Identification, establishment of connection, and clustering of social risks involved in the agri-food supply chains: A cross-country comparative study

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Abstract

Supply chain risk management (SCRM) literature is heterogeneous. While much attention has been given to the economic and environmental dimensions, the social dimension has so far received less focus. Thus, this study analyzes the social risks involved in the agri-food supply chains (AFSCs) of Argentina and China by employing an integrated approach. Semi-structured interviews were used to collect data, followed by using a combination of three complementary data analysis methods: thematic analysis to identify social risks, total interpretive structural modeling (TISM) to build interrelationships among the identified social risks, and fuzzy MICMAC (cross-impact matrix multiplication applied to classification analysis) to cluster social risks into four categories. Next, we conducted a comparative analysis between the two countries. Theoretical contributions are mainly threefold. First, we identified various social risks involved in the AFSCs of Argentina and China, including those just touched on by scholars, such as cultural issues, government's weak monitoring system, the power differential between managers and subordinates, inappropriate disposal of agrichemical containers, and the lack of basic literacy skills. Second, we believe that our study is the first to establish connections among the identified AFSC social risks, which represents the originality of this work. Third, we discover that cultural issues is the key risk that has the highest capability to elicit other social risks involved in the AFSCs. Our work extends scholarship's knowledge to understand AFSC social risks from the cultural perspective. This study also generates contributions to policymakers, migrant associations, and the government tax departments of Argentina and China.

Keywords: Social risks; agri-food supply chain; thematic analysis; total interpretive structural modeling; fuzzy MICMAC analysis; cross-country study

1. Introduction

An agri-food supply chain (AFSC) refers to the processes from "farm-to-fork", which involves a wide diversity of individuals and businesses from the initial stage of production to the final stage of consumption (Zhao et al. 2020; 2021). For example, there are farmers, harvesters, agri-chemicals, seeds, and agricultural machinery hire service providers involved in the growing cycle of crops, such as germination, leaf development, flowering, maturity, and harvesting (Inyinbor et al. 2019). In the processing stage, agri-food products need to be properly processed based on consumer requirements. For canned products, blanching, dehydration, pickling and canning are necessary, whereas for fresh products, cleaning and packaging are essential (Majerska et al. 2019). In the storage, trading, and distributing stages, agri-food products are stored at proper temperature, sold by auction markets, and transported through refrigerated transport. Finally, consumers are available to buy agri-food products from supermarkets and corner shops. Given this increasing complexity of modern AFSCs that involves many actors, entities, processes, relations, and more globally interconnected structures, it is difficult for the focal company or government to monitor every stage of an AFSC (Bier et al. 2020). To save costs, gain efficiency, and increase productivity, some companies involved in the AFSCs

particularly for companies in countries where it is more difficult for governments and non-governmental organizations (NGOs) to monitor them, recruit child labor and force employees to engage in harmful activities without protection. These practices seriously damage the reputation of the company and bring risks to other partners of AFSCs. These unethical practices known as social risks, have received considerably less attention from scholars, practitioners, consumers, investors, and regulators in comparison with risks emerging from economic and environmental perspectives (Nyamah et al. 2017; Behzadi et al. 2018).

AFSC risk is defined as "anything that presents a risk (i.e., an impediment or hazard) to information, material and product flows from original suppliers to the delivery of the final product to the ultimate end-user" (Peck. 2006, p. 132). Risk emerges from various sources. For example, from the *economic* perspective, AFSC risks can be pests and diseases, a shortage of skilled workers, agri-food products contamination, and outdated agricultural machines, all of which may bring financial losses to the AFSCs (Ghadge et al. 2020; Zhao et al. 2020). From the *environmental* perspective, AFSC risks are related to the external environment that may have negative impacts on AFSCs, such as electricity and oil price increase, lack of infrastructure, service units and waste disposal facilities, and customer preference change (Tang. 2006; Ho et al. 2015; Xu et al. 2020). From the *social* perspective, social risks of AFSCs can cause falling profits and reputational loss due to adverse stakeholder reaction (Hofmann et al. 2014). Examples such as child labor, unfair wage, freedom of association, and overtime work are social risks (Esteves et al. 2017; Zimmer et al. 2017). Based on the latest global slavery index (Walk Free Foundation. 2018), in 2017, 40.3 million people comprising 71% females and 29% males across the globe were in modern slavery. Of these, 25 million people were in forced labor and 15.3 million people were in forced marriages. It is estimated that global slavery will have a dramatic increase in the next few years due to the poverty, inequality, and unemployment caused by COVID-19 (Policy & Evidence Centre. 2021).

Existing research in this field on social risks tends to focus on two main areas: sustainable supply chain management (SSCM) and supply chain risk management (SCRM) (Zimmer et al. 2017). For example, from the perspective of SSCM, several theoretical and empirical studies related to social issues have been published in the last decade. Ahi and Searcy (2015) summarized various quantitative methods to measure social issues, Yawar and Seuring (2017) proposed an integrated framework to link social issues, actions and performance outcomes together, and Khan et al. (2021) identified several indicators to measure social sustainable supply chain performance. However, from the SCRM perspective, a paucity of research has been conducted to identify and assess social risks involved in the AFSCs in a cross-country setting. For example, Cruz (2013) presented a decision model to mitigate supply chain risks through corporate social responsibility (CSR), whereas Zimmer et al. (2017) proposed a quantitative analytical approach to assess social risks involved in the German automotive industry. Existing studies mainly assessed supply chain risks identified from economic and environmental perspectives, whereas supply chain risks identified from the social perspective seems to be neglected. Thus, this study aims to fill this gap by assessing social risks involved in the AFSCs from a cross-country setting. In particular, we focus on the identification, establishment of connection, and clustering of social risks. Four clearly defined research questions are formulated:

- RQ1: What are the social risks involved in the AFSCs of Argentina and China?
- RQ2: How are these AFSC social risks interrelated in each country?
- RQ3: What are the key social risks in each country that have the highest capability to elicit other social risks involved in the AFSCs?
- RQ4: What can be learned from the comparison of AFSC social risks between Argentina and China?

This study makes several contributions to the literature and managerial practices. *First*, we identified 14 social risks involved in the AFSCs of Argentina and 12 in the AFSCs of China. Of the identified social risks, some of them are just touched on by scholars, such as cultural issues, government's weak monitoring system, the power differential between managers and subordinates, inappropriate disposal of agrichemical containers, and lack of basic literacy skills. Previous studies identified various social risks related to human rights, labor practices and decent working conditions, and society (Bai et al. 2017; Cunha et al. 2019; Choudhary et al. 2022). Our study extends this area by identifying new social risks involved in AFSCs. *Second*, based on the authors' knowledge, we believe that our study is the first to build connections among various AFSC social risks identified from Argentina and China. Previous work on supply chain risk assessment mainly involved risks identified from economic and environmental perspectives, whereas only a few conducted risk assessment involved risks identified from the social perspective (DuHadway et al. 2019; Li et al. 2019; Narwane et al. 2021; Hermoso-Orzaez and Garzon-Moreno. 2022). This study also answers the call of Cunha et al. (2019) for more empirical research on social issues in supply chains. *Third*, we counted cultural issues as a kind of social risk and identified that cultural issues is a key risk that has the highest capability to elicit other social risks involved in the AFSCs of Argentina and China. Thus, this study extends scholars' understanding from the cultural perspective to understand AFSC social risks. This study also generated contributions to policymakers, migrant associations, and government's tax departments.

The remainder of this paper is organized as follows. In Section 2, existing literature on the SCRM of social issues are reviewed to identify research gaps. In Section 3, data collection and analysis methods are discussed and justified. Section 4 presents how data are collected from Argentina and China followed by data analysis in Section 5. In Section 6, findings and theoretical contributions are discussed. Finally, conclusions are drawn, and managerial contributions and future research directions are presented in Section 7.

2. Literature review

Risks frequently occur in supply chains due to the increase in natural disasters (e.g., COVID-19, floods, and heavy rainfall) and a variety of *black swan* and *grey rhino* risks, challenges caused by climate changes, man-made disasters (e.g., international trade barriers), strict environmental laws, and more complex global interconnected supply chains (Sharma et al. 2020; Xu et al. 2020). In particular, the rate and severity of extreme weather events increased across the globe in 2021, such as record-breaking snowfall in Madrid, dust storm in Beijing, record temperatures in Moscow, and deadly floods in Zhengzhou, implying that managing risks in supply chains is a challenging task (Pournader et al. 2020). Traditional SCRM addresses supply chain risks from the economic perspective, focusing on how to avoid or mitigate supply chain disruptions with less financial loss (Bode et al. 2011; Hofmann et al. 2014). After Elkington (1994) proposed the concept of the 'triple bottom line' (social, environmental and economic), the importance of the non-financial perspective of SCRM was recognized. The environmental perspective focuses on analyzing the interaction of processes with the environment without causing permanent damage to the environment, whereas the social perspective is concerned with how to build fair actions for workers, partners, and societies at large (Marshall et al. 2015; Fletcher et al. 2016; D'Eusanio et al. 2019). However, the social perspective of SCRM has so far received less attention than economic and environmental perspectives (Yawar and Seuring. 2017). In the following sub-sections, we review relevant literature related to SCRM definitions, social risk identification, categorization and assessment, and empirical research related to AFSC social risk management. Then, we identify research gaps and avenues for future research.

