keywords:** Adverse economic environment, Human capital, Supply chain collaboration, Information sharing, Agri-food chains

## 1. Introduction

Over the last few decades there has been a strong need for collaboration across the supply chain in order to secure an efficient and effective response to customer needs (Cao et al., 2010; Cao and Zhang, 2011; Fawcett et al., 2015; Soosay and Hyland, 2015). Supply chain collaboration (SCC) has to do with two or more organizations coming together, defining common goals, and working towards their execution (Simatupang and Sridharan, 2002; Ramanathan and Gunasekaran, 2014). The literature focuses on benefits and advantages (Soosay and Hyland, 2015; Akhtar et al., 2016; Dania et al., 2018; Despoudi et al., 2018) but also on the disadvantages of SCC, especially when partner relationships do not live up to the expectations which the participants had before the establishment of the partnership (Barringer and Harrison, 2000; Huang et al., 2014; Fawcett et al., 2015; Prosman et al., 2016).

We focus on collaboration within agricultural supply chains, as they form a major part of the world economy, producing raw materials for many industries (Shukla and Jharkharia, 2013; Vlachos et al., 2008; Sakali and Skalkos, 2016; Kastrinaki and Stoneman, 2011; Krejci and Beamon, 2015). Also, the demand for agricultural products is growing in parallel with population growth (Elik et al., 2019). Furthermore, data from the Food and Agriculture Organization of the United Nations (2016), shows that over 1.94 billion tons of fresh fruits and vegetables are produced each year globally, which spans over 122 million hectares of land. However, only 50% of these fruits and vegetables actually reaches the consumption stage, due to loss, spoilage and wastage (Gustavsson et al., 2011). Moreover, 30% of all food produced for human consumption is estimated to be lost or wasted somewhere within the food supply chain (Rezaei and Liu, 2017). Therefore, reducing postharvest losses and wastage are crucial moves toward developing a more efficient and economical global agricultural sector (Gustavsson et al., 2011). We locate our study within the agri-fresh produce (agri-food), which has complex supply chains due to the perishability of the products, price and demand fluctuations, and food safety concerns (Shukla and Jharkharia, 2013).

There has been substantial research on collaboration in agri-food supply chains from various perspectives and industries (Soosay and Hyland, 2015; Akhtar et al., 2016; Dania et al., 2018). However, limited studies have focused on the impact of the economic environment on SCC with respect to agri-food, and even less have looked at uncertainty, which is described as the rate at which changes in economic conditions occur (Ralston, 2014). Webster (1995), in referring to the customer supplier relationship, argues that characteristics of supply chains are highly susceptible to overall changes of the economic climate suggesting, among other strategies, the introduction of collaboration.

To address this gap, this study investigates empirically the impact of adverse economic conditions on agri-food SCC. The Greek agricultural supply chain is facing a number of issues due to the economic crisis and the declining number of agricultural cooperatives which raise concerns about the effectiveness of collaborative activities in the presence of adverse economic conditions (Kaditi and Nitsi et al., 2010; Paseges, 2012). There is lack of research on the impact of adverse economic conditions with respect to SCC and thus the paper aims to shed more light into this area, specifically within the context of the Greek agricultural supply chain.

To inform this study, a non-parametric regression along with OLS is utilized using data from Greece. Of all the different EU agricultural supply chains, Greece was chosen as it is the country with the largest agricultural labour force (1.2 million people) within the EU-28, having 723,010 agricultural holdings and the fifth largest producer of fresh agricultural products in Europe (Eurostat, 2016). Data was collected in 2013 when Greece was under economic hardship (for further discussion on hardship see Anagnostopoulos et al., 2018). We investigate whether or not seven types of collaborations -goal congruence, decision synchronization, incentive alignment, resource sharing, joint knowledge creation, information sharing and collaborative communication- are linked with adverse economic conditions. This study controls for human capital such as age, farming experience and education. Briefly, the results show that an inverted U shape exists between adverse economic conditions and most forms of collaboration. Simply put, in this case it means

that most forms of collaboration increase with adverse economic conditions until some threshold is reached, after which the collaborations decrease with any further increase in adverse economic conditions. We also find that human capital measured by age and education has a positive effect, but farming experience seems to have a negative effect on collaboration during times of crises.

The organization of this study is as follows: section 2 presents the hypothesis development which is mainly built around transaction cost economics and the resource based view. Section 3 discusses the data, outlines the sampling methodology and shows how the collaboration constructs are developed. Section 4 presents the empirical results where the findings are outlined, and section 5 discusses the results obtained and their policy implications. Finally section 6 draws conclusions and offers directions for future research.

## **2. Hypothesis development**

### **2.1 Agricultural supply chains and collaboration**

The agricultural supply chains include all the activities related to the “journey” of agricultural or horticultural products from production to distribution (Aramyan and Van Gogh, 2014). Two types of agricultural supply chains exist: (i) perishable or fresh agricultural products (agri-food) and (ii) non-perishable agricultural products (Defra, 2006; Shukla and Jharkharia, 2013). In this study, we are concerned with agri-food supply chains due to their particular characteristics such as limited shelf-life, quality and weather conditions (Tsolakis et al., 2014). Research on agri-food supply chains (Soosay and Hyland, 2015; Akhtar et al., 2016; Dania et al., 2018) has looked at various issues including for instance: (i) the relationship among levels of collaboration (Cao et al., 2010; Cao and Zhang, 2011; Fawcett et al., 2015; Soosay and Hyland, 2015), (ii) the nature of products and the structure of the sector (Matopoulos et al., 2007), (iii) uncertainty (Ralston, 2014), (iv) long term partnerships and promotions (Ramanathan and Gunasekaran, 2014), (v) conceptualizations of collaborative forecasting (Eksoz et al., 2014), (vi) strategic partnerships between manufacturers and retailers emphasizing the role of information sharing, integration, and collaborative forecasting

(Eksoz et al., 2019), and (vii) the impact of collaboration on the level of Postharvest Food Losses and quality (Despoudi et al., 2018). A brief comparison of the aforementioned studies is made in Table 1 where further details such as data used and methodology employed are presented. However, limited studies focus on the impact of the economic environment on agri-food SCC. We explore this in the next sections.

