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The importance of innovation adoption and generation in linking entrepreneurial orientation with product innovation and farm revenues: the case of vegetable farmers in West Java, Indonesia

RESEARCH ARTICLE

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Abstract

The growth of modern agrifood markets, especially in Indonesia, has stimulated entrepreneurially oriented farmers to seize business opportunities through innovation. This paper aims to investigate in a dynamic agrifood market if entrepreneurial orientation enhances innovation adoption and generation and if both of these actions enhance product innovation and, eventually, farm revenues of vegetable farmers in West Java, Indonesia. The findings demonstrate that entrepreneurial orientation enhances innovation adoption and generation, which in turn enhance product innovation. Finally, product innovation enhances farm revenues. The findings contribute to a better understanding of the role of innovation in facilitating entrepreneurially oriented farmers to perform better when facing a dynamic market. Entrepreneurial orientation enables farmers to innovate by taking risks to anticipate future demand, through either adoption of available innovations or generation of their own innovations, and both options result in new or improved products and eventually enhanced farm revenues.

Keywords: agrifood market, proactiveness, risk taking, new products, improved products
JEL code: L26, Q13

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1. Introduction

Agrifood market transformation has significantly changed the business environment of farmers in emerging economies, increasing the importance of modern markets, such as modern food retail, food processors, and export markets in Indonesia (Natawidjaja *et al.,* 2007; Reardon and Barrett, 2000; Sunanto, 2013). Although these modern markets require stricter arrangements than traditional markets, they provide farmers with new opportunities to participate in markets. In this market transformation, competitiveness and performance may depend on farmers' abilities to adapt to changes in the business environment (Mirzaei *et al.,* 2016; Shadbolt and Olubode-Awosola, 2016).

However, it is not clear if entrepreneurial farmers who are proactive and risk-taking, including those in certain regions of Indonesia, respond to agrifood market transformation, either by adopting innovations developed by other parties, such as research institutes (Sunding and Zilberman, 2001), or by actively researching and generating innovations themselves (Hoffmann *et al.,* 2007; Leitgeb *et al.*, 2011). Both innovation processes may result in new or improved products, indicating product innovation (Carletto *et al.*, 2010; Sahara *et al.*, 2015), which in turn, may impact farm performance. However, considering the differences in organizational conditions that facilitate the processes of adopting or generating innovations (Damanpour and Wischnevsky, 2006; Pérez-Luño *et al.,* 2011), it is not clear how farmers innovate in the context of agrifood market transformation. Therefore, this paper addresses the following research question: in a dynamic agrifood market, do entrepreneurially oriented farmers deploy innovation adoption and/or innovation generation to introduce product innovations and enhance their performance?

This paper builds on the literature of entrepreneurship and innovation management. The effect of entrepreneurial orientation on firm performance may vary with the innovative capabilities of the entrepreneurs (Jantunen *et al.*, 2005) and by business environment (Covin and Slevin, 1989; Shirokova *et al.*, 2016). There are claims that entrepreneurially oriented farmers are more proactive in exploiting market opportunities and in taking risks to renew market offerings by introducing product innovation (Grande *et al.,* 2011; Verhees *et al.,* 2012). The innovativeness dimension of entrepreneurial orientation can be elaborated by the concept of innovation process, positing that product innovations may come from either innovation generation or innovation adoption (Damanpour and Wischnevsky, 2006; Pérez-Luño *et al.,* 2011). Considering the dynamics in wider agrifood markets, this paper draws on prior studies that demonstrate that entrepreneurial orientation affects innovation generation and/or innovation adoption (Pérez-Luño *et al.,* 2011), entrepreneurial orientation is important for firms in developing countries (Boso *et al.,* 2013; Shirokova *et al.*, 2015), and entrepreneurial orientation enhances farm performance (Grande *et al.,* 2011; Verhees *et al.,* 2012). Farm performance can be demonstrated by financial performance indicators such as revenues, as suggested by Micheels and Gow (2015). We use farm revenues to indicate farm performance. This paper aims to investigate in a dynamic agrifood market if entrepreneurial orientation enhances both innovation adoption and generation and if both of these actions enhance product innovation and, eventually, farm revenues.

This paper is organized as follows: it begins with developing the theoretical framework of entrepreneurial orientation, innovation, and farm revenues, followed by developing the conceptual model and hypotheses. Next, the 'Methods' section explains our sample of Indonesian vegetable farmers, measurements, validations, and data analyses. This section is followed by the 'Results' section that provides test results and hypotheses tests. This paper discusses and concludes with the main findings, including the contributions, implications and limitations of this study, as well as suggestions for future research. When relevant, this paper uses the terms farm and firm interchangeably, indicating the same unit of research. Similarly, when relevant, our study considered the farmer as representing his/her firm, because, with few exceptions, the farms in our sample can be typified as so-called simple organizations, where the individual entrepreneur both owns and manages the firm (Miller, 1983). See also Entrepreneurial orientation in Section 3.

2. Theoretical framework and hypotheses

Entrepreneurial orientation represents a strategy-making process that enables firms to achieve a competitive advantage by exploring and exploiting new market opportunities (Miller, 1983; Pérez-Luño *et al.,* 2016). Since entrepreneurial orientation works better in a dynamic business environment (Covin and Slevin, 1989), entrepreneurial orientation is expected to excel in rapidly developing countries and markets, for both firms (Boso *et al.,* 2013; Gunawan *et al.,* 2015) and farmers (Grande *et al.,* 2011; Verhees *et al.,* 2012). Our paper expands on prior studies that investigate entrepreneurial orientation and innovation (Avlonitis and Salavou, 2007; Pérez-Luño *et al.,* 2011) and follows comparable studies (Hult *et al.,* 2004; Rhee *et al.,* 2010) by integrating proactiveness and risk-taking as dimensions of entrepreneurial orientation in anticipating innovations.

Firms face challenges, as well as opportunities, when confronted with the transformation of the business environment (Boso *et al.,* 2013; Reardon *et al.*, 2009). Firms that have higher levels of entrepreneurial orientation are considered to be more proactive and comprehensive when scanning their business environments (Miles *et al.*, 1978) and exploiting their knowledge (Lumpkin and Dess, 1996). Proactiveness relates to the striving for first mover advantages, responsiveness to market signals, and taking initial actions by venturing into the unknown (Rauch *et al.*, 2009). Proactive firms benefit from being the first movers in the market by having an opportunity to set up brand recognition (Lumpkin and Dess, 1996) and potentially achieve enhanced performance (Lumpkin and Dess, 2001).

