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Operationalization of Interorganizational Fairness in Food Systems: From a Social Construct to Quantitative Indicators

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Abstract: Fairness issues within food systems are of increasing concern for policy makers and other stakeholders. Given the topicality and policy relevance of fairness within food systems, there is value in exploring the subject further. Simulation modelling has been successfully used to develop and test policy interventions. However, the subjectivity and intangibleness of fairness perceptions make them difficult to operationalize in a quantitative model. The objective of this study is to facilitate research on fairness in food systems using simulation modelling by defining the social construct of fairness in model operational terms. The operationalization is conducted in two steps. First, the construct of fairness is conceptually defined in terms of its dimensions, antecedents, and consequences using the literature on interorganizational fairness. Then, by focusing specifically on fairness issues within food systems, the conceptual definition is used as a basis for the identification of proxy indicators of fairness. Seven groups of factors related to fairness perceptions were identified during the conceptualization phase: *financial outcomes*, *operational outcomes*, *power*, *environmental stability*, *information sharing*, *relationship quality*, and *controls*. From these factor groups, five indicators of fairness that are operational in a quantitative model were identified: profit margin as an indicator of distributive fairness and four indicators of procedural fairness related to market power and bargaining power.

Keywords: fairness; UTPs; food systems; simulation modelling; operationalization; quantification; interorganizational relationships

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1. Introduction

Fairness issues within food supply chains are of increasing concern to European Union (EU) and member states' policy makers [1,2] as findings indicate that the negative impact of unfair trading practices (UTPs) on small and medium-sized enterprises in the EU food sector is affecting the competitiveness of the industry as a whole [3]. Although fairness issues can arise in any market or sector of an economy, they have the potential to be especially problematic in food supply chains, as agricultural producers may be placed under undue pressure and have limited bargaining power in negotiations with larger purchasers, such as retailers, given the lack of alternative buyers [1,4,5]. Attesting to the importance of fairness in the context of food systems, the EU recently issued a Directive (2019/633) on UTPs which aims at protecting weaker suppliers (primarily farmers) including their organizations (e.g., cooperatives) against their buyers, as well as suppliers of agri-food products which are further downstream [6]. The Directive is focused on interorganizational fairness (IOF), which is also the focus of this particular research. IOF concerns fairness in exchange relationships (i.e., supplier-buyer relationships). Although not the subject of this paper, fairness within food systems is also of concern at the individual level (i.e., access to nutritious food at a reasonable price), intraorganizational level (i.e., food industry working conditions and pay), and at the societal level (i.e., food security and the environmental

impacts of food production). Given the topicality and policy relevance of fairness within food systems, there is reason to further explore the subject. If the aim is to be able to positively affect the level of fairness within food systems, the causalities of fairness perceptions within such systems need to be better understood. This is not a trivial task. Food systems are complex networks, with a mixture of social, technical, and economic elements, and a large number of interactions and inter-dependencies that show nonlinear and at times unpredictable behaviours [7]. Adding to that, the fairness concept is based on individual perceptions and thus highly intangible and difficult to grasp.

Simulation modelling is useful to study complex systems and problems where an analytical solution is not readily available [8]. Although originally intended for the study of physical systems, simulation modelling is increasingly used to model social phenomena, which adds a level of difficulty but also opens up opportunities in the modelling of human behaviours and systems under human control (e.g., socio-technical and socio-economic systems) [9]. Despite technological and methodological advances, simulation modelers still face challenges when attempting to model social systems. One relates to the problem of operationalization, which stems from the intangible nature of many social concepts (i.e., fairness) making them difficult to define in measurable terms. Unlike the physical laws underlying systems in engineering and the natural sciences, the laws governing the dynamics of change in social systems are to a large extent unknown and have not been formalized mathematically. Simulation models are mathematical and therefore require social concepts to be quantified in a meaningful way for them to be operational in a model. In order to study fairness in food systems using a simulation model and test policies that can potentially affect the level of fairness, the model must be equipped to measure fairness as a model output. Unfortunately, the simulation modelling literature offers limited guidance on how to operationalize and quantify social concepts [10,11]. Whereas, making assumptions and simplifications is an integral part of the process of abstracting a simulation model from the real world, it seems worthwhile to carefully and deliberately operationalize the concepts that are fundamental to the modelling work. This issue has been of major concern in the social sciences for a long time, and previous research in the field may be of value for simulation modelers venturing into the social realm.

With raised awareness of the prevalence of fairness issues within food systems and their extensive impact, the subject has moved up on the political agenda, and there is increased willingness to tackle the problem. The European Commission and academic researchers have stressed the need to fill the existing knowledge gap on UTPs within food systems in order to come up with possible solutions [1,7,8]. In the last decade, research on the topic has furthered our understanding of how fairness issues manifest in the different sectors of food systems [1,2], and the first steps towards developing and implementing solutions have been taken with legislative action [6]. Previous research efforts have not taken advantage of the benefits of using simulation modelling to develop policy interventions. The motivation behind this study was to explore the potential of using simulation modelling to develop and test policy implementation options aimed at improving fairness within food systems.

This study was part of a larger Horizon 2020 project called VALUMICS, the general aim of which was to provide tools and approaches to enable decision makers to evaluate the impact of strategic and operational policies aimed at enhancing fairness, integrity, and resilience in future scenarios of sustainable Food Value Chains. This study's specific aim is to operationalize IOF in an effort to facilitate research on the topic using simulation modelling. By drawing on fairness theory and measurement theory, the construct of IOF is translated into model operational terms in two consecutive steps: conceptualization and operationalization. The result is a set of measurements for IOF in the form of quantified indicators (e.g., model outputs). The rest of the paper is organized as follows. Following a summary of the study's theoretical foundations in Section 2, the construct of IOF is defined along two dimensions, and the immediate factors leading to and resulting from fairness perceptions (e.g., its antecedents and consequences) are identified through a literature

review in Section 3. This conceptual definition is then used as a basis for the development of a model operational definition of IOF in the form of quantified indicators (simulation model outputs) in Section 4. Finally, in Section 5, the results and their implications are discussed.