2.1 SCRM definitions, and social risk identification and categorization

There is no consensus on the definition of SCRM (Ho et al. 2015). Some concentrate on the objectives (e.g., reducing vulnerability and ensuring continuity) (Juttner et al. 2003), while others focus on the SCRM processes (e.g., identification, assessment, treatment and monitoring) (Wieland and Wallenburg. 2012) and pathways to define SCRM (e.g., external collaboration and coordination) (Tang. 2006). For example, Norrman and Jansson (2004) argue that SCRM is a process of dealing with risks and uncertainties through collaborating with supply chain partners. Thun and Hoenig (2011) state that SCRM is a cross-company orientation that aims to identify and tackle risks. After reviewing 354 articles, Fan and Stevenson (2018) propose that SCRM is a systematic process to identify, assess, treat, and monitor supply chain risks with the aid of tools, techniques, and strategies to facilitate external collaboration and coordination with supply chain members to achieve a competitive advantage. To mitigate or avoid social risks at the supply chain level, an integrated process including planning, implementation, monitoring, and evaluation should be set up across the whole supply chain (Kim et al. 2021).

Social risk is defined by Cunha et al. (2019, p. 1102) as "the risk of negative impacts felt by individuals or groups." It associates with human rights, labor, or environmental sustainability, which needs to be continuously monitored and assessed by companies (Graetz and Franks. 2016). At the supply chain level, social risks are related to products, operations or processes that may cause adverse effects on human safety, welfare, and community development (Klassen and Vereecke. 2012). For example, supply chain social risks are categorized into seven groups; these are, labor conditions, child labor, human rights, health safety, minority development, disabled/marginalized people inclusion, and gender issues (Yawar and Seuring. 2017). Further categorization is provided by Cunha et al. (2019), who classified social risks at the supply chain level into three categories – human rights, labor practices and decent work conditions, and society. Human rights encompass all rights related to human beings (e.g., language, place of residence, and religion), labor practices and decent work conditions encompass any benefits of employees' working conditions (e.g., medical care, sickness benefits, and old age benefit), and society encompasses elements (e.g., corruption, ethics, and transparency) that are supported by companies, local communities, and law (Morais. 2017). Other taxonomies categorize social risks either into endogenous and exogenous (Giannakis and Papadopoulos. 2016), or into six categories - reputational, financial, operational, relationship, populational, and legal - based on their consequences that can accrue to companies (Graetz and Franks. 2016), or within a project, supply chain, or company processes according to where and how social risks present (Husgafvel et al. 2015). In this study, we chose the categorization provided by Cunha et al. (2019) to categorize AFSC social risks, as they developed this taxonomy after reviewing more than 43 papers in the area of supply chain social risk management that represent the latest work in the field. Following Cunha et al.'s (2019) classification, various social risks that have been identified in supply chains are shown in Table 1.

Insert Table 1

2.2 Supply chain social risk assessment

Risk assessment is a critical step in the SCRM as it involves qualitative or quantitative measures for assessing supply chain risks (Aqlan and Lam. 2015). Various measures have been applied to assess supply chain risks, such as analytic hierarchy process (AHP) (Dong and Cooper. 2016), fuzzy AHP (Zimmer et al. 2017), analytic network process (ANP) (Fazil et al. 2015), decision tree approach (Ruiz-Torres and Mahmoodi. 2007), interpretive structural modeling (ISM) (Agrawal et al. 2020), total interpretive structural modeling (TISM) (Zhao et al. 2020), and alternative competing hypothesis (ACH) (Handfield et al. 2020). For example, Zimmer et al. (2017) assess the social risks with the fuzzy AHP based on their investigation of

the automotive supply chain. Their research results indicate that child labor is a very sensitive issue for original equipment manufacturers (OEMs). After analyzing operational, environmental, and social risks of global automotive supply chains with risk assessment space (RAS) analysis, Xu et al. (2019) argue that social risk is mostly likely to occur in the assembly stage and is least likely to be present in the manufacturing stage. To develop an evaluation framework for sustainable SCRM, Rostamzadeh et al. (2018) identify that seven main criteria and 44 sub-criteria may be useful for the evaluation. Based on the *technique in order of preference by similarity to ideal solution* (TOPSIS), their results discover that lack of proper sewage infiltration is the most important sub-criterion in the category of sustainable recycling risks. Table 2 shows different measures used in the supply chain social risk assessment.

Insert Table 2

2.3 Empirical research related to AFSC social risk management

The empirical research related to AFSC social risk management appears heterogeneous and fragmented (see Table 3). As for the reasons for causing a particular type of social risk in AFSCs, Medland's (2021) investigation of the relationship between time-related pressure and inequalities of workers shows that nature's time, industrial time and social-reproductive time are the reasons for the low wages of the workers in the tomato industry of Morocco. However, Bonisoli et al.'s (2019) research show a different result indicating that workers' wages depend on the type, size, and processes of farms. For example, organic and fairtrade banana farms perform better from environmental and economic perspectives, but worse from a social perspective in comparison with conventional farms.

As for the measures for mitigation of social risks, a number of the empirical papers present their work in this area. For example, Klassen and Vereecke (2012) investigate potential measures that could be used to mitigate social risks of food and beverage supply chains. Their results indicate that self-assessment, audit measures (e.g., pre-agreement audit), certifications, and rewards and penalties are effective. Gold et al. (2015) hold a similar view that centralized control through vertical integration, greater accountability of suppliers, and multi-stakeholder partnerships are critical for detecting and mitigating slavery problems. Their research also points out that a lack of appropriate key performance indicators (KPIs) to evaluate the slavery problem of AFSCs. After investigating AFSCs to provide GMO-free soybeans, Teuscher et al. (2006) propose a holistic approach to mitigate financial, social, and environmental risks through the plan-do-check-act (PDCA) cycle. Scholars also present their work on assessing specific social risks. For example, Blackstone et al. (2021) proposed a new method to evaluate forced labor risk of the fruit and vegetable supply chains in the USA through integrating distinct datasets and a risk-scoring method.

Insert Table 3

2.4 Research gaps

Based on the above literature analysis on social risk identification, categorization, and assessment, this study identifies several research gaps for future research:

- *First*, most studies conducted social risk assessment from a single country perspective, whereas only a minority of studies focus on the multi-countrie's perspective, as shown in Table 2. Among the studies that collected data from various countries for example, Handfield et al.'s (2020) research collected data from more than 10 countries and Zhao et al.'s (2020) research collected data from four countries - these data were analyzed in an integral manner, rather than adopting a cross-country comparative analysis. These

studies failed to generate insights into social risk analysis because they did not consider each country's characteristics. To the best of our knowledge, very rare studies have conducted a cross-country comparative analysis in terms of AFSC social risk assessment, which points to a valuable future research direction.

- *Second*, our observations show that almost all studies in the area of social risk assessment employed a quantitative approach to assess or prioritize risks, such as BSM, TOPSIS, ACH, and fuzzy AHP (see Table 2). However, qualitative modeling techniques for assessing social risks are seldom applied. Qualitative techniques are massively applied in risk identification, categorization, and construction of SCRM ideas, whereas their role in assessing social risks is neglected by scholars (Ho et al. 2015; Cunha et al. 2019). This study aims to fill this gap by applying a multi-method qualitative approach.
- *Third*, based on our literature review on AFSC social risk management, we identified that a majority of the literature concentrates on risk mitigation (Teuscher et al. 2006; Klassen and Vereecke. 2012), while only a minority focuses on risk identification and assessment (Song et al. 2017; Feng et al. 2021) (see Table 3). Even among the studies that concentrate on risk identification and assessment, risks were combined and analyzed in an integrated manner without distinguishing social risks, economical risks, and environmental risks. Apparently, social risks were not the main part of their discussion. To fill this gap, this study intends to identify and assess social risks from the AFSCs of Argentina and China.
- *Fourth*, most of the existing studies analyzed social risks from three perspectives, such as human rights, society, and labor practices and decent working conditions (see Table 1). It seems that scholars neglect the role of cultural effect as a driving factor in generating various social risks. Thus, this study fills this gap by considering the cultural issues as potential social risks.
- *Finally*, most of the existing studies focused on supply chain social risk analysis of manufacturing, automotive, apparel, and leather industries (see Table 2), whereas a paucity of research focuses on the agri-food industry. Agri-food industry is a labor-intensive industry and its characteristics point to interesting findings.

This study fills the aforementioned research gaps by employing a multi-method qualitative approach to investigate social risks involved in the AFSCs in a cross-country setting – Argentina and China.

3. Research methodology

A multi-method qualitative approach was adopted to analyze AFSC social risks in Argentina and China (see Figure 1). This includes semi-structured interviews to collect data from experienced AFSC practitioners, thematic analysis to generate various AFSC social risks, TISM to build interrelationships among the risks, fuzzy MICMAC analysis to validate TISM model and classify different risks into various categories and finally, comparative analysis to compare and contrast the results of the two countries. A multi-method approach was employed for three reasons. *First*, a multi-method qualitative approach is particularly suitable for investigating different but highly linked research questions (Davis et al. 2011). There are four highly linked research questions in this study, ranging from social risk identification, social risk interrelationship building, revealing key social risks through risk categorization, and inspirations from our study. *Second*, we can balance each method's strengths and weaknesses by deliberately combining different methods (Hunter and Brewer. 2002). *Third*, we enrich the findings through revealing insights from different research angles.