The literature on entrepreneurial orientation suggests that firms with risk-taking behaviors seek new opportunities and aim for high returns by creating a large amount of debt, allocating a large amount of important resources, investing in cutting-edge technologies, or introducing product innovations into new markets (Lumpkin and Dess, 1996). Entering new markets or partaking in a market transformation helps entrepreneurial firms deal with potential costs, such as costs to conduct market research to forecast the success of new or improved products (Falkner and Hiebl, 2015; Gilmore *et al.,* 2004), or invest heavily in developing processes and product innovations (Brustbauer, 2014; Falkner and Hiebl, 2015). As a result, these firms face risks, such as creating losses. Hence, entrepreneurially oriented firms also typically bear more risks, which reflects on their courage to take considerable risks to seize new opportunities (Lumpkin and Dess, 1996).

Regarding outcomes, entrepreneurially oriented firms are believed to pursue successful outcomes in risky situations (Lumpkin and Dess, 1996), but evidence is inconclusive on experiencing positive outcomes. The literature on entrepreneurship presumes that risk-taking firms/farms are able to seek out and transform new opportunities into superior performance, which can be reflected by their financial performance, such as profits or business growth (Shadbolt and Olubode-Awosola, 2016). However, evidence on the influence of risk taking on performance is mixed (Shadbolt and Olubode-Awosola, 2016). For instance, as a dimension of entrepreneurial orientation, Rauch *et al.* (2009) found that firms that with a tendency to bear risks also have enhanced firm performance, whereas Naldi *et al.* (2007) found that, among family firms, firms that take risks have decreased performance. Similarly, an empirical study conducted among dairy farmers in New Zealand found that farmers who perceive themselves as risk-seekers take almost the same risks as either risk-neutral or risk-averse farmers but perform worse, because risk-seeking farmers are less capable of managing risks (Shadbolt and Olubode-Awosola, 2016). These findings suggest that risk-taking farmers cannot be described only by their braveness in taking risks. Instead, risk-taking farmers are best described as those who can demonstrate success in taking and managing risks and thereby realize superior performance.

Although risk taking may not enhance firm performance, an elaboration of risk taking and proactiveness can potentially enhance product innovativeness, which in turn may enhance product performance, an indication of firm performance (Avlonitis and Salavou, 2007). Innovativeness is suggested as a dimension of entrepreneurial orientation (Lumpkin and Dess, 1996) that may help proactive and risk-taking firms in realizing higher performance. This paper places innovation in the context of entrepreneurial orientation of farmers, which is consistent with the conceptualization of innovation as 'creative destruction' suggesting that entrepreneurship

is an important source of innovation leading to new economic activities and enhanced revenues (Drucker, 1985; Schumpeter, 1961). Therefore, we define innovation as a consequence of entrepreneurial orientation, which may help farmers enhance farm revenues.

Previous studies show that entrepreneurial orientation helps farmers achieve better performance in the long run and enables farmers to expand their farm business (Grande *et al.,* 2011; Verhees *et al.,* 2012). Taking into account the comprehensive concept of innovation, this paper elaborates on the unknown role of innovation in the relationship between entrepreneurial orientation and enhanced farm performance, especially farm revenues, by developing subsequent relationships in a structural model. This paper posits that proactive and risk-taking farmers (i.e. entrepreneurially oriented farmers) use innovation adoption and/or innovation generation to produce product innovations, which eventually result in enhanced farm revenues.

2.1 Innovation adoption and innovation generation

The innovation management literature distinguishes between the innovation process and the resulting innovation output. Within the innovation process, one may distinguish between innovation adoption and innovation generation (Gopalakrishnan and Damanpour, 1994, 1997), whereas innovation output consists of product innovation and process innovation (Utterback and Abernathy, 1975). How firms develop innovation process and output can be viewed through the approach of innovation systems. The innovation systems approach refers to processes where information and knowledge are created, exchanged, and used by various actors involved in a system and result in the development and diffusion of innovations (Spielman *et al.*, 2011). For the agricultural sector in developing countries, innovation systems are conceptualized as the process of institutional learning and changes and the relationship between the innovations and the institutional environment where the innovation development takes place (Biggs, 1990; Spielman *et al.*, 2011). Innovations are developed by the exchange of information and knowledge among farmers, farmers' organizations/ cooperatives, researchers, or private companies, as a response to (socio-economic) environmental changes (Spielman *et al.*, 2011). In addition to farmers, we acknowledge the role of other actors who are involved in agricultural innovation systems; however, in this paper we focus on the processes of farmers developing innovations on their farms through either adoption or generation to produce product innovations.

To adapt to market changes, firms enhance their effectiveness and competitiveness by either adopting or generating innovations (Damanpour and Wischnevsky, 2006). Innovation adoption refers to innovation processes that enable firms to be more effective and competitive by assimilating products, services, or technologies that are new to the firm. Innovation generation refers to innovation processes that promote the creation and implementation products, services, or technologies that are new to the market (Damanpour and Wischnevsky, 2006). Innovation adoption exploits current opportunities or seeks out existing advantages by following rather predictable steps; innovation generation combines the creation of an idea and its commercial development by involving an uncertain process (Damanpour and Wischnevsky, 2006; March, 1991). As a consequence, innovation adoption is preferred as a short-term strategy to quickly satisfy market needs, whereas innovation generation is preferred as a long-term strategy to anticipate future market needs (Pérez-Luño *et al.,* 2011). This paper deploys innovation adoption, innovation generation, and product innovation to analyze the innovativeness of farms.

2.2 Entrepreneurial orientation enhancing innovation adoption

The dimension of proactiveness refers to the willingness to initiate an action or a tendency to be a first-mover by anticipating future needs (Lumpkin and Dess, 1996). To respond to changes in the environment, proactive firms are alert to opportunities and search for new possibilities to satisfy future market needs earlier than their competitors (Miller, 1983; Pérez-Luño *et al.,* 2011). Proactive firms may either rely on existing knowledge to select and assimilate innovations that are available in the market or create new knowledge by developing innovations (Pérez-Luño *et al.,* 2011). Innovation adoption is a process of acquiring information, introducing (new or existing) knowledge, and assimilating knowledge into firms through learning (Damanpour and

Wischnevsky, 2006; Spielman *et al.*, 2011). The process of innovation adoption is relatively fast because innovation adoption utilizes current knowledge for internal learning (Damanpour and Wischnevsky, 2006; Pérez-Luño *et al.,* 2011). Hence, proactive firms tend to adopt innovations to quickly satisfy market demands.