**Table 1.** Some previous studies of relevance

	<b>Key aspect(s)</b>	<b>Data used</b>	<b>Methodology employed</b>
Matopoulos et al., 2007	Collaboration/Sector structure	SMEs data	Exploratory case study
Cao et al., 2010	Levels of collaboration	Web survey/US manufacturing firms	Empirical analysis
Cao and Zhang, 2011	Collaboration/Firm performance	Web survey/US manufacturing firms	Empirical analysis
Ralston, 2014	Collaboration/Firm performance	Survey data	Empirical analysis
Ramanathan and Gunasekaran, 2014	Collaboration/Long term partnerships	Survey/Textile company	Empirical analysis
Eksoz et al., 2014	Collaborative forecasting	-	Systematic review
Soosay and Hyland, 2015	Collaboration	-	Systematic review
Fawcett et al., 2015	Collaborative behavior	Keyword literature/managerial interviews	Exploratory study
Despoudi et al., 2018	Collaboration/Post harvest food losses	Survey data	Empirical analysis
Eksoz et al., 2019	Collaborative forecasting	Survey data	Empirical analysis

## 2.2 Adverse economic environment

The adverse economic state is institutionalized (Wood et al., 2015) in a state of continued demand uncertainty. Uncertainty filters through the networks and this results in inefficient and irrelevant activities which add no value to the firm (Vorst et al., 2002). Improved coordination throughout the supply chain lowers the uncertainty within the manufacturing networks (Frohlich and Westbrook, 2001). As such, this can result in supply chain disruptions. Precisely, the exit of any entity can result in the failure of others and even the collapse of the entire supply chain (Jüttner and Maklan, 2011). The supply chain needs to be sufficiently resilient so that it can recover (Jüttner and Maklan, 2011; Chowdhury and Quaddus, 2016). Thus, the emergence of supply chain collaboration (Christopher and Lee, 2004; Scholten and Schilder, 2015), is predicated upon the collaborative advantage paradigm (Kanter, 1994; Dyer, 2000).

Collaborative advantage or joint competitive advantage, as it is sometimes called (Jap, 2001), refers to the strategic benefits in the market place that the collaborating members of the supply chain gain over their competitors (Cao et al., 2010). Vangen and Huxham (2006) refer to collaborative advantage as the gains that are realized through integrating the skills and capital of firms. The benefits through collaborative advantage are obtained through the supply chain among firms. According to Barratt (2004), SCC has two components: vertical and horizontal collaboration which is directly linked to the relationship that firms have with each other through the process of cooperation. Vertical collaboration exists when two or more firms at different stages in the supply chain share their responsibilities, resources, information and other value-adding activities in serving relatively the same end-consumers (Barratt, 2004). On the other hand, horizontal collaboration exists when firms at the same stage of the supply chain, identify and exploit win-win situations among themselves, thus allowing for greater ease of work and mutual aid towards accomplishing a shared objective. (Crujssen et al., 2007). Therefore, unlike the zero sum nature of the competitive advantage theory (Porter, 1994), SCC is a positive sum game because the competitive advantages of the supply partners are enhanced (Cao and Zhang, 2011).

The literature puts forward various perspectives with regards to the motives for supply chain collaboration which is based on different fields of study that include marketing, psychology and organizational behavior which governs the interaction of firms (Piboonrunroj, 2012; Wu and Chiu, 2018). The main theories of supply chain collaboration are Resource Based Theory (RBV), Transaction Cost Economics (TCE) and Social Exchange Theory (SET) (Chicksand et al., 2012). Two of the dominant perspectives are the TCE and RBV (Wiengarten and Longoni, 2015; Schoenherr and Swink, 2012). This study uses RBV, TCE, and SET to conceptualize the relationship between adverse economic environment and SCC due to the complexity of this relationship. The human capital and SCC relationship is conceptualized using the RBV theory.

RBV states that supply chain collaboration is a unique, almost irreplaceable resource asset that enables firms to achieve competitive advantages by utilizing their resources and technologies (Park et al., 2004; Gold et al., 2010; Fawcett et al., 2011; Hartmann and De Grahl, 2011; Richey et al., 2012). Under this view, human capital is seen as one such resource for competitive advantage (Delery and Gupta, 2016). The emergence of TCE arose to combat economic issues and phenomena that included but were not limited to vertical integration, regulation, labour market organization and corporate governance (Williamson, 2010).

The important application of TCE towards the theory and implementation of agri-food collaboration has been researched over the years. One perspective highlights the benefit of cooperatives through the reduction in transaction cost and achieving market power (Bonus, 1986 and Staatz, 1987). A more recent literature by Pagell et al. (2010) indicates that cooperatives result in lower transaction cost due to the greater level of trust and understanding between the buyers and suppliers. Another perspective given by Hansmann (1996), suggests that the formation of agricultural cooperatives reduces information asymmetries among firms through obtaining the knowledge of their costing and pricing behavior. Interaction between customers and suppliers depresses the barriers among firms which allow for lower information asymmetries (Wiengarten and Longoni, 2015). Cooperatives can also reduce information asymmetries, through the use of

information technology, to allow for computerized ordering of goods and services where applicable (Terjesen, et al., 2012). Valentinov (2007), further states that the cost among farmers who engage in establishing cooperatives is very low, especially in the Agriculture Industry that focuses on marketing agricultural products and procuring farm supplies. Another advantage of agricultural cooperation is via backward and forward integration that result in a cost effective quality control of goods (Valentinov, 2007). Hence it facilitates the reductions in the inherent market transaction costs associated with opportunism via the channels of mutual trust and process integration (Kaufman et al., 2000). For Greece, farmers form the basis of the fresh produce supply chain and are usually organized in agricultural cooperatives where the majority of the agricultural products are sold through the agricultural cooperatives (Manos and Manikas, 2010).