2. Theoretical Background

Fairness theory and measurement theory were used to substantiate the operationalization of the fairness construct, specifically the various dimensions of fairness as set out in the literature and the levels of measurement and how they affect the process of operationalizing social constructs.

2.1. Fairness Theory

Fairness, also referred to as justice, is a socially constructed concept based on the perceptions of individuals. Research on fairness has traditionally focused on two types of subjective perceptions called *distributive fairness* and *procedural fairness*. Distributive fairness, first described by Adams [12], is related to the perceived fairness of outcome distributions or allocations while procedural fairness, a concept introduced by Thibaut and Walker [13], is related to the perceived fairness of the procedures used to determine these outcome distributions or allocations. Later the concept of fairness has been extended to include social aspects. Interactional fairness, introduced by Bies and Moag [14], focuses on the quality of the interpersonal treatment people receive when procedures are implemented. Greenberg [15] further divided interactional fairness into, interpersonal fairness, which refers to the degree to which people are treated with politeness, dignity, and respect by those executing procedures, and informational fairness, which focuses on the quality of information provided about the procedures resulting in outcome allocations [16]. Figure 1 describes the development of the fairness concept. The notions of distributive and procedural fairness are well established in the literature while the way in which the social aspects of fairness are defined varies and thus the number of fairness dimensions considered, ranging from a single dimension up to four.

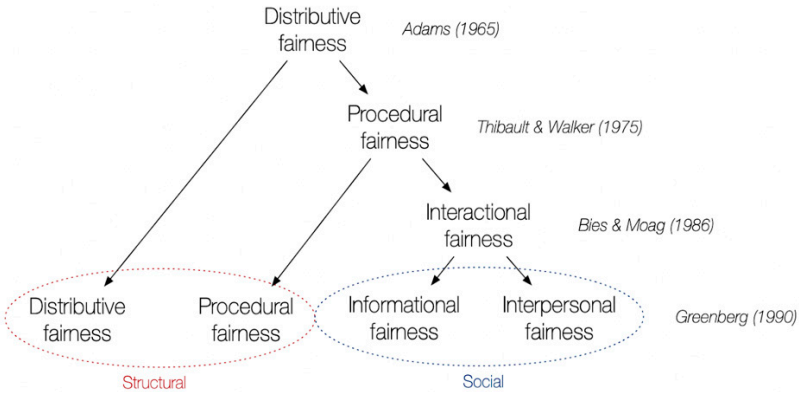

Figure 1. The development of the fairness concept.

The dimensionality of fairness has long been debated. Some authors have argued that while distinguishing between the different dimensions of fairness may be valuable, it may at times be overemphasized and unnecessary [17]. Others argue that the fairness construct is best conceptualized as four distinct dimensions [16,18]. It seems that the level of detail in terms of fairness dimensions should depend on the type of study and its objectives. The different dimensions, although distinguishable, are highly integrated, and in some instances, it might not serve the purpose of a study to focus too much on the dimensionality of fairness. This holds for the current research. Some aspects of fairness are more suitable for quantitative modelling than others (i.e., economic outcomes and structural aspects of procedures). Here, therefore, the research will not be limited to factors related to specific dimensions of fairness but rather the structural aspects of those factors. Certainly, this means that factors relating to the structural dimensions of fairness (e.g.,

distributive fairness and procedural fairness) will be prominent. However, factors relating to the social dimensions will not be automatically excluded.

2.2. Measurement Theory

Mathematical modelling is increasingly used to model social phenomena. While it is easier to model systems based on well-established physical laws that can be easily expressed in mathematical terms, it is interesting to try and expand into the social world as human decisions are the main drivers of physical systems. The problem of operationalization, e.g., the difficulty in defining intangible concepts, often social constructs, in measurable terms, is well known and thoroughly addressed in the social sciences. Constructs are phenomena that cannot be observed, neither directly nor indirectly. We may be able to observe their antecedents or consequences, but we cannot observe the constructs themselves [19]. Fairness is a social construct; hence, it is neither directly nor indirectly observable but can be operationalized based on observables (i.e., antecedents and consequences). The characteristics of data on social constructs usually make it difficult to operationalize them and develop meaningful measurements. Generally, data can be measured at four levels; nominal, ordinal, interval and rate [20]. The nominal level of measurement is only used for classification (i.e., religion). The ordinal level adds some ordered relationship between observations (i.e., a scale from least to most desirable), and at the interval level, the distance between the ordered observations has meaning (i.e., IQ). Rate, the highest level of measurement, encompasses the lower three levels, and hence, it has an order, a set value between units and additionally, a true zero, which enables the use of fractions (i.e., income) [20].

The precision and usability of data increases as we move from nominal towards ratio level of measurement. Different statistical and mathematical techniques (including simulation modelling) require measurement at the interval and preferably the rate level. Limited analysis can be done on a nominal measurement which simply classifies each observation. The ability to rank-order observations opens up some opportunities for analysis and indeed, ordinal data (i.e., measuring fairness on a scale from unfair to fair based on survey responses) are important to the discussion of social constructs. However, they are subjective (judgemental) in nature and cannot communicate true operational meaning [21]. Most social and behavioural data can be measured at one of the four levels of measurement, but as they become more subjective, like constructs, they are more likely to belong to the lower levels of measurement. As part of the operationalization process, measurements of constructs can be "moved up a level" through a process of quantification, which involves giving a numerical value to a measurement and thus allowing for statistical procedures and mathematical calculations [22]. Quantification methods include the creation of rating scales and the use of proxy variables (e.g., indirect indicators) with which the intangible concept under study is highly correlated. A good proxy variable e.g., one that is strongly related to the unobservable variable of interest and a reasonable substitute for it [11] can enable the study of intangible concepts (i.e., fairness) using quantified methods such as simulation modelling.