Insert Figure 1

3.1 Data collection method

A semi-structured interview was used to collect data from persons who are knowledgeable and have experienced a particular situation or phenomenon (Mclntosh and Morse. 2015). It was selected as the data collection method for three reasons. *First*, most AFSC practitioners prefer to be interviewed rather than filling out a questionnaire. In particular, most of the meetings with AFSC practitioners were followed by a field visit. Thus, contextually, the interview is more suited to this study. *Second*, the aim of this study was to gain a deep understanding of the social risks involved in the AFSCs of Argentina and China. The situation required us to have informative and interpretative interactions with the potential participants. A range of interview formats could be used, such as unstructured, semi-structured, and structured interviews. However, an unstructured interview falls short in providing a set pattern to focus on, and the structured interview fails in providing flexibility in asking questions. Hence, neither of them could be applied in this study. A semi-structured interview is the ideal data collection method for our research because it provides a topic to discuss while remaining responsive to the participant. *Third*, a semi-structured interview is particularly suitable for discussing sensitive issues, particularly since this study focuses on social risks, such as risks related to human rights and decent working conditions (Thunberg and Arnell. 2021).

3.2 Data analysis methods

In total, four data analysis methods are used in this study to ensure rigorous and stringent outcomes, including thematic analysis, TISM, fuzzy MICMAC analysis, and comparative analysis.

Thematic analysis was employed as the first data analysis method to identify various social risks involved in the AFSCs of Argentina and China. Thematic analysis is a widely used approach to extracting meanings and concepts from data, such as data from the transcript of an interview (Braun and Clarke. 2006). There are two reasons to select thematic analysis. *First*, thematic analysis pertains to flexibility, simplicity and tangibility of the analysis phase (Javadi and Zarea. 2016). *Second*, this study aims to understand AFSC practitioners' experiences, thoughts, or behaviors on social risks. From this perspective, thematic analysis is an appropriate method due to its capability to generate unanticipated insights by highlighting similarities and differences across different data sets (Kiger and Varpio. 2020).

Then, TISM was selected to build interrelationships among the identified social risks. It is a well-developed qualitative modeling technique and has been extended and upgraded from the ISM (Warfield. 1974). The theory behind TISM is based on the expert's judgments on whether and how social risks are related, converging in a highly structured model through extracting the expert's opinion on the relationships among various social risks and modeling in that the specific relationships and overall structure are portrayed in a directed graph (Sushil. 2012; Jena et al. 2017). TISM has been applied in various areas, such as retailer management, cybersecurity management, and supply chain management (Sharma et al. 2020; Zhao et al. 2022). There are other methods that may be used to interpret, model, and prioritize various social risks, but these cannot be applied in this study due to their unique limitations, as summarized in Table 4. For example, ISM can be used to prioritize various social risks through building a hierarchical model, but it fails to provide the "why" of the relationship between two social risks. Structural equation modeling (SEM) is a powerful technique to build relationships among variables, but it needs a large sample size and has difficulty in interpreting the relationships. TISM is more suitable for this research than ISM and SEM because TISM can not only build relationships among variables, but can also provide interpretations of links between variables based on an expert's explanation.

Insert Table 4

Thereafter, fuzzy MICMAC analysis was applied as a complement of TISM. This is because TISM can be used to prioritize social risks through building a hierarchical structure model, but we cannot know each risk's role in the system. Thus, we employed fuzzy MICMAC analysis to distinguish risks into driver, mediator, linkage, and dependent risks. Fuzzy logic was implemented because we assumed that the relationship between two social risks could be any real number between 0 and 1. This means that one social risk has an opportunity to cause the other one. Besides, fuzzy logic's implementation generates to more precise results in comparison with conventional MICMAC analysis that adopts Boolean logic (Zhao et al. 2020).

Finally, we adopted comparative analysis to compare and contrast the AFSC social risks generated through thematic analysis of Argentina and China, hierarchical models built by TISM, and social risk categorizations generated by fuzzy MICMAC analysis. Comparative analysis supports a deep understanding and contributes to theory building (Esser and Hanitzsch. 2012), particularly as this study compares AFSC social risks in different cultural settings.

4. Empirical data collection

The empirical data collection process was conducted between October 2020 and April 2022. During this period, we took advantage of Horizon 2020 RUC-APS (Risk and Uncertainty Conditions in Agricultural Production Systems) and a UK Royal Society-funded project to take secondments in Argentina and China. Argentina and China were selected because of several reasons. *First*, Argentina is located in the Southern Hemisphere, whereas China is located in the Northern Hemisphere. The different climates of these two countries support cultivation of different crops, which also involve various types of AFSCs. *Second*, the cultural differences between these two countries may elicit different attitudes towards labors, migrants, and human rights. *Third*, the difference in the economic development and agricultural policies of these two countries may cause a difference in agricultural infrastructure. Climate, cultural, policy, political system, and economic differences between Argentina and China may elicit different social systems and social risks, which generate fruitful findings through conducting a comparative analysis. Besides, we have wide connections with the local AFSC practitioners of Argentina and China through participating in the Horizon 2020 RUC-APS project and leading The UK Royal Society and National Natural Science Foundation of China (NSFC) co-funded program. Since partners from these two countries are project consortium members, it is easier for us to recruit local AFSC practitioners to conduct interviews.

In Argentina, we visited different types of AFSC practitioners including farmers, wholesalers, and processors, located in the La Plata – the main political, administrative and educational center of Buenos Aires Province. The La Plata Peri-urban area is the main "green belt" and high capitalization greenhouse area of Argentina that has more than 6,000 producers of tomatoes, lettuces, cucumbers, peppers, and other types of agri-food products. There are four types of greenhouses mainly applied in this area, including chapel type, modified chapel type, modified chapel type of higher height, and metal parabolic type. The local government has made great efforts to disseminate good agricultural practices at the organizational and AFSC levels, such as irrigation and crop management, integrated pest management, and extra training sessions. In China, our AFSC practitioners are from the Henan Province, where its agricultural industry is the backbone of the Henan's economy. Main food crops include corn, winter wheat, soybeans, and barley. The agricultural industry and its related activities are the key focus of each year's Chinese Communist Party Henan Provincial Committee. This includes guaranteeing stable production of vegetables, promoting the construction of high-standard farmland, improving the level of agricultural mechanization, promoting the revitalization of the seed industry, accelerating the development of the entire agricultural industry chain, and other key aspects related to agriculture.

We followed Strauss and Corbin's (1990) work to develop an interview guide (see Appendix 1), including topic selection, definition of all aspects of the topic, formulation of

initial questions, determination of questions, and order of questions. After several brainstorming sessions with the researchers involved in this project, such as two professors in supply chain and operations management (SCOM), we developed an initial interview guide. Then, we conducted pilot interviews with two academics and two AFSC practitioners from each country. The results showed that we needed to change the order of some questions and added more probe questions in the interview guide as a reminder. Finally, we organized the interview template into four sections. Section one is about the interviewee's information, section two about the company's information, section three is related to social risks involved or experienced, and section four is about measures or strategies that have been adopted to tackle social risks.

Purposive sampling and snowball sampling were used to recruit information-rich cases on AFSC social risks (Patton. 2002). This involves the identification and selection of AFSC practitioners that are knowledgeable about or who have had experience with social risks. Initially, purposive sampling was implemented with specific criteria to select suitable participants. Three criteria were used to select participants for the interview. *Criterion one* – the selected AFSC practitioners should have knowledge about social risks. To ensure we recruited the right participants, the information related to a workshop on AFSC social risks was widely disseminated in the local AFSC practitioners' networks through various social media platforms and our project partner's personal networks. We invited a wide range of local AFSC practitioners to participate in this workshop because gaps exist in their knowledge repository and practices. In particular, most AFSC practitioners do not receive a high level of education and lack an understanding of related professional words and concepts. Linkages were only built between related social risk concepts and AFSC practitioners' practices, so that appropriate and useful information would be elicited from the interviews. *Criterion two* – the selected participants should show their willingness or interest to participate in this research and have the capacity to communicate their experience in an articulate, expressive, and reflective manner (Palinkas et al. 2015). *Criterion three* – we prefer to use the AFSC practitioners who have a relationship with our local project partners, as we need to discuss sensitive issues (e.g., violating labor's rights) with them. We cannot get insight information if the local AFSC practitioners do not trust us. Based on the aforementioned three criteria, we identified seven AFSC practitioners from each country that were eligible to participate in this research. For an empirical study, data saturation point will be reached after conducting 9 – 17 interviews; this is reinforced by a systematic literature review on sample sizes for saturation as per Hennink and Kaiser (2022). Their research indicates that seven interviews in each country may not be enough. Thus, snowball sampling was employed to conduct more interviews (Handcock and Gile. 2011). At the end of each interview, participants were asked to recommend other AFSC practitioners whom they are familiar with and who would be willing to participate in this research. Another five AFSC practitioners from each country who fulfill the criteria were identified, which resulted in a total sample size of 24, with 12 in each country. Detailed information about each interviewee is shown in Appendix 2.