The SET is another useful theory to explain firm collaborative behavior in forming supply chains. The theory focuses on how one firm will foster relationships with other firms in the supply chain (Kingshott, 2006) and the ideal that individuals respond to the expected outcomes in a relationship (Blau, 1964). Supply chain collaborations are usually enforced through informal agreements or written contracts, therefore trust is a vital principle for a collaborative relationship that is successful (Fawcett et al., 2008). The main two variables of importance that govern the social exchange theory have been identified as trust and commitment (Wagner et al., 2011; Nyaga et al., 2010; Griffith et al., 2006; and Morgan and Hunt, 1994). Piboonrunroj (2012) further states that trust and commitment represent the social capital that is required for reducing the opportunistic behavior of partners and improving the performance of firms. Social capital describes the social resources within a cooperative, such as information, relationships, influence, emotional support and any other linkages embedded within the individuals of that social network (Han et al., 2013). A recent study by Chen et al. (2018) is consistent with social capital theory since it highlights that the informal personal ties of top managers of one firm with that of top managers of other firms help develop integrated supply chain relationships. Additionally, from a collaborative view, greater levels of social capital result in high cohesion and efficient

communication among firms and work units, thus increasing the performance and functioning of the overall collaboration (Ng and Feldman, 2010).

There are seven constructs that embody the various supply chain collaboration theories and these all view trust and information sharing to be most critical from commitment to collaboration (Kwon and Suh 2004; Daugherty et al., 2006; Chopra and Meindl, 2007; Zacharia et al., 2009; Bianchi and Saleh, 2010; Cao et al., 2010; Singh, 2011; Scholten and Schilder, 2015). For instance, information sharing has been acknowledged as the foundation (Lee and Whang, 2001), the key requirement (Sheu et al., 2006), the essential ingredient (Min et al., 2005) and the nerve centre (Chopra and Meindl, 2007). According to Wu and Chiu (2018), advancement in information and communication technologies, such as those utilizing the internet, allows for more integration of information flow within the supply chain and among firms, thus resulting in an efficient and productive supply chain and more effective information sharing. Furthermore, several studies show that information sharing is an essential factor for an effective supply chain collaboration (Narasimhan and Nair, 2005; Jeong and Leon, 2012, as cited in Wu et al., 2014). Wu et al. (2014) highlight that there is a relationship between information sharing and collaboration, as well as between information sharing and supply chain performance. One approach to improving information sharing proposed by Venkatesh and Goyal (2010) is to introduce an internal computerized information system that provides customers, work units and suppliers with easy access and real time information relating to the operations of the collaborative supply chain. Additionally, information sharing greatly facilitates the reduction in supply chain costs, and the achievement of competitive advantage (Cheng, 2011, Jain et al., 2009). Firms with a collaborative nature which utilize interorganizational systems for information sharing can attain lower levels of uncertainty, long term business relationships with their supply chain partners and easier information sharing management for their information resources (Zhang and Cao, 2018). Summarily, it is acknowledged as the “glue” that keeps the structures of the firms together and enables the supply chain to be more responsive to competitive challenges (Sanders and Premus,

2002). Trust, on the other hand, along with information sharing, enables a continuous flow of information (Cachon and Lariviere, 2005; Arshinder and Deshmukh, 2007; Bianchi and Saleh, 2010; Singh, 2011).

The literature suggests that there is a positive relationship between trust and information sharing with the commitment to SCC (Wu et al., 2004; Cheng, 2011; Fu and Lin, 2014; Abdullah and Musa, 2014; Wu et al., 2014). A recent study by Wu and Chiu (2018) shows that an organization aims at maintaining good information management by basing its information sharing decisions on the perception of its partner's fairness of network resource distribution and commitment of network resources. However, trust and information sharing relationships are maintained at the start of economic uncertainties. For instance, Yigitbasioglu (2010), shows that collaboration increases in order to bring products to the market place but with longer market cycles there is a decrease in the collaboration. Thus, the extent of shared information and supply chain collaboration are affected by both environmental and demand uncertainties. In fact, it has been shown that the level of trust in institutions has declined, especially in countries that have suffered the most as a consequence of the financial crisis (Stevenson and Wolfers, 2011).

The relationship among the seven sub-constructs of SCC and adverse economic environment in this study is viewed from the RBV and SET perspectives when the economic conditions have just started to appear. However, when adverse economic conditions are becoming more permanent the latter relationship is seen from the TCE perspective. This is because we expect that during the early stages of the adverse economic environment, the Greek farmers seek to collaborate with the cooperatives<sup>1</sup> in an effort to get their products to the market. However, as the adverse economic conditions get worse, the opportunistic nature of some firms may result in a declining rate of collaborative efforts. Therefore, we propose our first hypothesis, as outlined below:

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<sup>1</sup>This study focuses on the collaborative relationship between farmers and cooperatives and does not delve into exploring the relationship between farmers and wholesalers that is purely transactional and not involving collaborative activities (Whipple et al., 2010).