3. Materials and Methods

The purpose of this paper is to enable the exploration of problems related to IOF using a simulation model. To achieve this objective, an operational definition of IOF, in the form of quantitative indicators, was developed. Before defining the construct in operational terms, there was a need to conceptually define it. The multidimensional nature of fairness called for a consideration of the different dimensions and how they relate to each other. Additionally, because IOF is an unobservable construct, as a part of the conceptualization phase, the immediate factors leading to and resulting from fairness perceptions (e.g., antecedents and consequences) were identified and later used as a basis for the development of proxy measures in the operationalization phase. The research process therefore consisted of two steps: (1) conceptualization, and (2) operationalization

and resulted in an operational definition of the construct in the form of quantified indicators along two dimensions (see Figure 2). Each step is described in more detail below.

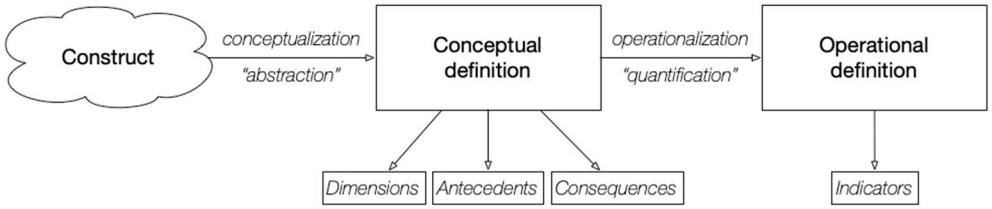

Figure 2. The two-step research process of defining model operational indicators of interorganizational fairness (IOF).

3.1. Conceptualization

The conceptualization process involved defining the construct of IOF including its dimensions and identifying associated observables (e.g., antecedents and consequences) in the IOF literature. A systematic literature search was performed using the ISI Web of Knowledge database to identify peer reviewed papers presenting research on the antecedents and consequences of IOF. The search was set up to identify articles with either the word fairness or justice in the title and at least one of the following words and phrases as topics: inter(-)firm, inter(-)organiz(s)ational, supply chain, value chain, channel, buyer-supplier and business. These search terms were identified through an explorative preliminary literature review using the Google Scholar database. The search resulted in 1083 items of which 32 were deemed relevant for the current research through an abstract review. Relevant papers were those that considered the interorganizational level of fairness, identified antecedents and/or consequences of fairness, and were accessible.

The result of the conceptualization phase was a conceptual definition of IOF along two dimensions: distributive IOF and procedural IOF. Furthermore, seven groups of observable factors (e.g., antecedents and consequences) relating to IOF were identified.

3.2. Operationalization

The operationalization phase had the seven factor groups resulting from the conceptualization phase as a starting point. The operationalization process involved defining proxy variables for IOF that can be used in a simulation model (e.g., indicators) and then quantifying them. Potential measurements were identified by reviewing the literature on food systems, specifically focusing on the factors comprising the conceptual definition. The result of the operationalization phase was an operational definition of IOF in the form of five quantified indicators that can be used to operationalize the concept of IOF in a simulation model. The operational definition consists of (1) the variable being measured (here, distributive or procedural IOF), (2) the measure to be used (here, proxies of distributive and procedural IOF), and (3) a description of how the results of the measure will be interpreted.

4. Results

4.1. Conceptualizing IOF

IOF is an unobservable, multidimensional construct. Unobservable constructs can be conceptualized in terms of associated observables (i.e., antecedents and consequences). The multidimensionality and lack of observability of the IOF construct call for an analysis of its dimensions, antecedents and consequences.

4.1.1. Dimensions of IOF

Fairness, in general, has been defined along up to four dimensions. Here, in line with the objectives of the research, the focus is on the structural dimensions of fairness (e.g., distributive and procedural), and the other dimensions (e.g., interpersonal and informational) are categorized as social aspects of procedural fairness. The definition of

procedural fairness in an interorganizational context which follows therefore encompasses the interpersonal and informational aspects of fairness.

Distributive fairness deals with the fairness of outcomes, or in an interorganizational context, how benefits and burdens are distributed among business partners [23]. More specifically, it relates to the fairness of the ratio of a business' inputs to its outcomes and how they compare to the ratio of others [12]. Inputs, in this context, can generally be defined as either cost (e.g., workload, financial input) or risk (e.g., due to uncertainty in supply and demand, price fluctuations, environmental factors) [12], and the most important outcome is the price that the company gets for its products [24]. Examples of distributive fairness issues in interorganizational settings are unfair pricing (e.g., retailers using their purchasing power to drive down suppliers' prices to uneconomic levels), unfair cost burden (e.g., suppliers having to bear unforeseeable costs and costs that were unjustly forced upon them), and unfair risk burden (e.g., suppliers having to bear risk that does not result in a larger share of profits) [5,25]. Here, drawing on the work of Kumar, Scheer and Jan-Benedict [23] and Duffy, Fearne and Hornibrook [5], distributive IOF will be defined as "the fairness of outcome distributions and allocations, that is, the fairness of how benefits and burdens are distributed between business partners".

In an interorganizational context, procedural fairness deals with the ways (e.g., procedures) in which outcomes are distributed between partners. Thibaut and Walker [13] extended the fairness concept to include procedural fairness and identified process control, the extent to which people have a chance to express their opinions about decisions, and decision control, the actual level of influence people have in decisions, as its antecedents. Leventhal, et al. [26] extended the notion of procedural fairness into nonlegal contexts such as interorganizational relationships by defining the six criteria of fair procedures in decision making. Such procedures should be consistent, free from bias, based on accurate information, equipped with a mechanism for correcting mistakes in decision making, ethical and moral, and take into account the opinions of various groups affected by the decision. Examples of potential procedural fairness issues in interfirm relationships are unequal power among partners to define prices (i.e., as a result of the existing governance structure and/or different firm strategies), unequal access to relevant information, and the inequitable treatment of different partners in a supply chain on behalf of a powerful party [24,25]. Here, procedural IOF will be defined as: "the fairness of the procedures (e.g., means) used to determine outcome distributions and allocations, that is, the extent to which individual organizations are in a position to express their feelings on those procedures and influence them".