5. Data analysis

As explained earlier, four data analysis methods were employed; thematic analysis, TISM, fuzzy MICMAC analysis, and comparative analysis. The detailed data analysis process and its related results are explained in the following four sub-sections.

5.1 AFSC social risks identification through thematic analysis

The qualitative data collected through semi-structured interviews were transcribed, edited, coded, categorized, and reviewed to generate social risks (see Figure 2). Each interview with AFSC practitioners was recorded with permission and then transcribed word-by-word to avoid missing any elements. We transcribed each interview audio file before the next interview with other AFSC practitioners because this helped us to identify the data saturation point. Afterward,

we edited and cleaned the transcripts through immersive reading and eliminating unnecessary words, sentences, and paragraphs. Then, we uploaded the transcripts into NVivo 13 to code, highlight and link relevant words, sentences, and paragraphs related to social risks. There are four steps involved in the coding activities: (I) training and brainstorming sessions about AFSC social risks, including its concepts, types, effects, and relevant cases; (II) identifying and highlighting the codes of what may cause social risks, why there are social risks, and how social risks can be mitigated; (III) recognizing the links between relevant codes and grouping them; and (IV) reviewing codes and their linkages to reach consensus among the authors involved in this study. Thereafter, we synthesized a theme to represent a group of codes by checking relevant theories and literature, and then aggregated various themes into different categories. Finally, codes, themes, and categories were vetted by team members.

Insert Figure 2

Thematic analysis results related to Argentina and China were presented by considering the framework proposed by King and Horrocks (2010). As shown in Table 5 and Table 6, first-order codes are direct quotes that are relevant to the research questions from the discussion with interviewees, second-order themes are AFSC social risks that are synthesized from relevant literature and theories, and aggregation dimensions are used to represent AFSC social risks that have similar meanings.

In Argentina, 14 AFSC social risks were identified that pose threats to brand values and enterprises' reputations, including those not frequently mentioned by scholars, such as lack of basic literacy skills, avoiding paying health insurance and labor tax, inappropriate disposal of agrichemical containers, government's weak monitoring system, and cultural issues. Among the identified AFSC social risks, 28.57% (n=4) of them are related to human rights, 42.86% (n=6) are related to labor practices and decent working conditions, and 28.57% (n=4) are related to society. We should mention that, among the 14 identified AFSC social risks, half of them (n=7, 50%) are related to good agricultural practices (GAP). They are limited or no access to personal protective equipment (PPE), a lack of limited understanding of agrichemicals, and inappropriate disposal of agrichemical containers. Thus, the Argentinian government has developed a plan to disseminate GAP to mitigate related risks, which includes practices related to security and hygiene, irrigation, crop management, amendments and fertilizers, integrated pest management, record keeping, and training. Some practices such as frequent water analysis, fresh manure must be composted or replaced, disseminating The National Standard for the use of agrichemicals (Resolution No 608/2012: Maximum Residues Limits for certain Products), and cleaning of different places and objects (e.g., toilets and machinery) were deployed. However, other practices only exist in the paperwork, such as the deployment of an empty phytosanitary container management system.

In China, the situation is different. Only three social risk factors are similar to or the same as those in Argentina, such as low, unfair and unpaid wages, limited or no access to PPE, and government's weak monitoring system. Other AFSC social risk factors contribute to a new understanding of AFSC social risks; these include lack of channels to make complaints and seek rights protection, injury risks related to agricultural machinery, the power differential between managers and subordinates, and the cultural issues. The enormous differences in AFSC social risks between Argentina and China may originate from several perspectives. *First*, the cultural differences between these two countries pertain to different social values and behaviors, and further induce various social risks. The cultural value orientation of China is high in the hierarchy and low in autonomy and embeddedness, whereas Argentina's cultural value orientation is high in embeddedness and low in hierarchy and autonomy (Schwartz. 2006). *Second*, high-horsepower agricultural equipment such as tractors and harvesters have been

widely deployed in the farms of China, in comparison to the manpower that is still largely used in the farms of Argentina. We can infer that China has more social risks related to injury risks related to agricultural machinery. *Finally*, China has a stable economic and political environment, whereas these are lacking in Argentina.

Insert Table 5

Insert Table 6

5.2 Establishing connections among AFSC social risks through TISM

Thematic analysis helps us to identify various AFSC social risks in Argentina and China. Then, we use these results as inputs to process TISM to establish connections among various AFSC social risks in each country. In this study, nine steps were employed to process TISM:

- *Step I – AFSC social risks identification and definition*: As the initial step of TISM, this step involves measures (e.g., brainstorming, literature review, and interview) to identify and define various social risks that need to be modeled. Through interview and thematic analysis, we identified 14 AFSC social risks from Argentina (see Table 6) and 12 from China that need to be modeled (see Table 7).
- *Step II – Determination of contextual relationships between two AFSC social risks*: The contextual relationship between two AFSC social risks is "AFSC social risk A would cause AFSC social risk B".
- *Step III – Interpretation of relationship*: The expert's opinion was involved in this step to confirm whether there is a relationship between two AFSC social risks. If the expert's opinion pertains to "yes", a further question will be asked to get an in-depth understanding of their relationship. The further question is, "In what way will AFSC social risk A cause AFSC social risk B." Three experts were involved including two professors in SCOM and one professor in agroeconomic analysis.
- *Step IV – Interpretive logic of pair-wise comparison*: This study aims to develop a comparative study between Argentina and China. Thus, we developed an "interpretive logic-knowledge base" for each country through pair-wise comparisons of the AFSC social risks. We identified 14 AFSC social risks in Argentina. Through conducting the pair-wise comparison of the 14 AFSC social risks, a total of 182 numbers of rows (e.g., $n\times(n-1)$, n represents the number of AFSC social risks) emerges in the knowledge base for performing the TISM analysis of Argentina. We repeated the same process for conducting the pair-wise comparison in China, which resulted in 132 rows in the knowledge base.
- *Step V – Reachability matrix and transitivity test*: The initial reachability matrix is formulated by transforming the "Y" and "N" entry codes of the knowledge base into "1" and "0" of the initial reachability matrix. "Y" entry codes in the knowledge base represent a relationship between two AFSC social risks, whereas "N" entry codes represent no relationship between two AFSC social risks. We further transformed the initial reachability matrix into final reachability matrix through a transitivity check. The transferability rule is "if risk "A" relates to risk "B", risk "B" relates to risk "C". Thus, AFSC social risk "A" necessarily relates to AFSC social risk "C". The initial and final reachability matrices for Argentina and China are shown in Appendix 3(a) and Appendix 3(b), respectively.
- *Step VI – Level determination by partitioning reachability matrix*: This is the key step of TISM to allocate different AFSC social risks into different layers of the TISM

hierarchy model. The final reachability matrix of each country was used to identify the reachability set and antecedent set. Reachability set consists of any AFSC social risks it may cause, whereas the antecedent set consists of any AFSC social risks that may cause it. In the final reachability matrix, if there is a "1" in the entries of the row of specific AFSC social risks, the identifier of the "1" should be included in the reachability set of the risk. We repeated the same process to identify any AFSC social risks that should be listed in the corresponding antecedent set. The intersection set depends on the AFSC social risks in the antecedent set and reachability set. If the AFSC social risks in the intersection set are the same as the risks in the reachability set, the level will be determined. This step will be repeated till all levels are determined. The level partitioning processes of Argentina and China are shown in Appendix 4(a) and Appendix 4(b), respectively.

- *Step VII – Digraph development*: A digraph is developed through allocating AFSC social risks into their respective levels and drawing directed and transitive links as per the relationship shown in the final reachability matrix. However, only important transitive links could be retained based on the expert's suggestion.
- *Step VIII – Interpretive matrix*: The linkages (e.g., directed and transitive links) between two AFSC social risks were interpreted by extracting explanation from the interpretive logic-knowledge base built in Step III.
- *Step IX – Total interpretive structural model*: TISM models associated with Argentina and China to depict the interrelationships among AFSC social risks were built, as shown in Figure 3 and Figure 4, respectively.

The TISM model is formulated based on each social risk's capacity to elicit other social risks. For example, social risk locates at the lowest level of the TISM hierarchy, which means that it has the highest capacity to elicit other social risks in the system. Conversely, social risks locate at the highest level of the TISM hierarchy, which means that it has the lowest capacity to elicit other social risks.