Entrepreneurially oriented farmers are more willing to take risks and to proactively explore market opportunities. Vegetable farmers in West Java, Indonesia, face a dynamic business environment with the growth of modern food retail and export markets. These markets require farmers to provide non-local vegetables (Reardon *et al.*, 2009), such as Japanese vegetables, or higher-quality local vegetables, such as organic vegetables. To quickly fulfill the market demand for new products, entrepreneurially oriented farmers may capture this opportunity by adopting innovations developed elsewhere, such as by research institutes or seed companies (Diederen *et al.,* 2003). Before investing in an innovation through innovation adoption, farmers assess the risks by searching information on potential costs (including switching costs) and benefits of the innovation from either their own or other farmers' experiments (Diederen *et al.,* 2003; Marra *et al.,* 2003). Hence, proactive and risk-taking farmers (i.e. entrepreneurially oriented farmers) anticipate and adapt to market changes by adopting innovations. Therefore, our hypothesis is the following:

H_1: Farmers who are more entrepreneurially oriented will adopt more innovations.

2.3 Entrepreneurial orientation enhancing innovation generation

Innovation requires firms to be proactive in predicting future needs and take considerable risks (Avlonitis and Salavou, 2007). The literature suggests that the proactive and risk-taking dimensions of entrepreneurial orientation not only stimulate innovation adoption but also may stimulate innovation generation. When proactive firms need to adapt to the dynamics of customer needs, it is claimed that firms cannot rely merely on innovation adoption (Pérez-Luño *et al.,* 2011, 2016). Proactive firms with forward-looking vision tend to generate innovation to address future competition (Avlonitis and Salavou, 2007). Firms may anticipate new market demands by generating innovations. Innovation generation does not mean that firms generate completely new products themselves, but they may continuously improve an existing product, including improving the product design. In this case, firms are required to develop knowledge to help them adapt to changes in customer preferences (Pérez-Luño *et al.,* 2011). To benefit from pioneering new products, risk-taking firms may take on a large amount of debt to invest in new technologies to be used in generating innovations (Lumpkin and Dess, 1996). Hence, proactiveness and risk-taking may stimulate firms to generate innovations.

The innovation generation of farmers combines farmers' own ideas with their existing knowledge (Leitgeb *et al.*, 2012) and capabilities to produce innovations (Gopalakrishnan and Damanpour, 1997). The process of generating innovations can be described as farmer experiments (Leitgeb *et al.*, 2011). Farmer experiments are usually conducted with an informal research approach, resulting in local innovations (Hoffmann *et al.,* 2007). These experiments are conducted on small plots with local resources as the main inputs (Leitgeb *et al.*, 2012) for developing well-adapted varieties, crop or animal breeding, plant protection, new production systems, or farm equipment (Hoffmann *et al.,* 2007). Outcomes of farmer experiments are assessed by observations and comparisons with consideration to the complexity of farm systems (Leitgeb *et al.*, 2012). An alternative approach to conducting farmer experiments is the formal research approach that follows a formal research design. To better respond to market changes, the synergy of the application of both research approaches is encouraged, either by farmers themselves or in collaboration with researchers (Hoffmann *et al.,* 2007). In summary, innovation generation through farmer experiments is an important means of learning to anticipate and adapt to changing markets (Hoffmann *et al.,* 2007; Leitgeb *et al.*, 2012).

The process of generating innovations may be stimulated by farmers' proactiveness in recognizing market opportunities and risk-taking in investing important resources (Grande *et al.,* 2011). Therefore, we expect

that proactive and risk-taking farmers (i.e. entrepreneurially oriented farmers) will generate more innovations in response to market changes. Therefore, our hypothesis is the following:

H_2: Farmers who are more entrepreneurially oriented will generate more innovations.

2.4 Product innovation

Product innovation is defined as a new technology or the assimilation of technologies that provide new products to the market (Avlonitis and Salavou, 2007; Utterback and Abernathy, 1975). Product innovation may represent different degrees of innovativeness, ranging from radical to merely incremental (Avlonitis and Salavou, 2007). Radical product innovation is perceived as new to the world or to sector, while incremental product innovation is perceived as new to the firm. Therefore, product innovation includes any changes that lead to new production techniques or improvement of existing products (Katila and Ahuja, 2002; Parisi *et al.,* 2006), including product upgrades, modifications, and extensions (Li and Atuahene-Gima, 2001). Thus, product innovation encompasses new products and improved existing products with different degrees of innovativeness (Avlonitis and Salavou, 2007).

The need to adapt to changing market demands may stimulate farmers to either adopt new innovations (Adesina and Baidu-Forson, 1995) or generate innovations by improving the existing ones (Hoffmann *et al.,* 2007; Leitgeb *et al.*, 2012), both of which may result in either new or improved products (Sunding and Zilberman, 2001). In the case of vegetable farmers in West Java, some were willing to fulfill the increasing demand of export markets for sweet peppers in the late 1990s. To produce this type of vegetable, the farmers adopted seeds from Dutch seed companies and learned greenhouse technology from a Dutch university. This process of innovation adoption resulted in production of sweet peppers, which were relatively new to the farmers and domestic markets. Overtime, the demand of both export and domestic markets for sweet peppers increased, similar to the situation in Thailand (Schipmann and Qaim, 2010); however, the prices of imported farm inputs also increased. Some farmers looked for a substitution for the imported farm inputs by conducting experiments, such as formulating plant nutrition from local ingredients or constructing greenhouses from local materials. This process of innovation generation resulted in sweet peppers that were well-adapted to the local environment, as indicated by Hoffmann *et al.* (2007) and Leitgeb *et al.* (2012). Hence, innovation adoption and innovation generation will enhance new or improved products. Therefore, our hypothesis is the following:

H_3: Innovation adoption (a) and innovation generation (b) will enhance product innovation of farmers.