**H1:** *The relationship between collaboration and economic environment is nonlinear, such that adverse economic environment enhances collaboration but at a declining rate as economic environment deteriorates.*

### 2.3 Human capital

According to Becker (1964), human capital consists of individual health, ideas, skills, information and knowledge. It can be broadly defined as any stock of knowledge or characteristics which the individual possesses, whether it is innate or acquired, that increases his or her “productivity” (Acemoglu and Autor, 2011). While some forms of knowledge can be easily transferable, others accumulate in the minds of individuals through experience and develop as tacit knowledge (Lui, 2012). Knowledge creation is essential for maintaining new business value generation within any organization (Lui, 2012). Investment in human capital is positively related to the performance of a firm (Crook et al., 2011). Put differently, it is a human resource that is an intangible asset and the RBV (Barney, 1991) implies that there is a direct positive relationship between human resources and the competitive advantage of the supply chain. Furthermore, this view goes on to say that the resulting competitive advantage is difficult to imitate and to sustain (Hayton, 2003). Another intangible asset is trust (Savolainen, 2011) which is accumulated from human capital (Wright and McMahan, 2011; Savolainen and Lopez-Fresno, 2013). An earlier study highlights the importance of trust, information sharing and commitment to supply chain collaboration (Kwon and Suh, 2004). Furthermore, when firms have high levels of trust, they share information more freely and are more likely to believe the information that they receive (Beccerra and Gupta, 1999). To recapitulate, trust facilitates information sharing and together, both lead to commitment in the supply chain collaboration.

Human capital can be measured by education, age and experience (Lutz and Samir, 2011). Education, whether compulsory, postsecondary and/or vocational, enables the individual to accumulate skills and knowledge (De la Fuente and Ciccone, 2002, as cited in Alan et al., 2008). Nevertheless, the individual who possesses greater education, whether general or task specific

(Alan et al., 2008), has greater human capital which enables that person to have several benefits. For instance, there are at least three views about the benefits. Firstly, the Schultz/Nelson-Phelps view states that such human capital has greater capacities of adapting to a changing environment. Therefore, human capital, according to this view, will allow the farmers and cooperatives to adapt quickly and seamlessly to the uncertainty of the economic environment. Secondly, the Bowles-Gintis view suggests that high levels of human capital allow for strict adherence to rules, respect for the hierarchical order of the cooperative and a more efficient organization. The Bowles-Gintis view is usually instilled through education in the school system. Thirdly, the Becker view points towards greater productivity. This view suggests that human capital translates into farmers and cooperatives being highly productive in all situations and areas of production. These three views all facilitate the decision to share information which also fosters greater trust. In line with this, a study by Khan et al. (2018) shows that information sharing has a positive and significant impact on trust. Furthermore, the process of accumulating education enables such a person to develop larger and more knowledgeable social networks. These networks enable the development of trust. In addition, they facilitate the decision to share information and engage in supply chain collaboration. Notably, there is an intimate relationship between social networks with social capital that promotes supply chain collaboration (Johnson et al., 2013).

Similarly, consideration can be given for age because it takes some time to accumulate education. Therefore, factors that affect human capital such as age and education ought to have a positive impact on supply chain collaboration (Akintoye et al., 2000). Farming experience enhances human capital, but it can either be a factor for or against supply chain collaboration. Like education, it develops knowledge, precisely tasked specific knowledge but, as Alan et al. (2008) point out, this knowledge is not transferable. Thus, if the farmer does not have many educational attainments, this might make him/her become locked in a traditional way of operating singularly in opportunistic behaviors, rather than collaborating. On the other hand, greater farming experience translates into greater amounts of product information that can be shared among larger

and more knowledgeable and trusted networks. Furthermore, experienced farmers will have firm-specific resource and knowledge in the agri-food sector; therefore, according to the RBV, these types of farmers are essential in order to acquire and sustain competitive advantage (Wang et al., 2009). The relationship among education, farming experience and age of the farmers with SCC is seen from the RBV perspective. This is because all the aforementioned elements that form the human capital can be considered as crucial resources that will enable the benefits of collaboration to emerge. Thus, the farming experience may have a positive effect on SCC.

In sum, there is a possible relationship between human capital and SCC. Therefore, we propose the following hypothesis:

**H2:** *There is a positive relationship between the producer's human capital and collaborative behavior, thus with greater knowledge, greater experience and higher age the farmers are more likely to collaborate.*

### **3. Data**

#### 3.1 Data collection and analysis

The data for this research was collected at the beginning of 2013, covering periods of economic hardship in Greece. Since the Greek peach producers were not registered anywhere and there was no specific list with names of the producers, the sampling frame was developed by approaching the cooperatives, to which the producers sold their produce, in three geographical regions namely Thessaly, Western Macedonia and Central Macedonia. Since the majority of peach producers in Greece are located in these three regions (Elstat, 2011), the sample size may be perceived as representative.

We pre-tested and pilot-tested the questionnaire using interviews with both academics working in the SCC area and producers, in order to clarify any ambiguities and ensure that the collaboration constructs that were used were clear and carefully designed to ensure that any potential construct development error is avoided (see Podsakoff and Organ 1986; Hinkin 1995;

Podsakoff et al., 2003; Simsen et al., 2010; Hair et al., 2011). The full questionnaire that was used can be found in Despoudi (2016).

Through the gatekeepers of the cooperatives, a pool of 2,000 farmers were identified and contacted. 11% of them responded (n=220, of which, after filtering the data, 217 were used in this study). The survey provides rich information that allows us to investigate the research hypotheses developed earlier, and the key measures used in the OLS models are discussed below (summary statistics is also provided in Table A1 in the Appendix).