In order to underpin the process of operationalization the antecedents and consequences of IOF were identified next.

4.1.2. The Antecedents and Consequences of IOF

Several authors have researched the antecedents and/or consequences of IOF (see Figure 3). Perceived IOF has been found to have a positive impact on relationship quality in a chain of businesses [23], mainly through increased trust [27–32] and commitment [28,29,33–36]. Furthermore, studies have concluded that perceived fairness leads to less opportunism [37,38] and conflict [39–41] between business partners who are then also more likely to share information with their partners [33,38], invest in their relationships [33,38], and view them as long-term [42,43]. Additionally, perceived fairness has been found to precede satisfactory operational outcomes [31] and result in businesses offering better quality products and services [27,37,44], spending more on research and development (R&D) and product innovation [37,44], and an overall better financial performance [40,45–48].

The observed positive consequences of perceived fairness have motivated research into the antecedents of fairness. The price a company or a business receives for their product is an important outcome and study findings have suggested that price satisfaction and resulting overall financial performance has a strong impact on perceptions of distributive fairness and is therefore considered one of the most important antecedents of a

supplier's fairness perceptions [28,37]. Important antecedents of fairness in general and procedural fairness in particular are related to the sharing of information between business partners [28], the quality of that information [27], and the stability of the business environment [28]. Furthermore, the exercise of power [46] and formal and social control [48] affect both distributive and procedural fairness perceptions.

A closer look at the antecedents and consequences of IOF reveals at least three things worth mentioning. First, there are overlaps between the two groups which indicates (not surprisingly) that fairness, to some extent, is a reciprocal concept (e.g., both a cause and an effect). Second, the factors affecting the different dimensions of fairness are often the same or at least related. This is to be expected as the different dimensions of fairness are interrelated and although separate dimensions, they affect each other. Fair procedures are probably more likely to lead to fair outcomes and perceived distributive fairness in a business relationship presumably leads to more courteous communication. Finally, there is some variability in the terminology used by different authors, and it seems that in some instances, different words are being used to describe the same or at least similar concepts.

The aim here is to identify observables associated with IOF that can be used to develop proxy indicators. To focus the attention on the core factors associated with fairness, similar or related factors are grouped together resulting in a consolidated view of the antecedents and consequences of fairness in an interorganizational context. The consolidated view consists of seven groups of factors for both dimensions of IOF: (1) economic outcomes, (2) operational outcomes, (3) information sharing, (4) power, (5) controls, (6) environmental stability, and (7) relationship quality. A list of the items comprising each factor group can be viewed in Table 1. These factor groups, extracted from the IOF literature, will serve as a foundation for the operationalization phase.

4.2. Operationalizing IOF

The factors resulting from the conceptualization relate to interorganizational relationships and fairness in different ways. Power asymmetries and lack of environmental stability pose challenges, particularly for the more disadvantaged organizations operating in a competitive market. Controls, collaboration, information sharing, and relationship quality relate to strategies used to meet these and other challenges facing organizations, both internally and when dealing with stakeholders. Outcomes are the results of their operational efforts and ultimately the main reason for doing business and thus the measure of success. In order to operationalize the social construct of IOF, these immediate observable factors leading to and resulting from perceptions thereof will now be examined in the context of supply chains in general and food supply chains in particular in an effort to identify potential proxies of IOF.