2.5 Farm revenues

Firms' abilities to recognize and respond to market transformation might be reflected in product innovation (Szymanski *et al.,* 2007) and firm performance (Micheels and Gow, 2015). To fulfill the rapid demands of the dynamic market, entrepreneurially oriented firms may generate and launch product innovations in the form of differentiated products, extra attributes, or product extensions (Walter *et al.,* 2006), all of which have potential commercial values (Banbury and Mitchell, 1995). The success of product-innovation commercialization can be described in terms of financial performance, such as higher sales or revenues (Szymanski *et al.,* 2007). For farms, revenues refer to amounts earned from sold farm-products (Argilés and Slof, 2001), which represent the value of products produced on the farm (Severini *et al.,* 2017). By introducing product innovations into the market, entrepreneurially oriented farmers may enjoy the first-mover benefit (Micheels and Gow, 2015) of enhancing revenues from either higher prices or selling more of the innovative products (i.e. new or improved products). For instance, premium prices for new vegetables or improved local vegetables in the market could potentially increase opportunities for farmers to enhance revenues. This paper posits that product innovation will lead farms to enhance farm revenues. Therefore, our hypothesis is the following:

H_4: Product innovation will enhance farm revenues.

3. Methods

Suitable testing grounds for the structural model were found in the dynamic business environment of West Java. West Java is one of the most densely populated provinces in Indonesia, where the demand for vegetables has increased in both modern and traditional markets (Natawidjaja *et al.,* 2007; Sunanto, 2013). The ongoing market transformation had already doubled the sales of vegetables and fruits in the decade between 1994-2004 (Natawidjaja *et al.,* 2007; Sahara and Gyau, 2014). Because modern markets require vegetables with strict quality characteristics, vegetable farmers in West Java have adapted themselves by producing vegetables with particular innovations, such as organic or greenhouse farming. Hence, the setting of vegetable farmers in West Java provides researchers with an opportunity to better understand the generic relationships among entrepreneurial orientation, innovation adoption and/or innovation generation, product innovation, and farm revenues for the agricultural sector, especially in the context of agrifood market transformation in developing countries.

To increase the validity of items used in the questionnaire, the questionnaire was pre-tested through in-depth interviews with experts from a farmer cooperative, a farmer group, a non-governmental organization, and an agricultural university. Based on in-depth interviews and results from a prior study by Natawidjaja *et al.* (2007), five regions in West Java were selected for a survey (i.e. Pangalengan Bandung, Cisarua Bandung, Pacet Cianjur, Warung Kondang Cianjur, and Bogor) by deploying the following criteria: diversity in vegetable types and variation in farm innovations.

We first used the list of 3,732 vegetable farmers in the five regions provided by local authorities, extension agents, and cooperative managers as the population database. After rechecking the list with farmer-group chairmen in villages, we found the list was not updated. Some farmers on the list were not available, could not be contacted, or were not producing vegetables. Similar difficulties in accessing an updated study population from local authorities also occurred in a previous study conducted in West Java (Gunawan *et al.,* 2015). We, then, found 1,263 vegetable farmers on the updated list, which was used as the sampling frame. Using proportional quota sampling, we tried to contact all farmers on the list in each region. We finally obtained a total of 282 farmers who could be reached systematically or who were willing to participate in the survey. The data set was collected through face-to-face interviews. Fourteen cases were excluded due to missing data on revenues or due to small farm size (less than 0.05 ha), which yielded a final sample size of 268 farmers. This final sample size represented a response rate of 21.2% from the target population.

3.1 Measurements

This section presents the operationalization of independent and dependent variables, which consist of reflective and formative constructs. Each construct was evaluated based on reliability and validity. The 'construct reliability' of the reflective construct is determined by (1) loadings of construct-to-items that should be higher than cross-loadings of constructs (Chin, 2010); (2) Cronbach's Alpha (CA), which represents internal construct consistency that should be higher than 0.70 (Nunnally, 1978); and (3) the composite reliability (CR), suggested to be higher than 0.60 (Hair *et al.,* 2011). The 'construct validity' of the reflective construct is determined by the discriminant validity of constructs, calculated by the average variance extracted (AVE), indicating the amount of variance explained by the construct. AVE should be higher than 0.50, and the square root of AVE values (Table 1; the bold diagonal) should be higher than correlations among constructs (Chin, 2010). The 'construct reliability' of the formative construct is demonstrated by the variation inflation factor (VIF) that should be lower than 10, indicating the absence of collinearity (Field, 2009).

Table 1. Measurement for reflective constructs and inter-construct correlations.[1]

Constructs and items	Factor loadings	CA	CR	AVE	1	2	3	4
1. Entrepreneurial orientation		0.87	0.90	0.60	**0.77**			
Proactive on initiating changes	0.74							
Proactive on being a pioneer	0.80							
Proactive over competitors	0.80							
Risk-taking on new projects	0.79							
Risk-taking on achieving goal	0.80							
Risk-taking on being a first mover	0.72							
2. Innovation adoption		0.78	0.87	0.69	0.49**	**0.83**		
Adopting new seeds	0.82							
Adopting new farming techniques	0.84							
Adopting new farm inputs	0.83							
3. Innovation generation		0.80	0.88	0.70	0.66**	0.20**	**0.84**	
Generating new fertilizers	0.85							
Generating new pesticides	0.76							
Generating new farming techniques	0.89							
4. Farm revenues		0.75	0.86	0.68	0.44**	0.21**	0.27**	**0.82**
Gross revenues	0.71							
Gross revenues per hectare	0.86							
Gross revenues per employee	0.89							

[1] CA = Cronbach's Alpha; CR = composite reliability; AVE = average variance extracted. The bold numbers on the diagonal are the square root of the average variance extracted. Below the diagonal are correlations among the constructs. ** Significant at the $P<0.01$; * Significant at the $P<0.05$.

■ *Independent variable*

Entrepreneurial orientation

The concept of entrepreneurial orientation assumes firms as the unit of analysis. Accordingly, our study took the farmer as representing the firm because a farm shows characteristics of a simple organizational form, where the individual entrepreneur both owns and manages the firm (Miller, 1983). Additionally, most farms embody the characteristics of an entrepreneurial firm, which has a flexible structure meaning that the entrepreneur manages the firm, allocates the resources, and organizes production activities through direct supervision (Douma and Schreuder, 2008). One may characterize almost all farms in West Java as having a simple and undiversified organizational structure, and the survey indicated how many of the farmers embodied characteristics of an entrepreneurial firm.