The TISM analysis of Argentina's AFSC social risks resulted in a TISM model of nine levels, as shown in Figure 3. Cultural issues (E14) is located at the lowest level of the TISM hierarchy, avoiding paying health insurance and labor tax (E4), limited or no access to PPE (E5), overtime work (E7), and inappropriate disposal of agrichemical containers (E9) occupy the highest level of the TISM hierarchy, while other AFSC social risks disperse from level II to level VIII. Our study presents a novel and interesting result in terms of Argentina's AFSC social risk analysis. Argentina's cultural value orientation is high in embeddedness and low in affective autonomy, where its cultural value orientation pertains to greater political activism (Schwartz. 2006). In the last few years, there have been several massive anti-government protests in Argentina, most recently the 2022 Argentinian protest against the government for signing a loan revision agreement with the International Monetary Fund (IMF) and the 2021 protest against government responses to the COVID-19 pandemic. Simultaneously, the exchange rate of the US dollar to the Argentine Peso has experienced a dramatic increase in the last decade. At the time of writing, one US dollar equals to 130 Argentine Pesos in comparison with one US dollar to four Pesos 10 years ago. The frequent protests across the whole country and falling exchange rate result in an unstable economic and political environment (E12) and a weak government monitoring system (E11). Besides, as the country's cultural value orientation emphasizes embeddedness, people are more likely to respect the traditions and cherish the established social structure, which results in the whole society having a low technology acceptance level and low readiness to accept immigrants and foreign workers (Schwartz. 2006). From this perspective, applying traceability technology to monitor labor status is difficult, forcing most of the illegal migrants from Bolivia, Paraguay and Uruguay into forced and bonded labor (E1) in farms. Illegal immigrants do not have opportunities to receive

training and further education. Limited knowledge of agrichemicals and lack of appropriate facilities to tackle agrichemical containers exposes laborers and their children to harmful agrichemicals. The situation is even worse where more than 10 families working in a big farm could share the same toilet, which facilitates the dissemination of bacteria as well as illness among the workers. Thus, the priority for the Argentinian government is to increase the security and hygiene of AFSC practitioners through frequent water analysis, washing products, workers' hygiene and improved living conditions. The farm owners always try to avoid paying health insurance and labor tax for their foreign employees because of the weak government monitoring system – random checks on labor tax every two years.

Insert Figure 3

The TISM analysis of China's AFSC social risks resulted in a TISM model of six levels, as shown in Figure 4. Cultural issues (F12) and a weak monitoring system of the government (F10) occupy level VI and level V, followed by the power differential between managers and subordinates (F7) and lack of channels to make complaints and seek rights protection (F1) in level IV, whereas the rest of AFSC social risks occupy level III to level I. It is interesting to note that cultural issues (F12) also play a key role in eliciting other AFSC social risks. The cultural value orientation of China is hierarchical, which means that people view the unequal distribution of power, roles, and resources as legitimate (Schwartz. 2006). In this cultural context, governments cannot be effectively supervised by other authorities, which may cause low working efficiency of the government's monitoring system and further compound the lack of channels to make complaints and seek rights protection (F1). Besides, the hierarchy cultural value orientation pertains to power differential between managers and subordinates (F7). To reduce operational costs, managers lack the willingness to provide training sessions and promotion opportunities for their employees. The situation is even worse in some private-owned small- and medium-sized enterprises (SMEs), as they cannot provide PPE for their employees. Thus, there is a very high likelihood that employees may suffer injury due to a lack of sufficient training in agricultural machines and PPE. Age and gender discrimination (F11) always happen in the recruitment process; most enterprises in China prefer to recruit men rather than women; people aged 35 or older may have fewer opportunities to be recruited, and there is a degree of inequality. In particular, some enterprises may set essential criteria for the job seekers that their Bachelor's degree should be from the "211" or "985" project universities.

Insert Figure 4

5.3 AFSC social risk clustering and prioritization through fuzzy MICMAC analysis

We modeled the interrelationships among AFSC social risks through TISM by denoting the relationship between two AFSC social risks as "0" or "1". If there is a relationship between two AFSC social risks, then it is denoted by 1. Conversely, it is denoted by 0. However, the relationship between two AFSC social risks is not only just two conditions; other conditions also should be considered, such as very weak, weak, medium, strong, and very strong. Thus, we introduced fuzzy MICMAC analysis as a complement to overcome the drawback of TISM and increase the sensitivity of the analysis by considering the strength of two AFSC social risks (Zhao et al. 2020). The steps for conducting fuzzy MICMAC analysis were performed as follows.

- *Step I – Development of the binary direct relationship matrix (BDRM)*: The BDRM of each country (see Appendix 5(a) and Appendix 5(b)) was obtained by converting the

diagonal entries from "1" to "0" and ignoring transitivity in the final reachability matrix through transforming "1*" into "0".

- *Step II – Construction of the fuzzy direct relationship matrix (FDRM)*: The conventional MICMAC analysis only considers the binary relationship among the selected variables, which poses threats to the sensitivity analysis of MICMAC and hinders the decision-making flexibility of experts (Yadav and Desai. 2017). Thus, fuzzy set theory was introduced to strengthen the sensitivity analysis of MICMAC by considering the possibility of reachability among the selected AFSC social risks. According to the fuzzy set theory, the possibility of interaction between the variables can be represented by a numerical value on a 0-1scale, such as no – 0, very low – 0.1, low – 0.3, medium – 0.5, high – 0.7, very high – 0.9, and complete – 1 (Bhosale and Kant. 2016; Zhao et al. 2020). Using these values, the judgments of the same experts involved in Step III of the TISM analysis were used to rate the relationship between two AFSC social risks. Afterward, the values were superimposed on the BDRM to obtain a FDRM, as shown in Appendix 6(a) and Appendix 6(b).
- *Step III – Generation of the fuzzy MICMAC stabilized matrix*: The FDRM obtained in Step II was used as inputs to generate the fuzzy MICMAC stabilized matrix. The FDRM was multiplied till the hierarchy of the driving and dependence power of each AFSC social risks were stabilized. We followed the principle proposed by Kandasamy et al. (2007) to obtain the stabilized matrix, in which the basic principle of fuzzy multiplication was used. That is, fuzzy matrix multiplication is fundamentally a generalization of Boolean matrix multiplication. According to the fuzzy set theory, the result is always a fuzzy matrix when two fuzzy matrices are multiplied. The rule for conducting matrix multiplication is:

$$C = A, B = \max k (\min (a_{ik}, b_{kj})), \text{ where } A = [a_{ik}] \text{ and } B = [b_{kj}]$$

By using the aforementioned rules and assisted by MATLAB for calculating matrices, we generated a stabilized matrix for each country, as shown in Appendix 7(a) and Appendix 7(b). Then, we developed a cluster diagram for each country to differentiate the role of each of the AFSC social risks (e.g., driver and mediator) in the system based on their driving and dependence power. The driving power of each AFSC social risk was obtained by summing the entries in the rows, whereas the dependence power of each AFSC social risk was determined by adding the entries in the columns. Driving power means the capability of each social risk to elicit other social risks of the system. If a social risk has a higher driving power, this indicates that it has a higher capability to elicit more social risks. Dependence power means that the capability of each social risk can be elicited by other social risks. For example, if a social risk pertains to a higher dependence power, this means that it can be induced by more of the other social risks.

The findings of fuzzy MICMAC analysis of Argentina's AFSC social risks are shown in Figure 5. *First*, the combination of TISM and fuzzy MICMAC analysis shows that cultural issues (E14) is the independent social risk located in the lowest level in the TISM hierarchy, which is the key risk that has the capability to elicit most of the other AFSC social risks of the system. *Second*, a majority of AFSC social risks identified in Argentina were clustered into autonomous social risks, which means that these social risks do not have many effects on the system. For example, most of the farmers of Argentina try to avoid paying health insurance and labor tax (E4) for their labors because they will lose their competitive advantage if they pay tax while others do not. The situation cannot be changed; only the monitoring system can be strengthened. *Third*, no linkage social risks were identified, which indicates that independent social risks can cause other AFSC social risks directly without mediators. For example, cultural issues (E14), an unstable political and economic environment (E12), and a weak government monitoring system (E11) act as drivers of the system. *Finally*, four AFSC social risks were

identified as dependent social risks as they have the highest dependence power and may not elicit other risks of the system, such as avoiding paying health insurance and labor tax (E4), limited or no access to PPE (E5), overtime work (E7), and inappropriate disposal of agrichemical containers (E9).

Insert Figure 5

The fuzzy MICMAC analysis of China's AFSC social risks also generates interesting results that are different from others' research (see Figure 6). *First*, three AFSC social risks such as cultural issues (F12), weak monitoring system of the government (F10), and the power differential between managers and subordinates (F7) were identified as independent social risks. However, only cultural issues (F12) were identified as a key risk as it is located in the lowest level in the TISM hierarchy and has the highest driving power. *Second*, four AFSC social risks were categorized into dependent social risks, such as injury risk related to agricultural machinery (F6), overtime and unpaid work (F5), low, unfair, and unpaid wages (F3), and limited or no access to PPE (F4). *Third*, seven AFSC social risks located in the middle of the TISM hierarchy are considered to have little effects on the system. Finally, no linkage social risks were identified.

Insert Figure 6

5.4 Comparative analysis of research findings between Argentina and China

This section compares the findings of Argentina and China, with a focus on cultural issues, policies, and agricultural industry development.