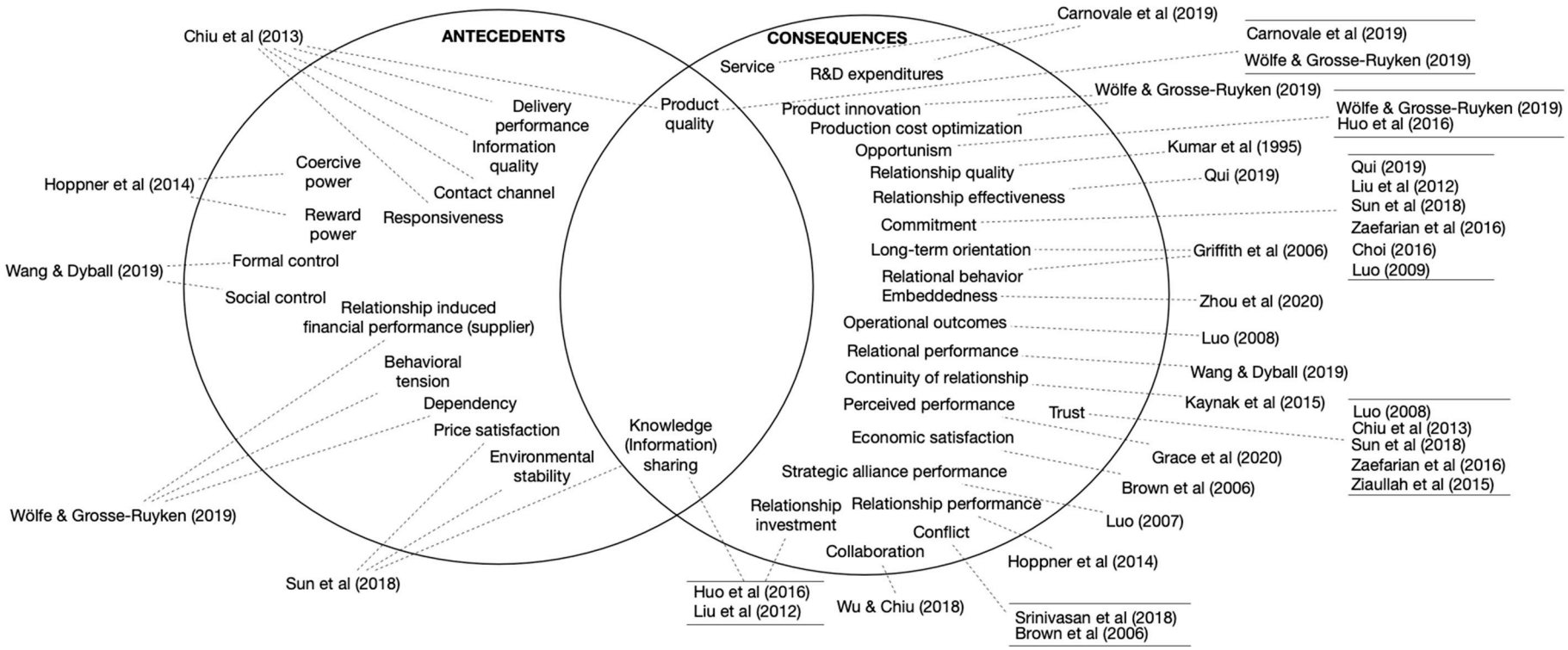

Figure 3. The antecedents and consequences of IOF based on a review of the interorganizational fairness literature.

Table 1. The factors (e.g., antecedents and consequences) comprising the factor groups.

Factor Group	Factor	Reference	Definition
Financial outcomes	Financial outcomes	Luo (2008) [31]	"alliance performance in financial return (i.e., profitability)"
	Price satisfaction	Sun et al. (2018) [28]	na
	Relationship induced financial performance	Wölfel and Grosse-Ruyken (2019) [37]	na
	Strategic alliance performance	Luo (2007) [47]	"cooperation payoffs"
	Perceived performance	Grace et al. (2020) [45]	"financial goals of running the business"
	Production cost optimization	Wölfel and Grosse-Ruyken (2019) [37]	na
	Economic satisfaction	Brown et al. (2006) [40]	na
	Relationship performance	Hoppner et al. (2014) [46]	"the multidimensional outcomes, including financial, strategic and satisfaction elements, resulting from the activities performed by firms on behalf of the relationship"
Operational outcomes	Operational outcomes	Luo (2008) [31]	"operational consequence (i.e., competitive strength in labor productivity, quality control, technology development, customer service, and managerial efficiency)"
	Delivery performance	Chiu et al. (2013) [27]	"the time taken to receive the item purchased from a seller"
	Contact channel	Chiu et al. (2013) [27]	"the availability of assistance"
	Responsiveness	Chiu et al. (2013) [27]	"the willingness to help customers and provide prompt service"
	R&D expenditures	Carnovale et al. (2019)	na
	Service	Carnovale et al. (2019)	na
	Product quality	Wölfel and Grosse-Ruyken (2019) [37]	na
	Product innovation	Wölfel and Grosse-Ruyken (2019) [37]	na
Information sharing	Information sharing	Sun et al. (2018) [28]	"effectively using acquired information and rationally sharing information with partners"
	Knowledge sharing	Liu et al. (2012) [33]	"two firms simultaneously and equally exchange relevant knowledge and information thorough dynamic processes, including both explicit information (e.g., electronic data interchange) and tacit technology know-how"

Table 1. *Cont.*

Factor Group	Factor	Reference	Definition
	Information quality	Chiu et al. (2013) [27]	"the quality of information provided by sellers, including relevance, understandability, reliability, adequacy, scope, and perceived usefulness"
	Communication	Huo et al. (2016)	"the exchange of information associated with business transactions and related issues with a supply chain partner"
Power	Coercive power	Hoppner et al. (2014) [46]	"based on their partner's perception that the party has the ability to mediate punishments"
	Reward power	Hoppner et al. (2014) [46]	"based on their partner's perception that the party has the ability to mediate rewards"
Controls	Formal controls	Wang and Dyball (2019) [48]	"an architecture that 'institutionalizes' how partners cooperate, interact and learn from each other","contracts, planning and budgeting formal authority relationship standardized procedures and rules, supervision performance evaluation, structural grouping and departmentalization and management reports"
	Social controls	Wang and Dyball (2019) [48]	"focus on informal cultures and systems, communication, socialization and self-regulation","include meetings and organized personal contact, networking and other socialization processes, teams and taskforces, transfer of managers/lateral movements, rituals, traditions and ceremonies rotation of personnel, ad hoc committees, face-to-face communication and participatory decision-making"
Environmental stability	Environmental stability	Sun et al. (2018) [28]	"the ability of an enterprise to forecast the future markets, policies and other factors accurately, according to the current external environment"
Relationship quality	Relationship quality	Kumar et al. (1995) [23]	"encompassing conflict, trust, commitment, and two constructs that represent the converse of disengagement—willingness to invest in the relationship and expectation of continuity"
	Commitment	Sun et al. (2018) [28]	"an ongoing relationship with another and is important enough to warrant a great deal of effort to maintain it"
		Liu et al. (2012) [33]	"both parties actively maintain and strengthen the exchange relationship"
		Qui (2018) [36]	"a high level of affective attachment to the relationship and a strong expectation of relationship continuity"