To measure entrepreneurial orientation, we used the dimensions of proactiveness and risk-taking, consisting of six items in total (Covin and Slevin, 1989). All items were measured with a seven-point semantic-differential scale, adapted from Covin and Slevin (1989). Regarding the debate about the dimensionality of the entrepreneurial-orientation construct, we followed the argument that entrepreneurial orientation is a unidimensional construct, because all dimensions should be highly correlated (Wiklund and Shepherd, 2005). To test this argument, a principle component factor analysis of the six items was conducted. The analysis revealed that all six items were loaded on a single factor, with a total variance of 60.43% and an eigenvalue of 3.63. This construct exhibits good reliability and validity (CA=0.87, factor loadings≥0.72, CR=0.90, AVE=0.60, square root AVE=0.77>correlations among the constructs) (Table 1). We concluded that entrepreneurial orientation is reliable and valid as a unidimensional construct.

■ *Dependent variables*

Innovation adoption

We assessed innovation adoption by farmers based on three items: adopting new seeds, new farming techniques, and new farm inputs, adapted from Diederen *et al.* (2003). In West Java, farmers typically source these three items from input suppliers, research institutes, or farmer groups. We used a seven-point Likert's scale ranging from 1 (not at all) to 7 (a great extent) to rate the extent to which they adopted the items in the period 2009-2011. The construct exhibits adequate reliability and validity (CA=0.78, factor loadings≥0.82, CR=0.87, AVE=0.69, square root AVE=0.83>correlations among the constructs) (Table 1).

Innovation generation

We assessed innovation generation by farmers based on three items adapted from Hoffmann *et al.* (2007) and Van der Veen (2010): generating new fertilizers, new pesticides (especially for bio-pesticides and bio-fertilizers, both of which were formulated from local-based ingredients), and new farming techniques. We used a seven-point Likert's scale ranging from 1 (not at all) to 7 (a great extent) to rate the degree to which the farmers generated or developed (by themselves) the three items from 2009 to 2011. This measure, see Table 1, posits good reliability and validity (CA=0.80, factor loadings≥0.76, CR=0.88, AVE=0.70, square root AVE=0.84>correlations among the constructs). A potential of collinearity (0.66) is indicated for the correlation between entrepreneurial orientation and innovation generation (Table 1). This potential for collinearity was not confirmed by the VIF, which was higher than 2.5 for both constructs in the ordinary least squares regression, far below the threshold of 10, thus indicating the absence of collinearity.

Product innovation

To operationalize product innovation, we used a formative construct with objective and subjective measures as items that indicate new and improved products. We used two items to indicate new products: number of new products and the type of high-value vegetables; and two items to indicate improved products: number of new varieties and the degree of product changes. Respondents were asked to indicate the number of new products and the new varieties they have cultivated and sold in the market from 2009 to 2011, respectively. High-value vegetables provide high economic returns per unit of farm size or per unit of weight (GFAR, 2005). This item was measured by using a dummy variable (1=high-value vegetable; 0=otherwise). The degree of product changes contains a perceptual question related to improved products (Avlonitis and Salavou, 2007; Covin and Slevin, 1989; Utterback and Abernathy, 1975). This item was measured by using a seven-point-semantic-differential scale with a neutral midpoint (Covin and Slevin, 1989) measuring the extent to which the existing products have improved from the previous ones. The formative construct of product innovation (Supplementary Table S1) exhibits good reliability (VIF scores of the four items ranged from 1.09 to 1.36, indicating the absence of collinearity).

Farm revenues

Vegetable farmers in West Java usually cultivate various types of vegetables on their farms (Natawidjaja *et al.,* 2007), representing general characteristics of the agricultural sector, which usually produces multiple crops in the same season (Just and Pope, 2001). To assess farm performance, we used objective measures as suggested by Micheels and Gow (2015); objective measures have the advantage of being less prone to common method bias, compared to subjective measures (Andersén, 2010). A previous study recognized that many farmers, especially the smallholder farmers, were lacking accounting information because they have no legal obligation to make financial statements (Argilés and Slof, 2003). We found a similar situation among farmers in West Java. That forced us to examine financial performance in a different manner. Because only a few farmers could or wanted to share financial records, our study relied on recall data. As a consequence, we arrived at incomplete information for production costs of vegetables. The farmers' abilities to recall

quantities and prices of sold vegetables proved much better than their ability to recall the amount and value of specific farm inputs used for each vegetable. As a consequence, the value of net farm revenues or farm profitability could not be derived. Alternatively, we operationalized farm revenues as gross farm revenues. Adapted from the concept of total revenues (Mankiw, 2003), the value of farm revenues was calculated as the sum of gross revenues from all vegetables produced in a year (2011), which is formulated as follows:

$$\text{Gross farm revenues} = \sum_{i=1}^{n} P_i \times Q_i \quad (1)$$

Where P_i is vegetable prices, and Q_i is vegetable quantities sold.

Farm revenues were measured as a construct that was reflected by three items: gross revenues and gross revenues per unit of farm capital, in terms of farmland (revenues/ha) (adapted from Nuthall, 2011; Shadbolt and Olubode-Awosola, 2016), and per employee (revenues/employee) (adapted from Nuthall, 2011). This construct, see Table 1, shows strong reliability and validity (CA=0.75, factor loadings≥0.71, CR=0.86, AVE=0.68, square root AVE=0.82>correlations among the constructs).

■ *Control variable*

This paper used control variables for farm size and farmer age. Farm size is a proxy of farm resources that allows farmers to conduct trials or experiments for innovations (Mariano *et al.,* 2012). Larger farms adopt more innovations, such as new farm inputs and new equipment (Feder, 1985). Hence, farm size is likely to be positively correlated with innovation adoption, innovation generation, and/or product innovation. We operationalized farm size by the size of farmland (hectares) dedicated to vegetable production. Farmer age is a proxy of human resources, which indicates older farmers are likely to be more risk-averse than younger farmers. One may, therefore, expect that older farmers will be less innovative than young ones (Adesina and Baidu-Forson, 1995). Thus, farmer age is likely to be negatively correlated with innovation adoption, innovation generation, and/or product innovation. We operationalized farmer age by taking the age of the farmer (years).