### 3.2 Dependent variable: measuring collaboration

Following the initial work by Cao et al. (2010) and the most recent work by Despoudi et al. (2018), this paper uses combined measures of seven different sub-constructs of collaboration measured initially on a 7-point Likert scale, with anchors ranging from 1= “strongly disagree” (i.e. evidence of no collaborative efforts) to 7= “strongly agree” (i.e. evidence of strong collaborative efforts) being used to capture differently perceived aspects of collaboration over the previous three years of experience, and link them for the first time with adverse economic conditions. The seven sub-constructs of collaboration are information sharing, goal congruence, decision synchronization, incentive alignment, resource sharing, collaborative communication and joint knowledge creation.

### 3.3 Key independent variables: measuring adverse economic conditions and human capital

To measure the farmers’ perception of whether adverse economic conditions affect them, we asked the respondents whether economic conditions had directly or indirectly affected them and their businesses, and the way in which they had operated over the previous three years (Despoudi, 2016).<sup>2</sup> The constructs are measured in a Likert scale, with the average measure capturing

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<sup>2</sup> We argue that farmers’ perceptions about the state of the economy, mainly formed by changes in key macro economic indicators, can affect their collaborative strategy. However, we acknowledge that high levels of collaboration may reduce the potential impact generated by poor economic conditions and improve future economic circumstances. This is an interesting issue but due to the lack of longitudinal information in the data our efforts are restricted, and thus we leave this aspect for future research.

movements from positive (1) to negative (6) impacts due to perceived economic climate. We included adverse economic environment squared as a way to capture a nonlinear relationship.

We measured human capital by the age of the producer, his/her farming experience and education (Lutz and Samir, 2011). The age and education of the producers are other variables that might influence a person's decision-making to collaborate. We can argue that older-aged farmers might have a stronger network compared to younger-aged farmers and thus, might be more open to collaborations.

To capture the effect of experience on collaboration, we included the years of "farming experience" in the specification. Regarding the education variable, we created a dichotomous variable taking the value of "1" if the producer had 'high-level qualification' (i.e. bachelor or above) and "0" if the producer had 'low-level or no qualification'.

### 3.4 Control variables

We used several control factors in our paper that were available from our dataset. We controlled for types of peaches, that is: (a) table peaches only, those which are sold straight for human consumption, (b) processing peaches only, those which went through processing in order to become a value added product), and (c) mixed table and processing types of peaches. Finally, we controlled for the farm size measured in acres and geographical location by including regional dummies to capture peach production in Central Macedonia, Thessaly and Western Macedonia.

## 4. Findings

### 4.1 The relationship between adverse economic environment and collaboration

An OLS regression was used to estimate the model.<sup>3</sup> The results are presented in Table 2. We found that in most models the relationship between collaboration and adverse economic

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<sup>3</sup> Also, we extended our analysis to allow for dependency of collaboration within differently sized cooperatives. The models are estimated using multilevel modelling that allows for size effects on collaboration. However, the results are robust to those discussed here. Finally, we also re-estimated the model using an ordered probit technique by

environment was nonlinear (inverted U). The turning points were estimated between the region of 2.625-3.426, where, after this, the economic uncertainty started to kick in. In other words, as the economy moved to deeper economic contraction, the effect of adverse economic conditions on collaboration was lessened (see Figure A1 in Appendix). Hence our hypothesis *H1* is partially supported. Table 3 summarizes the findings of the relationship between different types of collaboration with adverse economic conditions.

#### 4.1.1 Robustness check: non-parametric regression

The pattern of the relationship between adverse economic conditions and collaboration can be further investigated using the Lowess locally linear regression method (Cleveland, 1979; Hardle, 1990), which allows the data to suggest an appropriate model specification. Figure A2 in the Appendix presents the results from the nonparametric Lowess fit (dash line) along with the linear regression (dot line) and quadratic regression (solid line) lines. Figure A2 shows that the Lowess regression closely tracks the quadratic regression curve suggesting that a quadratic model is appropriate to examine the existence of a nonlinear relationship between adverse economic conditions and the above forms of collaboration.

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regrouping the collaboration variable and creating an index for each measure of collaboration to correspond to low, moderate and high levels of collaboration. However in this model, (in which the economic conditions variable is initially treated as continuous and then as an ordinal measure), we generally extract similar conclusions. Also, previous studies such as Ferrer-i-Carbonell and Frijters (2004) have shown that assuming ordinality or cardinality makes little difference.

**Table 2.** OLS results

Type of collaboration:	Information sharing	Goal congruence	Decision synchronisation	Incentive alignment	Resource sharing	Collaborative communication	Joint knowledge creation
Variable	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Adverse economic environment	-0.411*** (0.053)	1.569*** (0.539)	0.840** (0.409)	1.007* (0.592)	1.810*** (0.511)	-0.188*** (0.056)	1.161** (0.476)
Adverse economic environment squared		-0.229*** (0.067)	-0.160*** (0.055)	-0.178** (0.074)	-0.273*** (0.064)		-0.190*** (0.062)
Farming experience (in years)	-0.020 (0.014)	-0.053*** (0.014)	-0.043*** (0.013)	-0.045*** (0.013)	-0.037*** (0.013)	-0.021* (0.012)	-0.049*** (0.015)
Education (low-level/no qualification)							
High-level qualification	-0.051 (0.397)	1.365*** (0.443)	0.789** (0.384)	1.265*** (0.388)	0.564 (0.408)	0.786*** (0.300)	0.393 (0.410)
Age (<31)							
31-40	1.003*** (0.330)	1.377*** (0.353)	1.818*** (0.305)	1.528*** (0.326)	1.357*** (0.317)	1.096*** (0.312)	1.407*** (0.298)
41-50	0.724 (0.476)	1.746*** (0.487)	1.228*** (0.395)	1.671*** (0.411)	1.029** (0.421)	0.566 (0.433)	1.479*** (0.437)
>50	0.400 (0.537)	1.496*** (0.555)	1.475*** (0.431)	1.719*** (0.446)	1.397*** (0.468)	0.462 (0.508)	1.144** (0.475)
Types of peaches (Mixed)							
Peaches for processing only	0.088 (0.596)	0.776 (0.537)	-0.067 (0.505)	1.015* (0.547)	0.622 (0.697)	0.435 (0.507)	0.562 (0.355)
Table peaches only	-0.159 (0.265)	-0.418 (0.284)	-0.295 (0.248)	-0.256 (0.255)	-0.298 (0.245)	-0.085 (0.254)	-0.105 (0.246)
Farm size (in acres)	0.005** (0.002)	0.009*** (0.003)	0.008*** (0.002)	0.006** (0.003)	0.008*** (0.003)	0.008*** (0.002)	0.009*** (0.002)
Geographical location (Central Macedonia)							
Thessaly	0.584	0.937*	1.341***	1.001*	1.554***	0.553	1.158***