Table 1. *Cont.*

Factor Group	Factor	Reference	Definition
		Zaefarian et al. (2016) [29]	"the willingness of the exchange partners to make short-term sacrifices to develop and maintain long-lasting, stable, and profitable relationships"
		Choi et al. (2016) [35]	na
		Luo (2009) [34]	na
	Trust	Sun et al. (2018) [28]	na
		Chiu et al. (2013) [27]	na
		Zaefarian et al. (2016) [29]	"the willingness of the firm to rely on its partner in whom it has confidence"
		Luo (2008) [31]	"the willingness to take a risk in the partnership that is expected to create a higher payoff than pursuing it alone"
		Ziaullah et al. (2015) [30]	"a willingness to rely on the exchange partner"
	Long-term orientation	Griffith et al. (2006) [42]	"when an exchange partner believes that the on-going relationship with another is so important as to warrant maximum effort in maintaining the relationship"
	Continuity of relationship	Kaynak et al. (2015) [43]	na
	Relationship investment	Liu et al. (2012) [33]	"both parties make idiosyncratic investments in the relationship","creates a lock-in situation in which two parties are interdependent and are motivated to maintain the relationship"
	Relational behaviours	Griffith et al. (2006) [42]	"desired behaviours on the part of one or more partners in the exchange such as flexibility, sharing of information and solidarity"
	Relationship effectiveness	Qui (2018) [36]	"focuses on the extent to which relationship partners find the relational interactions satisfying, productive and worthwhile"
	Embeddedness	Zhou et al. (2020) [49]	"represents a kind of reciprocal relationship between partners; it is a type of investment that brings about mutual benefits by way of cooperation, trust, and learning from one another"

Table 1. *Cont.*

Factor Group	Factor	Reference	Definition
	Behavioural tension	Wölfel and Grosse-Ruyken (2019) [37]	"characterized by the co-existence of two, contradicting forces with dichotomous goals between partners, which induces conflicts and risks to break up the social exchange"
	Conflict	Brown et al. (2006) [40]	na
	Task conflict	Srinivasan et al. (2018) [41]	"the awareness that there are differing viewpoints and opinions on task execution among transacting partners"
	Opportunism	Wölfel and Grosse-Ruyken (2019) [37]	na
		Huo et al. (2016) [38]	"self-interest seeking with guile"
	Dependency	Wölfel and Grosse-Ruyken (2019) [37]	na
	Specific investment	Huo et al. (2016) [38]	"tangible and intangible investments in a particular buyer-supplier relationship that are difficult to redeploy to other relationships"
	Supply chain collaboration	Wu and Chiu (2018) [50]	"a mechanism to managing interdependencies for operations, product/process designs, marketing effort and sale planning/forecasting, as well as establishing strategic decision among SC members"

4.2.1. Challenges: Power Asymmetries and Environmental Uncertainty

The concept of fairness in the context of transactional relationships is closely connected to power. The more powerful party in a business relationship is in a position to misuse its power and thus treat their business partner unfairly [51]. Power asymmetries in interfirm relationships can therefore potentially lead to unfair trading practices [1,2] and indeed, Hoppner, Griffith and Yeo [46] confirmed power as an antecedent of both procedural and distributive fairness.

Traditional research on power asymmetries in food systems has focused on market power or "the ability of a firm (or group of firms) to raise and maintain a price above (if selling) or below (if buying) the level that would prevail under perfect competition, ultimately leading to lower output levels, higher profits and (usually) welfare losses" (Bonanno, et al. [52], p. 8). Both oligopolistic (e.g., few sellers), but more frequently, oligopsonistic (e.g., few buyers) market power is observed in food supply chains (i.e., retail power). However, Bonanno, Russo and Menapace [52] suggest that the traditional market power models are not applicable to modern food systems, characterized by high levels of concentration, vertical coordination, cooperative behaviours and focus on quality. Bargaining power, or "the power to obtain a concession from another party by threatening to impose a cost, or withdraw a benefit, if the party does not grant the concession" (Kirkwood [53], p. 637), is considered to better describe the power complexities of such systems [51,52].

Bargaining power in interorganizational relationships is a consequence of both the relative strategic significance of the partners (i.e., size of supplier or buyer) and the availability of alternatives (i.e., number of available suppliers/buyers and ease of switching supplier/buyer) [54,55]. Bargaining power asymmetries are evident in food supply chains and in agri-food in particular. These imbalances have been highlighted by the European Commission and are seen as the driving force behind UTPs within European food systems that have an extensive impact on the outcomes of a large number of businesses through ripple effects [2].

The relationship between environmental stability and procedural fairness was described by Kumar, Scheer and Jan-Benedict [23]. Later Sun, Liu and Yang [28] confirmed environmental stability defined as "the ability of an enterprise to forecast the future markets, policies and other factors accurately, according to the current external environment" (Sun, Liu and Yang [28], p. 4), as an antecedent of both procedural and distributive fairness. The main sources of uncertainty (e.g., lack of stability) in the external environment of supply chains, including food systems, are unpredictable quantity and timing of supply and demand [56,57]. The actions of the various stakeholders of an organization (i.e., its suppliers, customers, and competitors), affect the actual demand for its products and whether it has the appropriate amount of supplies to meet that demand. The socio-political environment can also affect both supply and demand through constrictions on trade, production licensing, etc. The unpredictability of prices, which are closely related to the dynamics of supply and demand, can seriously increase the uncertainty faced by organizations in their decision making. The ability to predict prices depends amongst other things on types of transactions between chain partners (i.e., long- or short-term contracts, spot market transactions, auctions, etc.) and the price volatility in the market. Agricultural prices vary because both production (e.g., supply) and consumption (e.g., demand) are variable (i.e., draught or diseases affecting production and changes in income and diet trends affecting consumption) [58].

4.2.2. Coordination Strategies: Controls, Relationship Quality, Collaboration, and Information Sharing

Many characteristics of food products, including their perishability and the mandatory requirement of food safety and quality, call for coordination within food supply chains in addition to governmental rules and regulations. Furthermore, coordination helps to minimize transaction costs [59] and facilitate decision making by reducing uncertainties, mainly in terms of supply, demand, and price. These relationships are of various types,

either vertical or horizontal, and include strategic alliances, long-term contracts, licensing, subcontracting, joint ventures, franchising, and cooperatives [60]. Although, distinct factors, controls, relationship quality, collaboration, and information sharing, to some extent all relate to the way in which supply chain partners interact and cooperate. Collaboration implies the interdependence of the interacting parties [50], and information sharing is a prominent coordination strategy. Controls concern the (formal and informal) management of partner interactions [48], and relationship quality concerns the relational behaviours, such as trust and commitment, that facilitate the collaborative partnerships [23].