3.2 Data analysis

To test our hypotheses, we performed a data analysis by partial least squares (PLS) as a component-based structural equation modeling approach, which requires less stringent assumptions concerning variable distribution and error terms (Diamantopoulos and Winklhofer, 2001; Henseler *et al.,* 2009). To carry out the data analyses, we used SmartPLS (version 3.0, SmartPLS GmbH, Boenningstedt, Germany) (Ringle *et al.,* 2015).

To assess the potential bias of common method variance, we used the marker variable test (Podsakoff *et al.*, 2003). We used networks with governmental institutes as the marker variable, because it was a subjective measure, similar to other main variables, with low correlations with the dependent variables. The marker variable consisted of four (seven-point-Likert's scale) items measuring farmer networks with government officers, government financial agencies, government administrative agencies, and top officials in government (Li and Atuahene-Gima, 2001). The assessment demonstrated that adding the marker variable to the structural model did not substantially change the path coefficients of the structural model, as required. To conclude, the test indicated no substantial bias for common method variance in our data.

4. Results

The descriptive statistics of our model show that the average gross revenue per hectare is 13,082 USD (standard deviation (s.d.)=23,377). The indicators of entrepreneurial orientation are positively and significantly correlated with the indicators of innovation adoption and generation. Regarding the control variables, the average farm size in the sample is 1.53 hectare (s.d.=3.04), which is above average for vegetable farms in

West Java. The control average age of the farmers in the sample is 44.07 years (s.d.=11.16), roughly similar to the average age of vegetable farmers in the general population.

The reliability and validity of the structural model were evaluated using the variance explained, requiring R^2 values>0.10 (Falk and Miller, 1992) and the significance of all path estimates as the core of the PLS analysis (Chin, 2010). Results demonstrate that for the four endogenous variables, all constructs reached the R^2 threshold of 0.10, ranging from 0.13 to 0.45 (Figure 1).

Figure 1 presents the effects of the main and control variables on the structural research model. The standardized path coefficients (β) indicate the degree to which exogenous variables contributed to the explained variance of the endogenous variables, using bootstrap estimation. Bootstrapping of 500 resamples of the PLS estimation was then used to derive the path coefficients, standard errors and *t*-statistics of the structural research model (Chin, 1998) (Figure 1).

The results support hypothesis 1 that entrepreneurial orientation enhances innovation adoption (β=0.49, $P<0.01$), and the results support hypothesis 2 that entrepreneurial orientation enhances innovation generation (β=0.62, $P<0.01$). Furthermore, the results support hypothesis 3a that innovation adoption enhances product innovation (β=0.50, $P<0.01$) and support hypothesis 3b that innovation generation enhances product innovation (β=0.28, $P<0.01$). Finally, the results also support hypothesis 4 that product innovation enhances farm revenues (β=0.29, $P<0.01$). To conclude, the results confirmed all hypotheses related to the structural research model.

Regarding the control variable, the results show that larger farm size corresponds to higher innovation generation (β=0.10, $P<0.05$), and younger farmers correspond to higher the innovation adoption (β=-0.12, $P<0.05$). The results also confirmed that larger farm size corresponds to higher farm revenues (β=0.14, $P<0.01$). Interestingly, in this extensive research model, neither farm size nor farmer age is directly,

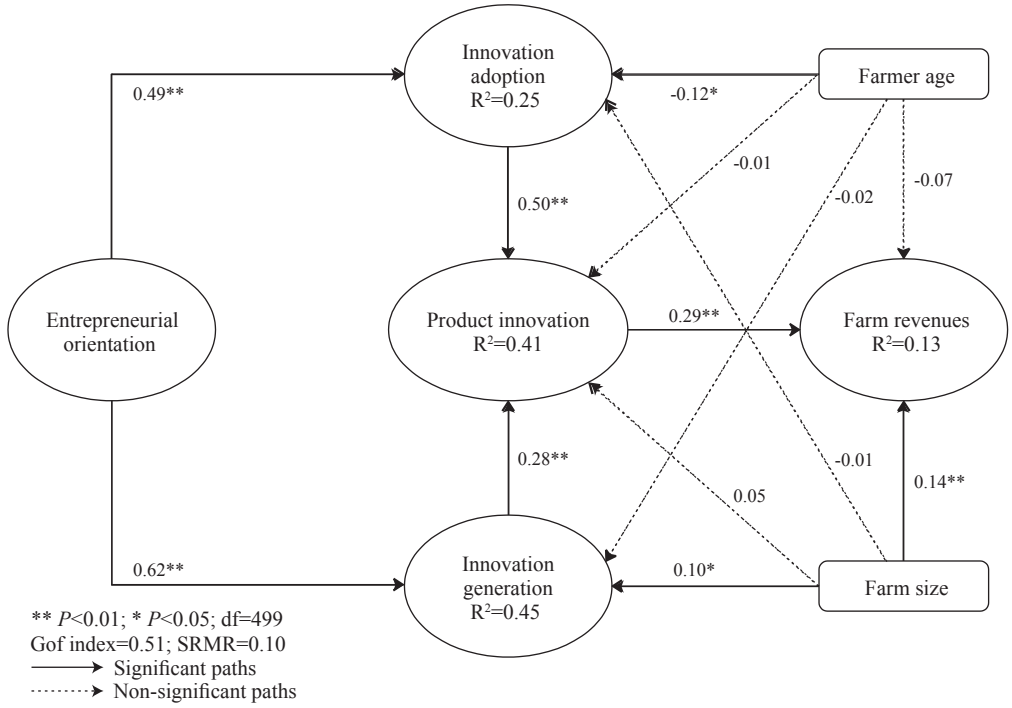

Figure 1. Results for the research model. SRMR = standardized root mean square residual; GoF = goodness of fit.

significantly correlated with product innovation. Furthermore, counter to the expectation, farmer age is not significantly correlated with innovation generation. The results imply that physical assets, such as farm size, and human resources, such as younger age, enable farmers to realize innovations via innovation generation and adoption, respectively, and farm size correlates with a better performance (Grande *et al.,* 2011).