The TISM and fuzzy MICMAC analysis of Argentina and China indicate that cultural issues are the key AFSC social risks that deserve special attention. However, there are cultural differences between these two countries. Argentina's cultural value orientation is focused on embeddedness, whereas China's cultural value orientation mainly focuses on hierarchy. Embeddedness pertains to low readiness to accept immigrants, foreign workers, or people with criminal records. Our findings are congruent with Schwartz's (2006) theory that most foreign workers working on the farms of Argentina are forced and bonded labors. Besides, cultural embeddedness may have a higher opportunity to cause political activism in comparison with that of hierarchy. This may be because of Argentina's cultural respect traditions and social order, whereby any challenges to the social order may induce protests. In the hierarchical cultural environment, important values include social power, authority, humility, and wealth. A critical characteristic of a hierarchical system is that people are expected to fulfil tasks and obligations assigned to their roles and be obedient to those in roles of greater status (Schwartz. 2006). This cultural value orientation causes a power differential between managers and subordinates. Thus, managers take advantage of a culture of hierarchy and obedience to violate labor's rights. A particular example of this phenomenon is the "996" working regime - that is, employees are forced to work from 9am to 9pm, six days a week, without extra pay for those extra hours (Wang. 2020). Besides, the Chinese are deeply affected by other cultural traditions, such as Confucianism and The Doctrine of the Golden Mean. For example, Confucianism upholds prejudice against women, and The Doctrine of the Golden Mean requires people to follow the rules to act and not perform outside the norms (Gao. 2003). Thus, gender discrimination against women is high, and people feel that channels to make complaints to protect their rights are lacking. In particular, most of the private enterprises do not want to recruit women because paid maternity leave is 158 days in most places in China and is required by law, which will bring additional costs for enterprises. From the above comparative analysis,

we find that the cultural differences between these two countries promise different behaviors and have strong effects on other social risks involved in AFSCs.

The differences in policies of these two countries also result in different social risks involved in AFSCs. We discuss migrant policies because most of the forced and bonded labor working in the farms of Argentina are illegal migrants. Argentina enacted a restrictive migration law in 1981 and implemented it in 2004. Based on the law, undocumented migrants have restricted access to healthcare and education, and it is difficult for them to be involved in employment and commercial transactions (Cortes. 2017). Although there are fewer limitations to children's education, the complicated assessment process of school enrolment (e.g., date of arrival, the regularity of school attendance, and the performance of migrants) and legally residing in Argentina for at least three years make it difficult for them to receive education. Thus, we can see that children working with their parents and a lack of basic literacy skills are a normal phenomenon in the Argentinian farms. In contrast, in China, the migrant policy is particularly friendly for foreign workers. Anyone who has a close relative, or residence in China, or other plausible reasons, is allowed to become a permanent resident.

Finally, agricultural industry development differs between these two countries. Currently, China is heavily relying on "Internet + Agriculture" to facilitate the transformation to intelligent agriculture, including the application of Big Data, internet-of-things, remote control, and other techniques. However, most farmers in Argentina rely on manual power to cultivate, irrigate, and harvest agri-food products. The situation creates different social risks in the AFSCs, such as injury risks related to agricultural machinery in China and inappropriate disposal of agrichemical containers in Argentina.

6. Discussion and theoretical contributions

Our study makes significant contributions to theory by identifying various social risks of AFSCs, revealing interrelationships among them, clustering social risks, pointing out the key risks that have the capability to elicit most of the other social risks of the system, and using the lens of a cultural perspective to explain the interrelationships.

First, this study identifies various social risks involved in the AFSCs of Argentina and China. Among the identified AFSC social risks, a number are new compared with those discussed in literature (see Table 1). For example, cultural issues, inappropriate disposal of agrichemical containers, weak monitoring system of the government, and the power differential between managers and subordinates were seldom mentioned by scholars in the literature. The research conducted by Yawar and Seuring (2017) shows that any issues related to labor conditions, child labor, human rights, health and safety, minority development, disabled people inclusion, and gender can all be considered as social risks. This study supports this point as most of the social risks identified in this study are related to the aforementioned seven categories. Other researchers such as Mani et al. (2016) and Cunha et al. (2019) hold a similar view that social risks are related to equity, ethics, and human rights. However, these researchers neglected cultural issues that are rooted in people's minds, which might generate strong effects on people's behavior. For example, Argentineans' low willingness to accept migrants and China's patriarchal society are examples of cultural effects. Our study extends researchers' understanding on social risks from the cultural perspective.

Second, based on the authors' knowledge, we believe that our study is the first to build connections among various AFSC social risks. Previous studies on the SCRM of social issues mainly focus on social risk identification and taxonomy, linking social risk with the performance of supply chain entities, CSR evaluation, actions/measures/management capabilities to tackle social risks, and conceptual development by conducting literature reviews on social issues (Klassen and Vereecke. 2012; Freise and Seuring. 2015; Feng et al. 2017; Cunha et al. 2019; Manteghi et al. 2021). Although there are several studies that made contributions to interrelationship building of supply chain risks (Vishnu et al. 2019; Babu et al.

2020; Zhao et al. 2020), they either focused on general supply chain risks or on industries other than agriculture. This study generated insights into interactions among three types of social risks (human rights, labor practices and decent working conditions, and society) and clustered them into driver's and mediator's risks based on their role in the whole system.

Third, this study indicates that cultural issues is the key risk that has the capability to induce most of the other social risks of AFSCs. Through the lens of different cultural value orientations (e.g., embeddedness and hierarchy), Confucianism, and The Doctrine of the Golden Mean, we explained the cause-effect relationship among various social risks, which represents the originality of this study. Comparing the findings of this study with those in literature, our results are new for the AFSC social risk domain. However, we find that our study is consistent with other areas of existing research. For example, Zhang et al. (2005) highlighted that Confucianism hierarchy is one of the reasons driving the power differential between managers and subordinates, which is reinforced in this study. The research carried out by Zhao et al. (2020) illustrates that an unstable political and economic environment is the key risk that may elicit other supply chain risks. This current study also demonstrates that an unstable political and economic environment, along with weak monitoring system of the government and cultural issues, are the drivers behind other AFSC social risks.

7. Conclusions and future research directions

This study develops a cross-country comparative analysis of social risks involved in the AFSCs through an integrated approach. After using semi-structured interviews to collect data from Argentina and China, we employ thematic analysis to generate various social risks related to each country: TISM to build interactions among the generated social risks, fuzzy MICMAC analysis to distinguish the role of each social risk in the system, and comparative analysis to compare the research results generated by each method. This study makes several contributions to the literature. *First*, it is the first to establish connections among various social risks involved in the AFSCs. *Second*, we identified that cultural issue is the key risk that may elicit other social risks of the system, such as the embeddedness of Argentina and hierarchy, Confucianism and The Doctrine of the Golden Mean of China. *Third*, we extended existing literature to understand social risk from a cultural perspective.

7.1 Implications for managerial practices

This study also generates implications for managerial practice. In the case of Argentina, three improvements to government, policymaker and local migrants' association are suggested. *First*, the tax department of the government should be strengthened by recruiting more employees. Currently, tax professionals/tax inspectors visit local farms randomly once every two years. Thus, most farmers of Argentina are reluctant to pay labor tax and health insurance for their labors because oversight is lacking. By recruiting more tax inspectors and increasing the frequency of checking local farms, forced and bonded labor will be reduced. *Second*, policymakers should consider the situation of illegal migrants with children to give the children more opportunities to receive an education. Currently, only children who have legally resided in Argentina for more than three years and pass the assessment (e.g., performance of migrants and relatives and attendance rate) have the opportunity to receive an education. An easier assessment system should be introduced. *Finally*, migrants' associations should truly work to ask for more rights for their children and other migrants. Several migrants' associations were observed in Argentina, such as the Bolivians' Association and the Uruguayans' Association, but they were not really working. Thus, we suggest that they collaborate with other migrants' associations and the migrant authority to protect their rights.

As for China, three suggestions are advised for labors, governments, and labors' association. *First*, labors should increase their legal awareness or education through reading related rules, laws, and policies. *Second*, the General Labour Union of the government should work for the labors and impose stricter rules and punishments for those who violate labor's

rights. For example, the Labor Law of the People's Republic of China has set clear punishment for managers who are found to pay low or unfair wages, or fail to pay them at all: the Labor Law requires that more than 50% and less than 100% of the payable amount shall be paid to the worker. *Third*, labors should formulate labors' associations and collaborate with the General Labour Union to protect their rights.

7.2 Limitations and future research directions

This study has several limitations that open avenues for further research. *First*, we did not achieve data source triangulation as the semi-structured interview was the only data collection method used in this study. Triangulation is an effective approach to test validity through convergence of information from various sources (Carter et al. 2014). There are four types of triangulations - method, investigator, theory, and data source triangulations. Thus, future research would employ document analysis (e.g., peer-reviewed publications, reports from the International Labour Organization, and reports from non-government organizations) as a complement to semi-structured interviews to achieve data source triangulation (Farmer et al. 2006).

Second, various social risks involved in the AFSCs were identified, modeled, clustered, and prioritized, but we did not provide an integrated framework of social risk management of supply chains. Future studies might investigate social management capabilities, such as any monitoring practices, collaborative practices, and social innovations that could be used to mitigate social risks and the outcomes of social risks to supply chains (Mani et al. 2018). Through linking social management capabilities, various social risks involved, and the outcomes of social risks to supply chains, a framework could be formulated as a guide for the researchers who have an interest in social risk supply chain management.

Third, this study developed a cross-country comparative analysis between Argentina and China in terms of AFSC social risks. However, it is difficult for us to generalize the findings of this study only based on the findings from two countries. To generalize the findings of this study, we suggest evaluating the research results (e.g., identified social risks, interrelationships among social risks, and social risk categorizations) in other countries that share the same cultural value orientations with Argentina and China through a questionnaire. For example, Thailand, India and South Korea have similar cultural backgrounds as China, while others such as Brazil and Bolivia have the same cultural value orientation as Argentina (Schwartz. 2006).