The dynamics of food systems and the ways in which individual organizations interact and cooperate are to a large extent shaped by the modes of governance. Governance structures are complex and fluid. They include international as well as national regulations, and public (i.e., government regulations), private (i.e., cooperatives), and social (i.e., non-governmental organizations) forms of governance, acting vertically (e.g., along the chain) or horizontally (e.g., within a single level of the chain) [61]. Individual organizations or networks of organizations use private forms of governance to countervail issues and challenges they face in their operations. These include both vertical and horizontal coordination strategies aimed at counteracting or diminishing the effects of power asymmetries and environmental uncertainty.

Vertical coordination strategies concern the alignment and control of sources of risk and uncertainties, namely, price, quantity, quality and terms of exchange [62]. They range from open markets to complete vertical integration. Between those extremes lie various types of hybrid coordination strategies, from formal contracts to more informal arrangements such as information sharing and joint planning [63]. At the spot market end the coordination is typically short-term, information sharing is limited, and the partners are not dependent on one another. As we move towards full vertical integration, the interests of the involved parties become more intertwined, the relationships are more likely to be long-term, and information sharing is more open and frequent [62]. In an empirical study of the governance structures in European food value chains, Schiefer, et al. [63] positioned transactions on a continuum ranging from spot markets, through different forms of contractual forms, to vertical integration. Their findings indicated that governance structures along food value chains are diverse, but contractual relationships of different types are notably dominant.

Horizontal coordination strategies (i.e., cooperatives and producer organizations) are useful as countermeasures against known market failures such as power asymmetries between different levels of food chains due to increasing concentration at certain levels and efficiency problems faced by small actors (mainly farmers) causing them to have problems with reaching economies of scale. Particularly, small farmers lack bargaining power and access to markets and can with collective action generate countervailing power and reduce likelihood of buyer opportunism and UTPs [64].

Private standards increasingly drive innovation and change in food systems as although not legally-binding they have become prerequisits to suppliers' access to markets [65]. Certain standards are specifically focused on the social aspects of food systems, including fairness (i.e., the "Fairtrade"-seal) [66]. In recent years the food industry and academia have increasingly turned their focus towards emerging information technological developments such as blockchain, internet-of-things, machine learning, and artificial intelligence, to solve problems related to food safety, quality, and traceability [67,68]. Of particular relevance to fairness in food systems is the application of blockchain technology as it can improve the transparency and efficiency of processes and transactions [69]. Increased transparency has been highlighted as instrumental in the effort to improve fairness in food systems [1].

4.2.3. Outcomes: Operational and Financial

Food safety, quality, and sustainability are important operational outcomes in food supply chains as consumer demand for food is increasingly focused on those factors

rather than price only. This has led to the development of private standards and third-party certification of food safety, quality and sustainability that increasingly shape the global food systems in addition to public regulations and control [65]. Adherence to these standards has been linked to operational and thus financial performance, and in many cases, it is a prerequisite for continued operation of food production and processing companies. Various factors relating to operational outcomes have been confirmed as both antecedents and consequences of IOF (i.e., [27,31,37,44]).

Fairness of financial outcomes within food systems has mainly been considered in relation to the value distribution among chain partners. Indeed, according to Adams [12], people are more concerned with the fairness of the distribution of outcomes than the absolute level of those outcomes. The value distribution in food supply chains has been of concern to policy makers for some time. Research has indicated that farmers create more value than they capture, in some cases to the extent that their businesses are barely profitable [70,71]. This has led to suspicions of UTPs of more powerful chain partners [1].

Various indicators have been used to determine the value distribution among chain partners. Price has been identified as an important outcome for any supply chain partner, and several studies have confirmed that price satisfaction is positively correlated with perceived fairness [23,28,37]. When asked about issues relating to fairness and power, 50 stakeholders representing five European food chains mainly mentioned issues related to price setting and the means by which pricing decisions are made [72]. Price has been used to measure the value distribution in food supply chains (i.e., Seják and Zaviral [73]); however, a good price is relative, and an outcome should preferably be rated against the relevant inputs used to obtain it and the outcomes of other chain partners and their contributions. One such indicator is the share of the retail food dollar (or euro), which measures the share of the consumer's dollar received by each stage of the agri-food chain [74]. Food dollar analysis has been used extensively by researchers and policymakers to estimate value distribution (i.e., Canning, Weersink and Kelly [71]). While the division of the food dollar gives indications as to the distribution of the value captured by different chain partners, it does not take into account their contributions to the value addition along the chain, e.g., their inputs. In their research, Cucagna and Goldsmith [75] found that farmers, indeed, capture less value than other chain partners but that they also create relatively less value. In any case, it is important that a measure of outcomes takes into account the inputs used to obtain them.

Profit is the difference between the amount spent and the amount earned and thus takes into consideration both the outcome (e.g., the revenues resulting from the product's sales price and volume) and the inputs (e.g., the various expenses made in order to make and sell the product). While not the only objective of a business, turning profit is vital for long-term survival in a competitive market. Hence, profit is a good measure of financial outcomes, and consequently an appropriate measure of perceived fairness of outcomes in business relationships (e.g., distributive fairness). Companies of different sizes can earn radically different but equally fair amounts of profit. To be able to compare profits of different supply chain partners and establish the outcome distribution, one can use profit margin (e.g., the ratio of profit to revenues). This was the approach used by for example Bertazzoli, Ghelfi, Rivaroli and Samoggia [70].

Table 2 summarizes the manifestation of the immediate factors leading to and resulting from fairness perceptions in food supply chains. While the literature confirms the relationship between these factors and fairness perceptions, the causalities are not obvious nor whether and then how the factors are interrelated. In order to get a more thorough understanding of IOF, it is helpful to view the different factors in context.