To assess overall model fit, we calculated the overall goodness-of-fit (GoF) index of the research model. The GoF index=0.51 is higher than the GoF of the single-factor model (Henseler and Sarstedt, 2013; Sirén *et al.,* 2012). The measure of standardized root mean square residual=0.10 is in the range of suggested cut-offs (Garson, 2016) (Figure 1). One may conclude that the structural research model fits the data.

5. Discussion

This paper investigates in a dynamic agrifood market if entrepreneurial orientation enhances both innovation adoption and generation and if both of these actions enhance product innovation and, eventually, farm revenues. First, this study positively answers the research questions, providing evidence that entrepreneurial orientation via different innovation processes leads farmers to introduce product innovations and perform better. Although entrepreneurial orientation may have a direct impact on performance, this relationship cannot capture the whole scenario (Shirokova *et al.*, 2016). The results regarding the structural research model show that all main effects are substantial and highly significant. The inclusion of innovation processes adds significantly to the explanation of how entrepreneurial orientation enhances performance (Pérez-Luño *et al.,* 2011, 2016), especially in a dynamic farm business environment (Mirzaei *et al.,* 2016; Shadbolt and Olubode-Awosola, 2016). Therefore, we may derive that entrepreneurial orientation needs further articulation regarding innovation processes and output and in terms of enhancing revenues in the context of agricultural sectors (Grande *et al.,* 2011) and/or developing countries (Boso *et al.,* 2013; Gunawan *et al.,* 2015; Shirokova *et al.*, 2015).

Our findings indicate that farmers may follow a series of processes to enhance their farm revenues. Farmers seem to monitor the environment and predict the market needs before taking risks in innovative projects to produce innovative outputs for changing markets, which may enhance farm revenues. Therefore, enhanced farm revenues may indicate the success of farmers in understanding, adapting to, and satisfying markets by being entrepreneurially oriented and innovative, deploying innovation adoption or innovation generation, and introducing product innovation. We built on an existing debate in the literature regarding how entrepreneurial orientation affects farm revenues, and we presented a more detailed view on the relationships between entrepreneurial orientation, innovation adoption, innovation generation, product innovation, and ultimately their effects on farm revenues.

The results of vegetable farmers in a dynamic business environment in West Java, with growing modern food retail and export markets show that proactiveness and risk-taking (the items) characterize their entrepreneurial orientation (construct). The results add to the knowledge of countries gathered from farmers in more mature markets, such as the Netherlands (Verhees *et al.,* 2012) or Norway (Grande *et al.,* 2011). Thus, it was concluded that entrepreneurial farmers who are proactive and risk-taking seek innovation to create benefit in the future (De Lauwere, 2005). For our reflective construct, entrepreneurial orientation (Entrepreneurial orientation in Section 3, and Table 1), we used the dimensions of proactiveness and risk-taking, comprised of six total items (Covin and Slevin, 1989). The dataset on Indonesian farmers shows that entrepreneurial orientation is also a unidimensional construct in dynamic agrifood markets in developing countries, featuring risk-taking on projects, goal achievement and first mover advantages, in addition to proactiveness to be a pioneer and initiate change.

The contribution of entrepreneurial orientation, especially risk-taking, to the realization of product innovations may be explained, to some extent, by resource allocation for innovation generation. Previous studies acknowledge innovation generation by farmers as local innovations that represent incremental innovation (Hoffmann *et al.,* 2007; Micheels and Gow, 2015), such as modifications to farm practices or equipment

(van der Veen, 2010). Farmers take part in innovation generation by means of uncertain farm experiments (Hoffmann *et al.,* 2007) that require farmers to allocate resources already in use, such as time, parts of farmland, labor, farm inputs, and money. Thus, in terms of innovation generation, entrepreneurially oriented farmers are risk-taking, focusing on possible future benefits, carefully assessing the costs and potential additional benefits of an investment (Abadi Ghadim *et al.,* 2005; Marra *et al.,* 2003). The study identified the generation of new fertilizers, pesticides, and/or farming techniques as recognized innovation generation processes.

This study also shows that entrepreneurial orientation enhances innovation adoption. For high-technology sectors, it is no surprise to find evidence that entrepreneurial orientation greatly enhances innovation generation (Pérez-Luño *et al.,* 2011). Similar to agricultural sectors in developing countries, innovation adoption plays an important role (Bandiera and Rasul, 2006; Mariano *et al.,* 2012). Agricultural innovations were conventionally developed via public sector R&D, and diffusion took place via (orchestrated) extension networks (Pant and Hambly-Odame, 2010). Demand for new crops, such as non-local vegetables, could be fulfilled quickly by adopting seeds developed by seed companies or research institutes (Carletto *et al.*, 2010). Data set from the five regions in West Java that was selected for the survey shows that, indeed, most farmers adopt seeds, farm inputs and new farming techniques from external sources. Here, innovation adoption is restricted by farmer age, indicating that older farmers tend to decline to adopt new innovations.

As hypothesized, the results show that innovation adoption, as well as innovation generation, enhance product innovation in the dynamic agrifood industry context of West Java. The formative construct product innovation reflects the number of new products, high-value vegetables, new varieties, and the improvement of existing products (Product information in Section 3). An original and interesting outcome from the data is that the control variables do not relate directly to the variable product innovation, but impact product innovation only through innovation generation, taking into account farm size as a proxy of farm resources, or through innovation adoption, taking into account farmer age as a proxy for human resources. The results confirm that product innovation enhances farm revenues as a robust, reflective construct, developed due to deficient information on production costs of vegetables. This result may explain different effects of entrepreneurial orientation on innovations.

6. Conclusions

Transformation of the agrifood market in developing countries stimulates farmers to enhance performance by seizing market opportunities. This paper investigates in a dynamic agrifood market if entrepreneurial orientation enhances both innovation adoption and generation and if both actions enhance product innovation and, eventually, farm revenues. The study was carried out in West Java, geographically near the urban area of Jakarta, providing a dynamic business environment for entrepreneurially oriented Indonesian vegetable farmers (Natawidjaja *et al.,* 2007; Sahara *et al.*, 2015). The results confirm each of the four hypotheses and the related structural research model, showing first, that entrepreneurial orientation enhances both innovation adoption and innovation generation; second, that innovation adoption and generation enhance product innovation; and third, that product innovation enhances farm revenues. Overall, the findings indicate that subsequent relationships among entrepreneurial orientation, innovation adoption, innovation generation, and product innovation are important to enhancing farm revenues.