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Data availability statement: The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

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Appendix 1 Interview guide

I. Interviewee information

1) What is your current designation?
2) Can you give me a brief introduction to your job within the company's operations? **Probe** – What type of crop(s) do you grow/process/deliver?
3) How many years of your working experience have been in agriculture? **Probe** – What kind of agricultural activities have you done (e.g., pest management, harvesting and marketing)
4) How many years of your working experience have you been in the same job role in total? **Probe** – Have you done other jobs related to agriculture or agri-food supply chains?

II. Company information

1) Can you give me an overview of the company's operations? **Probe** – How do you understand agricultural business and its role in supply chains?
2) How many employees are working for the company? **Probe** – Have you employed any temporary workers?
3) Can you give a brief overview of your company's upstream and downstream collaborators in the AFSC?

III. Social risks involved or experienced

1) How would you describe the sources of social risks that affect your company? **Probe** – What affects your company, such as loss of reputation and profit?
2) How would you describe any social risks related to violating human rights? **Probe** – How do you understand children working with their parents? How do you understand forced and bonded labor? How do you understand local migrant worker rights violations?
3) How would you describe any social risks related to labor practices and decent work conditions? **Probe** – How do you understand limited or no access to personal protective equipment? How do you understand over time work? How do you understand local poor-quality water?
4) How would you describe any social risks related to society? **Probe** – How do you understand the unavailability of public facilities? How do you understand exposure to unemployment?

IV. Measures adopted or will be adopted to tackle social risks

1) How would you describe any measures or strategies that have been adopted by your company to tackle social risks related to violating human rights?
2) How would you describe any measures or strategies that have been adopted by your company to improve the working conditions of employees?
3) How would you describe any measures or strategies that have been adopted by the local government to tackle social risks from the whole society's perspective?
4) How would you describe any measures or strategies that have been adopted by the focal company of the AFSC to tackle social risks?

Appendix 2 Detailed information of each interviewee involved in this study

Country	Case firm	Role in AFSCs	Ownership	Education level	Working experience	Interviewee
Argentina	A	Input supplier (agrichemical provider)	Private	Junior high school	25 years	Co-founder
	B	Farmers	Private	Master in Agricultural Engineering	30 years	Owner
	C		Private	Junior high school	20 years	Owner
	D		Private	Primary school education	30 years	Owner
	E		Private	Master in Pest Management	10 years	Owner
	F	Research institutes	Public	PhD in Rural Extension	30 years	Professor in Rural Extension
	G		Public	Master in Agricultural Science	22 years	Technical Manager
	H		Public	PhD in Agricultural Sensors	30 years	Dean of the faculty of agriculture
	I	Wholesalers	Public	Master	20 years	Marketing director
	J	Government	Public	Master	15 years	Director of Agri-food Ministry of Buenos Aires province
	K		Public	PhD in Chemistry	10 years	Technical Manager of pesticide residue test
	L	Distributor	Private	Primary education	20 years	Owner
China	A	Farmer	Public	Master in Agricultural Management	10 years	Technical Manager of intelligent farm
	B		Private	Master in Gene Modification	20 years	Owner
	C		Public	Bachelor's degree in Management	25 years	CEO
	D		Private	Master's degree in Science	15 years	Owner
	E		Private	Master's degree in science	10 years	Owner
	F	Research institutes	Public	PhD in Engineering	20 years	Professor of Supply Chain Management
	G		Public	PhD in Management	25 years	Professor of Management
	H		Public	PhD in Engineering	15 years	Professor of Agricultural Sensors
	I		Public	PhD in Management	10 years	Professor of Supply Chain Management
	J	Supermarket	Private	Primary School	25 years	Owner
	K	Wholesaler	Private	Primary School	15 years	Owner
	L	Government	Public	Master in Agricultural Science	30 years	Director

Appendix 3(a) Initial and final reachability matrix of AFSC social risks of Argentina

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
E1	1	1	1*	1	1	1*	1	1	1*	1	0	0	0	0
E2	0	1	1	0	1*	1*	0	0	1*	0	0	0	0	0
E3	0	0	1	0	1*	1	0	0	1	0	0	0	0	0
E4	0	0	0	1	0	0	0	0	0	0	0	0	0	0
E5	0	0	0	0	1	0	0	0	0	0	0	0	0	0
E6	0	0	0	0	1	1	0	0	1	0	0	0	0	0
E7	0	0	0	0	0	0	1	0	0	0	0	0	0	0
E8	0	0	0	0	0	0	1	1	0	0	0	0	0	0
E9	0	0	0	0	0	0	0	0	1	0	0	0	0	0
E10	0	0	0	0	0	0	0	0	1	1	0	0	0	0
E11	1	1	1*	1	1	1*	1	1	1	0	1	0	1	0
E12	1	1	1	1	1	1	1*	1	1	1	1	1	1	0
E13	1	1	1*	1	1*	1*	1*	1*	1*	1*	0	0	1	0
E14	1	1	1	1	1	1*	1*	1	1	1*	1*	1	1*	1

Note: * means transitivity

Appendix 3(b) Initial and final reachability matrix of AFSC social risks of China

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	1	1*	1	1	1	1*	0	1*	1	0	1	0
F2	0	1	1*	1*	1*	1	0	1	0	0	1*	0
F3	0	0	1	0	1	0	0	0	0	0	0	0
F4	0	0	0	1	0	1	0	0	0	0	0	0
F5	0	0	0	0	1	0	0	0	0	0	0	0
F6	0	0	0	0	0	1	0	0	0	0	0	0
F7	0	1	1	1	1	1	1	1*	1	0	1*	0
F8	0	1*	1	1	1	1	0	1	0	0	1	0
F9	0	0	1	0	1	1	0	0	1	0	0	0
F10	1	1	1	1	1	1*	1	1*	1*	1	1	0
F11	0	1	1	1*	1*	1*	0	1*	0	0	1	0
F12	1	1*	1	1	1*	1*	1	1*	1*	1	1	1

Note: * means transitivity

Appendix 4(a) Partitioning the reachability matrix into different levels – Argentina

Variable	Reachability Set (RS)	Antecedent Set (AS)	RS∩AS	Level
Iteration 1				
E1	1,2,3,4,5,6,7,8,9,10	1,11,12,13,14	1	
E2	2,3,5,6,9	1,2,11,12,13,14	2	
E3	3,5,6,9	1,2,3,11,12,13,14	3	
E4	4	1,4,11,12,13,14	4	I
E5	5	1,2,3,5,6,11,12,13,14	5	I
E6	5,6,9	1,2,3,6,11,12,13,14	6	
E7	7	1,7,8,11,12,13,14	7	I
E8	7,8	1,8,11,12,13,14	8	
E9	9	1,2,3,6,9,10,11,12,13,14	9	I
E10	9,10	1,10,12,13,14	10	
E11	1,2,3,4,5,6,7,8,9,11,13	11,12,14	11	
E12	1,2,3,4,5,6,7,8,9,11,12,13	12,14	12	
E13	1,2,3,4,5,6,7,8,9,10,13	11,12,13,14	13	
E14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	14	14	
Iteration 2				
E1	1,2,3,6,8,10	1,11,12,13,14	1	
E2	2,3,6	1,2,11,12,13,14	2	
E3	3,6	1,2,3,11,12,13,14	3	
E6	6	1,2,3,6,11,12,13,14	6	II
E8	8	1,8,11,12,13,14	8	II
E10	10	1,10,12,13,14	10	II
E11	1,2,3,6,8,11,13	11,12,14	11	
E12	1,2,3,6,8,11,12,13	12,14	12	
E13	1,2,3,6,8,10,13	11,12,13,14	13	
E14	1,2,3,6,8,10,11,12,13,14	14	14	
Iteration 3				
E1	1,2,3	1,11,12,13,14	1	
E2	2,3	1,2,11,12,13,14	2	
E3	3	1,2,3,11,12,13,14	3	III
E11	1,2,3,11,13	11,12,14	11	
E12	1,2,3,11,12,13	12,14	12	
E13	1,2,3,13	11,12,13,14	13	
E14	1,2,3,11,12,13,14	14	14	
Iteration 4				
E1	1,2	1,11,12,13,14	1	
E2	2	1,2,11,12,13,14	2	IV
E11	1,2,11,13	11,12,14	11	
E12	1,2,11,12,13	12,14	12	
E13	1,2,13	11,12,13,14	13	
E14	1,2,11,12,13,14	14	14	
Iteration 5				
E1	1	1,11,12,13,14	1	V
E11	1,11,13	11,12,14	11	
E12	1,11,12,13	12,14	12	
E13	1,13	11,12,13,14	13	
E14	1,11,12,13,14	14	14	
Iteration 6				
E11	11,13	11,12,14	11	
E12	11,12,13	12,14	12	
E13	13	11,12,13,14	13	VI
E14	11,12,13,14	14	14	
Iteration 7				
E11	11	11,12,14	11	VII
E12	11,12	12,14	12	

E14	11,12,14	14	14	
Iteration 8				
E12	12	12,14	12	VIII
E14	12,14	14	14	
Iteration 9				
E14	14	14	14	IX