		(0.441)	(0.493)	(0.455)	(0.543)	(0.368)	(0.416)	(0.414)
Western Macedonia		1.304***	0.762	0.801**	1.423***	1.438***	0.622**	0.841**
		(0.234)	(0.509)	(0.378)	(0.491)	(0.438)	(0.286)	(0.360)
Constant		6.813***	2.530**	3.764***	3.322***	1.883*	5.425***	3.123***
		(0.416)	(1.066)	(0.771)	(1.141)	(1.005)	(0.418)	(0.889)
R <sup>2</sup>		0.279	0.307	0.399	0.363	0.377	0.234	0.354
	N	217	217	217	217	217	217	217

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01

Robust standard errors in parentheses.

**Table 3.** The relationship between different types of collaboration and adverse economic conditions

Information sharing	Negative linear relationship	H1 is rejected
Goal congruence	Positive but concave relationship	H1 is accepted
Decision synchronization	Positive but concave relationship	H1 is accepted
Incentive alignment	Positive but concave relationship	H1 is accepted
Resource sharing	Positive but concave relationship	H1 is accepted
Collaborative communication	Negative linear relationship	H1 is rejected
Joint knowledge creation	Positive but concave relationship	H1 is accepted

#### 4.2 The relationship between human capital and collaboration

Turning to our human capital variables, we generally found that both age and education<sup>4</sup> were positively related to collaborative behavior, but farming experience was negatively related to it. This result could be attributed to distrust among such farmers as they may not have benefitted from previous attempts at collaboration with the cooperatives. Unfortunately, this information was not sought from the farmers in the questionnaire. However, all our constructs, barring information sharing, were statistically significant. This suggests that such farmers would still share information through their social networks and relationships. However, the trust to commit in supply chain collaboration by farmers investigated in this study was not sufficient to realize the benefits. Furthermore, the effect of age was found to be weaker for information sharing and collaborative communication models, with only those aged between “31-40” having higher collaborative behavior than younger producers. Also, the coefficient of the education variable was found to be statistically insignificant for three out of the seven models. Thus, the results provide partial support for hypothesis *H2*.

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<sup>4</sup> The educational qualification coefficients are found to be statistically significant for four of the seven factors (i.e. Goal congruence, Decision synchronisation, Incentive alignment and Collaborative communication) ranging from 0.786 to 1.365). The farming experience coefficients are generally small in magnitude but statistically significant with the exception of information sharing, which its coefficient was found to be statistically insignificant. We also check the correlation between the two variables but is found to be weak (-0.24). We also re-estimated the models including an interaction term between the two but the coefficients of the interaction terms are found to be statistically insignificant in all the models.

#### 4.3 Other variables used in the regression

We found that farm size was positively associated with various measures of collaboration. Larger farms will have greater capabilities of economies of scale and human capital. Greater human capital translates into greater social capital, and thereby, greater social networks. Additionally, there is the likelihood of larger farms linked geographically in the sense that they are large enough to engage a substantial segment of the community. Whereas, economies of scale require that the products be delivered to the cooperatives in a faster time, so as to reduce product wastage, supply chain collaboration is more likely. Finally, we find a statistically significant effect of geographical location in all models.

### **5. Discussion**

This study investigates the impact of adverse economic conditions on collaborations among the peach farmers in three of the geographical regions of Greece. The results reveal that the impact of adverse economic conditions on five of the seven various constructs of collaboration (that is, goal congruence, decision synchronization, incentive alignment, resource sharing and joint knowledge creation) are all nonlinear, specifically an inverted U. We argue that as the adverse economic conditions continue, farmers begin to drop out sequentially from their collaborative efforts.

The central assumption of transaction cost economics is that the farmers in the supply chain possess bounded rationality and act opportunistically. Bounded rationality in the context of transaction costs refers to the inability of a firm to make the best choice due to imperfect information (Barros, 2010) and opportunistic behavior refers to firm collaboration in supply chains whereby one firm may supply another firm that is part of the supply chain with low quality goods that might be difficult to detect (Wuyts and Geyskens, 2005 and Morgan et al., 2007). Morgan et al. (2007) further highlight that opportunistic behavior caused by firms results in low performance. Therefore, opportunistic behaviors may not surface from the farmers in response to the prolonged adverse economic environment considered as institutionalized. In other words, according to

transaction cost economics (Williamson, 1991) the farmers will collaborate and look to the market directly. This is to minimize product wastage in conditions of low demand and plenty supply. In fact, research has shown that the incentive of a firm to collaborate will drive high transaction cost down (Sriram et al., 1992). However, for certain types of collaboration, such as information sharing and collaborative communication, the relationship is linear and negative. The lack of collaboration among the farmers could have been as a result of the absence of significant cooperative skills to foster cohesiveness, the distant location of a business from other supply chain firms may have been far apart, limiting collaborative activities (Bragg et al., 2011), and lack of support by all firms involved for the management system and culture of supply chain partners (Akintoye et al., 2000; Min et al., 2005).