Entrepreneurial orientation enables farmers to innovate by risk-taking and being proactive to anticipate demand, either through adopting available products, services or technologies that are new to the firm (innovation adoption), or through researching and developing their own techniques, fertilizers, or pesticides (innovation generation). Both of these options provide new or improved products. Our results support studies that demonstrate entrepreneurial orientation enhancing innovation and firm or farm performance (Avlonitis and Salavou, 2007; Boso *et al.,* 2013; Grande *et al.,* 2011; Pérez-Luño *et al.,* 2011). Our study of both innovation adoption and innovation generation combined with the dynamic agrifood context in a developing country, adds significantly to the knowledge regarding the basis of how entrepreneurial orientation enhances performance, especially farm revenues. On the basis of extensive empirical research, we conclude that the elaboration of

the innovation dimensions – innovation adoption, innovation generation, and product innovation – provides additional insights into the relationship between entrepreneurial orientation and farm revenues.

More specifically, this paper benefits from a wide and deep database and contributes to the literature by providing insights on the entrepreneurial orientation-innovation-performance relationships in a specific context. The literature on farm entrepreneurship is mainly focused on the direct effects of entrepreneurial orientation on farm performance (Grande *et al.,* 2011). However, in general, the relationship between entrepreneurial orientation and firm performance is complex (Dess *et al.,* 1997; Moreno and Casillas, 2008), with reviews continually suggesting to take into account different applications of key constructs (Rauch *et al.*, 2009). A promising line of research involves organizational efforts that aim for innovation adoption and generation (Pérez-Luño *et al.,* 2011) and product innovation (Avlonitis and Salavou, 2007). There is an indication that the entrepreneurial orientation-performance relationship is contextual, where entrepreneurial orientation does not seem to directly enhance firm performance in developing countries (Shirokova *et al.*, 2015). This paper succeeded in developing and confirming a structural research model incorporating entrepreneurial orientation, innovation, and farm revenues as subsequent relationships, in the agricultural sector of a developing country.

This paper has implications for farmers as well as for policy makers. In terms of dynamic agrifood markets, this paper encourages farmers to pursue market opportunities by taking both innovation adoption and generation seriously, when aiming at product innovations and performance enhancement. Farmers adapt to the business environment by taking risks and pioneering markets with innovations in order to stay competitive. Farmers should be critical when analyzing how to pursue market opportunities, either through short term innovation adoption, or through longer term innovation generation, by considering the nature and consequences of both innovation processes (Pérez-Luño *et al.,* 2011). The results show that both innovation processes positively impact product innovation and farm revenues. Thus, policy makers are encouraged to provide farmers with information about business forecasts that could help them anticipate changes in their business environment and prevent a one-sided approach in stimulating the innovativeness of farmers.

Regarding the limitations, one should interpret our findings with caution. In general, our results show that entrepreneurial farmers, who are proactive and risk-taking, adopt or generate more innovations, produce more product innovation, and in turn enhance farm revenues. However, the evidence on the influence of risk-taking on firm/farm performance is inconsistent (Naldi *et al.*, 2007; Shadbolt and Olubode-Awosola, 2016). For instance, by confirming the measures of perceptual risk preference (attitude to risks) with actual risks, Shadbolt and Olubode-Awosola (2016) found that risk-seeking farmers performed worse than risk-neutral and risk-averse farmers. In this paper, we measured risk taking with perceptual measures (Covin and Slevin, 1989), which may limit our findings in explaining the positive impact of risk-taking on innovations, and eventually on farm revenues. Therefore, we suggest future studies on entrepreneurial orientation elaborate on perceptual measures of risk-taking (e.g. Covin and Slevin, 1989) with actual measures of risks taken by firms (e.g. Lee *et al.,* 2001), and with measures of risk management strategies (e.g. Shadbolt and Olubode-Awosola, 2016).

Next, this paper studied the relationships of entrepreneurial orientation, innovations, and farm performance. However, one may still question whether entrepreneurial and innovative farmers realize profits or not. Farm profitability, as indicator for farm performance (Nuthall, 2011), could not be used in this paper due to the absence of data on costs. We suggest future studies take into account farm profitability measures, such as operating profit margin or return on assets (Shadbolt and Olubode-Awosola, 2016). To obtain these profitability measures, it will be necessary to develop methods for collecting the data of farm production costs and capital investment, especially from farmers who lack financial records.

Another limitation of this paper is related to the sample selection. With the five selected areas in West Java, the farmer population used was based on lists provided by local authorities or extension agents. However, during fieldwork, it was discovered that many farmers, especially young farmers, were not on any of these lists. One may argue that the sample might be biased towards an over-representation of farmers with government

support. A study is needed to improve the sampling method in developing countries, such as Indonesia, which might suffer from incomplete data availability (Gunawan *et al.,* 2015). West Java is near the capital city, Jakarta, which allows farmers in West Java to benefit from better access to information, technology, and logistics than farmers in other provinces in Indonesia. Although it is evident that West Java cannot represent the whole country of Indonesia, the fast growth of modern markets in areas near West Java (Minot *et al.*, 2015) is similar to situations in other developing countries as well, which makes West Java an interesting study location of entrepreneurial orientation and innovations in changing markets, in line with Covin and Slevin (1989). We recommend similar studies that apply the structural research model to farmers in flexible vs protected sub-sectors, especially in rural areas in other countries that express similar dynamic markets.

A final limitation of this paper is related to the relatively simple specification of the context, which was caused by the partial analysis adopted in this study. As in any study, due to our objective of investigating the subsequent relationships of entrepreneurial orientation, innovations, and farm performance, which were constructed in a structural model, a large data base was needed. We then went in-depth to gather data on specific variables and reported in a succinct manner. In adopting or generating innovations, farmers may rely on other stakeholders as sources of innovation (Biggs, 1990). Hence, we suggest further studies consider innovation systems incorporating farmer social networks and/or collaboration with diverse stakeholders, such as scientists (Hoffmann *et al.,* 2007) and upstream or downstream partners (Micheels and Gow, 2015), as these contextual variables might impact farm innovativeness and farm performance.

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Supplementary material

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Table S1. Measurement for formative construct and inter-construct correlations.

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