Appendix 4(b) Partitioning the reachability matrix into different levels – China

Variable	Reachability Set (RS)	Antecedent Set (AS)	RS∩AS	Level
Iteration 1				
F1	1,2,3,4,5,6,8,9,11	1,10,12	1	
F2	2,3,4,5,6,8,11	1,2,7,8,10,11,12	2,8,11	
F3	3,5	1,2,3,7,8,9,10,11,12	3	
F4	4,6	1,2,4,7,8,10,11,12	4	
F5	5	1,2,3,5,7,8,9,10,11,12	5	I
F6	6	1,2,4,6,7,8,9,10,11,12	6	I
F7	2,3,4,5,6,7,8,9,11	7,10,12	7	
F8	2,3,4,5,6,8,11	1,2,7,8,10,11,12	2,8,11	
F9	3,5,6,9	1,7,9,10,12	9	
F10	1,2,3,4,5,6,7,8,9,10,11	10,12	10	
F11	2,3,4,5,6,8,11	1,2,7,8,10,11,12	2,8,11	
F12	1,2,3,4,5,6,7,8,9,10,11,12	12	12	
Iteration 2				
F1	1,2,3,4,8,9,11	1,10,12	1	
F2	2,3,4,8,11	1,2,7,8,10,11,12	2,8,11	
F3	3	1,2,3,7,8,9,10,11,12	3	II
F4	4	1,2,4,7,8,10,11,12	4	II
F7	2,3,4,7,8,9,11	7,10,12	7	
F8	2,3,4,8,11	1,2,7,8,10,11,12	2,8,11	
F9	3,9	1,7,9,10,12	9	
F10	1,2,3,4,7,8,9,10,11	10,12	10	
F11	2,3,4,8,11	1,2,7,8,10,11,12	2,8,11	
F12	1,2,3,4,7,8,9,10,11,12	12	12	
Iteration 3				
F1	1,2,8,9,11	1,10,12	1	
F2	2,8,11	1,2,7,8,10,11,12	2,8,11	III
F7	2,7,8,9,11	7,10,12	7	
F8	2,8,11	1,2,7,8,10,11,12	2,8,11	III
F9	9	1,7,9,10,12	9	III
F10	1,2,7,8,9,10,11	10,12	10	
F11	2,8,11	1,2,7,8,10,11,12	2,8,11	III
F12	1,2,7,8,9,10,11,12	12	12	
Iteration 4				
F1	1	1,10,12	1	IV
F7	7	7,10,12	7	IV
F10	1,7,10	10,12	10	
F12	1,7,10,12	12	12	
Iteration 5				
F1	1	1,10,12	1	IV
F7	7	7,10,12	7	IV
F10	1,7,10	10,12	10	
F12	1,7,10,12	12	12	
Iteration 6				
F10	10	10,12	10	V
F12	10,12	12	12	
Iteration 7				
F12	12	12	12	VI

Appendix 5(a) Binary direct reachability matrix of Argentina

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
E1	0	1	0	1	1	0	1	1	0	1	0	0	0	0
E2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
E3	0	0	0	0	0	1	0	0	1	0	0	0	0	0
E4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E6	0	0	0	0	1	0	0	0	1	0	0	0	0	0
E7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E8	0	0	0	0	0	0	1	0	0	0	0	0	0	0
E9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E10	0	0	0	0	0	0	0	0	1	0	0	0	0	0
E11	1	1	0	1	1	0	1	1	1	0	0	0	1	0
E12	1	1	1	1	1	1	0	1	1	1	1	0	1	0
E13	1	1	0	1	0	0	0	0	0	0	0	0	0	0
E14	1	1	1	1	1	0	0	1	1	0	0	1	0	0

Appendix 5(b) Binary direct reachability matrix of China

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	0	0	1	1	1	0	0	0	1	0	1	0
F2	0	0	0	0	0	1	0	1	0	0	0	0
F3	0	0	0	0	1	0	0	0	0	0	0	0
F4	0	0	0	0	0	1	0	0	0	0	0	0
F5	0	0	0	0	0	0	0	0	0	0	0	0
F6	0	0	0	0	0	0	0	0	0	0	0	0
F7	0	1	1	1	1	1	0	0	1	0	0	0
F8	0	0	1	1	1	1	0	0	0	0	1	0
F9	0	0	1	0	1	1	0	0	0	0	0	0
F10	1	1	1	1	1	0	1	0	0	0	1	0
F11	0	1	1	0	0	0	0	0	0	0	0	0
F12	1	0	1	1	0	0	1	0	0	1	1	0

Appendix 6(a) Fuzzy direct reachability matrix of Argentina

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
E1	0	0.1	0	0.5	0.3	0	0.5	0.3	0	0.5	0	0	0	0
E2	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
E3	0	0	0	0	0	0.3	0	0	0.5	0	0	0	0	0
E4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E6	0	0	0	0	0.5	0	0	0	0.5	0	0	0	0	0
E7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E8	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0
E9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E10	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0
E11	0.1	0.3	0	0.7	0.5	0	0.3	0.5	0.7	0	0	0	0.5	0
E12	0.5	0.1	0.1	0.7	0.5	0.5	0	0.5	0.5	0.5	0.3	0	0.5	0
E13	0.3	0.3	0	0.5	0	0	0	0	0	0	0	0	0	0
E14	0.1	0.7	0.3	0.5	0.3	0	0	0.1	0.1	0	0	0.5	0	0

Appendix 6(b) Fuzzy direct reachability matrix of China

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	0	0	0.3	0.3	0.3	0	0	0	0.3	0	0.1	0
F2	0	0	0	0	0	0.5	0	0.3	0	0	0	0
F3	0	0	0	0	0.3	0	0	0	0	0	0	0
F4	0	0	0	0	0	0.9	0	0	0	0	0	0
F5	0	0	0	0	0	0	0	0	0	0	0	0
F6	0	0	0	0	0	0	0	0	0	0	0	0
F7	0	0.3	0.3	0.3	0.7	0.3	0	0	0.3	0	0	0
F8	0	0	0.5	0.3	0.3	0.1	0	0	0	0	0.1	0
F9	0	0	0.3	0	0.5	0.3	0	0	0	0	0	0
F10	0.7	0.5	0.5	0.3	0.5	0	0.5	0	0	0	0.5	0
F11	0	0.3	0.3	0	0	0	0	0	0	0	0	0
F12	0.1	0	0.3	0.3	0	0	0.5	0	0	0.5	0.3	0

Appendix 7(a) The fuzzy MICMAC stabilized matrix of Argentina

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	Driving power
E1	0	0.1	0.1	0.5	0.3	0.1	0.5	0.3	0.5	0.5	0	0	0	0	**2.9**
E2	0	0	0.5	0	0.3	0.3	0	0	0.5	0	0	0	0	0	**1.6**
E3	0	0	0	0	0.3	0.3	0	0	0.5	0	0	0	0	0	**1.1**
E4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
E5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
E6	0	0	0	0	0.5	0	0	0	0.5	0	0	0	0	0	**1**
E7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
E8	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	**0.3**
E9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
E10	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0	**0.9**
E11	0.3	0.3	0.3	0.7	0.5	0.3	0.3	0.5	0.7	0.3	0	0	0.5	0	**4.7**
E12	0.5	0.3	0.3	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0	0.5	0	**5.6**
E13	0.3	0.3	0.3	0.5	0.3	0.3	0.5	0.3	0.3	0.3	0	0	0	0	**3.4**
E14	0.5	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.5	0.5	0	**6.5**
Dependence power	**1.6**	**1.7**	**2**	**2.9**	**3.2**	**2.3**	**2.6**	**2.1**	**4.9**	**2.1**	**0.6**	**0.5**	**1.5**	**0**	

Appendix 7(b) The fuzzy MICMAC stabilized matrix of China

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	Driving power
F1	0	0.1	0.3	0.3	0.3	0.3	0	0.1	0.3	0	0.1	0	**1.8**
F2	0	0	0.3	0.3	0.3	0.5	0	0.3	0	0	0.1	0	**1.8**
F3	0	0	0	0	0.3	0	0	0	0	0	0	0	**0.3**
F4	0	0	0	0	0	0.9	0	0	0	0	0	0	**0.9**
F5	0	0	0	0	0	0	0	0	0	0	0	0	**0**
F6	0	0	0	0	0	0	0	0	0	0	0	0	**0**
F7	0	0.3	0.3	0.3	0.7	0.3	0	0.3	0.3	0	0.1	0	**2.6**
F8	0	0.1	0.5	0.3	0.3	0.3	0	0	0	0	0.1	0	**1.6**
F9	0	0	0.3	0	0.5	0.3	0	0	0	0	0	0	**1.1**
F10	0.7	0.5	0.5	0.3	0.5	0.5	0.5	0.3	0.3	0	0.5	0	**4.3**
F11	0	0.3	0.3	0.3	0.3	0.3	0	0.3	0	0	0	0	**1.8**
F12	0.5	0.5	0.5	0.3	0.5	0.5	0.5	0.3	0.3	0.5	0.5	0	**4.9**
Dependence power	**1.2**	**1.8**	**3**	**2.1**	**3.7**	**3.9**	**1**	**1.6**	**1.2**	**0.5**	**1.4**	**0**	