Drawing on RBV, age and education are resources and assets that generate competitive advantage when strategically employed in terms of information sharing (Gold et al., 2010; Richey et al., 2012). Furthermore, social capital via social networks is more likely in the presence of these human capital variables and according to organizational learning and knowledge of social exchange theory, there is a motive for supply chain collaboration (Cao et al., 2010). Our results show that there is indeed a negative relationship between experience in farming and supply chain collaboration. Ha et al. (2011) suggest that the relationship between supply chain collaboration and the performance of firms is unpredictable. Some reasons for supply chain collaboration failures identified in the literature are information gaps between partners, lack of capital and investment and poor planning strategies (Kotzab et al., 2011). Furthermore, this non-collaboration could possibly be attributed to lack of trust. Although trust was not examined in this study the literature (Fawcett et al., 2008; 2015; Pagell et al., 2010) explains that trust allows for a lower transaction cost and it is essential for a successful collaboration. However, further research should examine the exact impact of trust on collaboration.

Our findings indicate that farm size is positively related to collaboration. This corroborates previous studies arguing that with greater farm size there are greater intra-community linkages or

a greater pool of human capital and under these conditions there is a greater likelihood of the emergence of social capital (Johnson et al., 2013). According to the social exchange theory, the quality of social interactions within the intra-community social network will facilitate both a continuous and more informative flow of information (Brandes et al., 2004). Hence there is a positive impact on supply chain collaboration (Cao et al., 2010; Soosay and Hyland, 2015; Fawcett et al., 2015; Prosman et al., 2016; Despoudi et al., 2018).

### 5.1 Managerial implications

According to the results, education, which develops an intangible asset of human capital and by extension the social networks, has a positive impact on supply chain collaboration. Furthermore, this has implications for policy makers who can implement educational programmes geared towards the promotion of greater supply chain collaboration that will translate into collaborative advantages. This is important if Greece is to emerge from the prevailing adverse economic conditions as the global trend today is having extended enterprises in the form of supply chains (Marwah et al., 2014) which engage in cooperative practices (Galdeano-Gómez et al., 2015). In particular, small firms benefit the most from cooperative strategies (Gnyawali et al., 2006) as they are able to realize economies of scale, technologies, new capabilities and also to venture into international markets (Vanyushyn et al., 2009; Kock et al., 2010; He et al., 2012; Granata, 2012; Galdeano-Gómez et al., 2015). Furthermore, cooperative strategies can be the most viable response for the farming-cooperative sector, primarily as a consequence of their low power of bargaining in the supply chain (Czakoń, 2009). This study is an important addition to the pool of research around supply chain collaboration. It builds the literature by providing insight into the impact of each variable (e.g. education, information sharing, age, experience) on collaboration. For example, this study adds an additional benefit to a study by Cheng et al. (2013) which explores the benefits of information sharing in supply chains.

Education can be used to build better relationships between the farmers and the cooperatives. Thus, this can result in the development of relational human assets and capital which has a positive impact on supply chain collaboration and by extension supply chain cooperation. Education can also be used to encourage and influence the farmers who have the farming experience to venture into collaborative ventures as the results show that such farmers do not venture into collaboration. This study may influence trust building activities between farmers and the cooperatives to promote a more stable and long term collaboration that is important for sustainable development (Oelze et al., 2016). Although it is generally expected to attain increased productivity, efficiency and competitive advantage through collaborative efforts, the literature shows that collaboration does not always reap the expected rewards (Fawcett and Magnan, 2002; Sabath and Fontanella, 2002; Daugherty et al., 2006; Fawcett et al., 2012; Ramanathan and Gunasekaran, 2014; Fawcett et al., 2015).

## **6. Conclusion**

This paper examined the role of adverse economic conditions and human capital on different types of collaboration within agri-food supply chains. We showed that the impact of adverse economic conditions on the collaborative constructs of goal congruence, decision synchronization, incentive alignment, resource sharing and joint knowledge creation is nonlinear, specifically an inverted U for all of them.

Although our study provides new and interesting findings, there are also some limitations. Firstly, this study employed a non-probability sampling technique with the peach producers being approached through the cooperative. While this was perhaps the most feasible, as well as cost and time effective, there were some disadvantages to this approach. For instance, the level of generality was lower than that of probabilistic sampling as some farmers were possibly left out of the study and likely bias was more difficult to identify. Secondly, a long-scale longitudinal survey might have been more revealing as the farmers just provided their responses at only one point in time allowing

us to explore deeply and deal with potential endogeneity in our models as well as overcome restrictions about the generalization of the findings. To this end, it will be interesting to explore how farmers' perceptions of economic conditions change over time. It will also be interesting to examine the role of adverse economic conditions on firm performance, and how this effect is moderated by the producers' collaborative efforts with their cooperatives. Despite the limitations, this study provides several useful findings on the relationship of adverse economic conditions and human capital on collaboration within the agri-food supply chain; however, the findings can be generalized to be used for the collaborative nature of supply chains for other types of products or for other economies.

Future research should further impact the relationship between collaboration and human capital. In particular, it will be interesting to compare how human capital affects collaborative efforts before and after the crisis. In the existing literature, human capital can be proxied via age, experience and education since all three measures contribute to the building and raising of human capital. However, if there was data available then additional factors such as training, which also contributes to human capital enhancement, can be explored. Also, exploration of whether other external factors may affect the economic environment – collaboration relationship would be useful. Furthermore, this study considers collaboration between producers and cooperatives, but collaboration among producers also deserves research attention. Finally, this study considered the Greek agricultural supply chain, in the context of this research, during a period of economic crisis. The results of this study may be applicable to other EU countries that face similar economic conditions. Future research can replicate the study in other EU countries.

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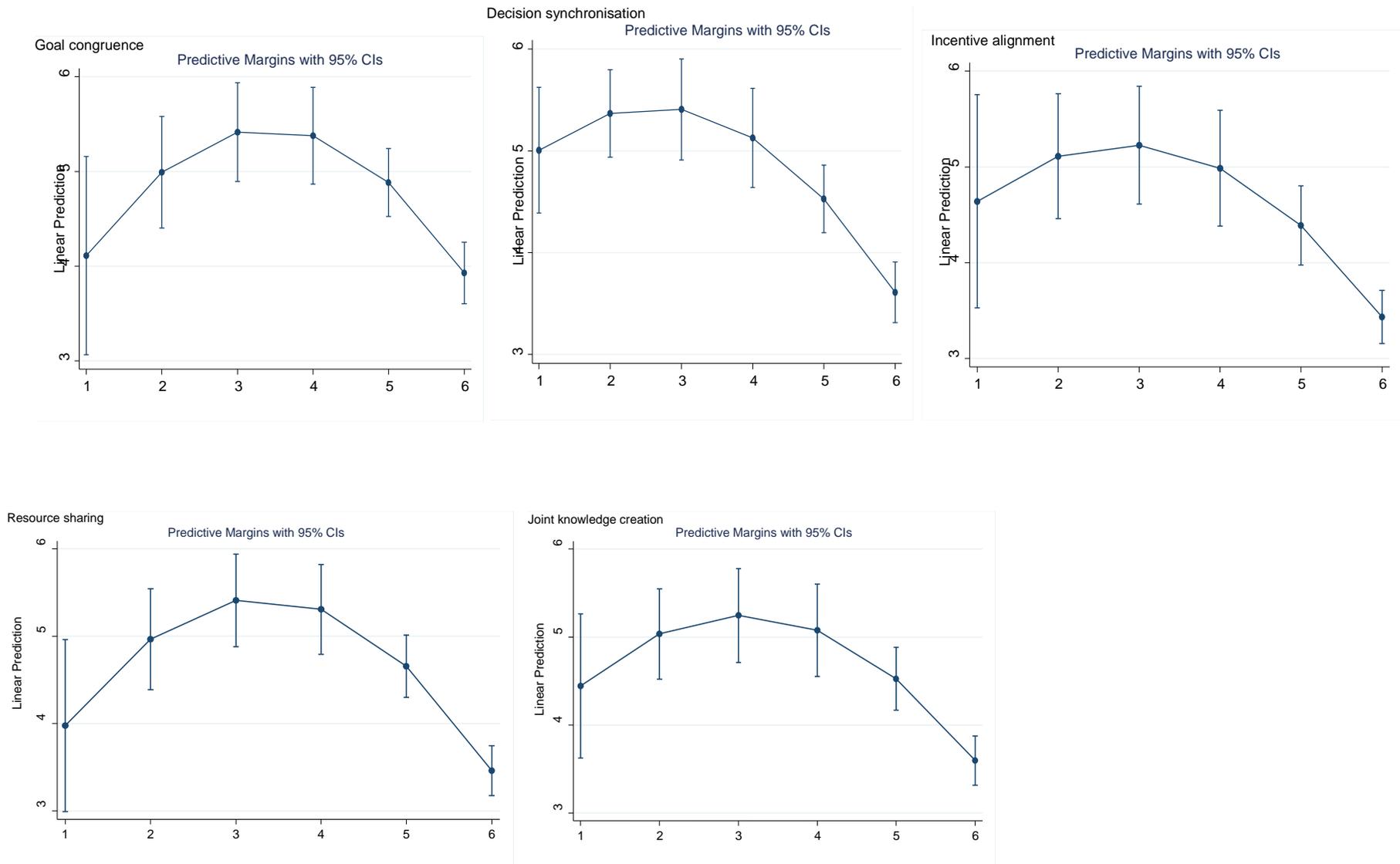
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**Table A1.** Summary statistics of the variables included in the models ( $n=217$ )

<b>Details</b>	<b>Mean (Std. Dev.)</b>	<b>%</b>
Combined sub-constructs used to measure collaboration		
(a) Items capturing information sharing	5.15 (1.80)	
(b) Items capturing goal congruence	4.30 (2.11)	
(c) Items capturing decision synchronization	4.11 (1.97)	
(d) Items capturing incentive alignment	3.93 (2.05)	
(e) Items capturing resource sharing	3.96 (2.00)	
(f) Items capturing collaborative communication	5.15 (1.66)	
(g) Items capturing joint knowledge creation	4.03 (1.90)	
Adverse economic environment	5.04 (1.56)	
Farming experience (in years)	28.56 (11.79)	
Education (ref. categ.: low-level/no qualification)		11.52
Age of the producer (ref. categ.: < 31 ref. categ.)		11.52
31-40		37.33
41-50		23.04
> 50		11.98
Types of peaches (ref. categ.: mixed)		
Peaches for processing only		2.30
Table peaches only		58.06
Farm size (in acres)	64.39 (46.19)	
Geographical location (ref. categ.: Central Macedonia)		
Thessaly		9.21
Western Macedonia		8.76

**Appendix: Figure A1.** The relationship between adverse economic environment (x-axis) and collaboration (y-axis)



**Appendix: Figure A2.** The relationship between adverse economic environment (x-axis) and collaboration (y-axis) – comparing linear regression, quadratic regression and non-parametric regression