Table 2. Manifestations of the immediate factors leading to and resulting from IOF in food systems.

	Factor Groups	Food Supply Chain Manifestation
Challenges	Power	- Bargaining power - Market power
	Environmental uncertainty	- Supply uncertainty (i.e., crop failure, disease, regulations) - Demand uncertainty (i.e., diet trends, substitute products) - Price volatility
Strategic coordination	Controls, Collaboration, Relationship quality, Information sharing	- Vertical (i.e., contract types, alliances, information sharing, trust, commitment, transparency, interbranch organizations). - Horizontal (i.e., cooperatives, producer organizations)
Outcomes	Financial outcomes	- Profitability - Efficiency
	Operational outcomes	- Safety - Quality - Sustainability

Figure 4 presents a conceptual view of the factors related to IOF. It shows how fairness perceptions relate to organizations' challenges in their decision-making to fulfil their purpose of producing outcomes and the strategies they use to overcome those challenges. The key to understanding fairness in the context of interorganizational relationships might possibly lie in the fact that the primary purpose of doing business is to produce outcomes. Indeed, outcomes and the means by which they are achieved are what shapes fairness perceptions [72]. In a sense, perceptions of fairness relate to equal opportunities of businesses to meet their objectives. In simple terms businesses operate and thus meet their objectives by making series of decisions. These decisions are constrained by internal (i.e., financial position, know-how, technology, etc.) and external (i.e., rules and regulations, market dynamics, etc.) factors. Fairness perceptions are firmly linked to decision making in the literature and involvement in decision making in particular [13,76]. Involvement essentially means to take part or have a say. In order to have a say, one must be allowed at the table and be equipped to take part. When considering the say that organizations have in decision making affecting their outcomes, two factors can therefore be considered, their decision-making leverage (e.g., the ability to affect the decision-making process and results), and their decision-making capacity (e.g., the extent to which they are equipped to make decisions). An organization's decision-making leverage is very dependent on its relative power position, and the decision-making capacity is affected by the level of uncertainty about the external environment. Organizations use different coordination strategies to affect their decision-making leverage and capacity in an effort to make better decisions and meet their objectives. In a chain of businesses, less powerful actors can increase their leverage in decision making by forming horizontal alliances (i.e., cooperatives, producer organizations). Vertical coordination strategies (i.e., contracts, collaboration, information sharing, etc.) can be used to reduce uncertainties and thus influence decision-making capacity. Procedural fairness perceptions are strongly related to the ability to influence decision making. The ability to make decisions also directly influences distributive fairness perceptions as decision-making is the process by which organizations produce outcomes. Better decision-making leads to better outcomes and thus more distributive fairness.

This research has identified several factors that influence perceptions of IOF and could therefore potentially be used to develop proxy indicators of the construct for use in a simulation model. However, these factors differ in terms of ease of quantification. In the next section, in line with the study objectives, indicators of IOF along two dimensions will be selected among the factors that have been analysed.

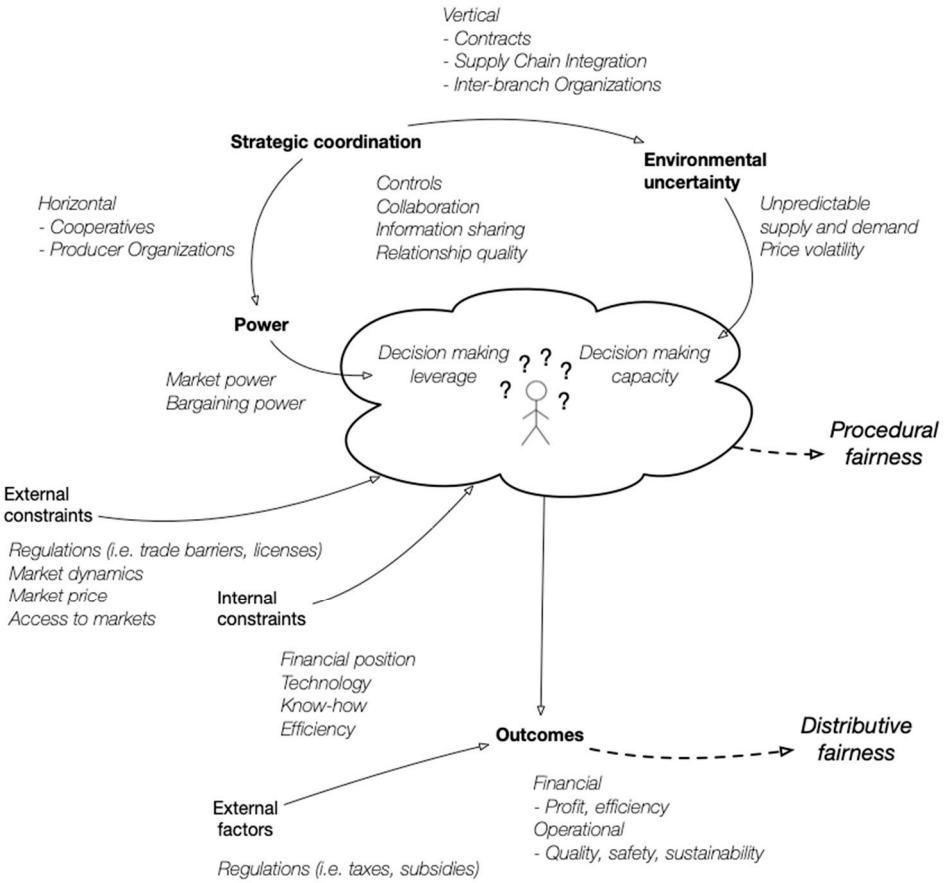

Figure 4. The factors related to IOF viewed in the context of organizational decision making. Perceptions of distributive fairness depend on outcomes and perceptions of procedural fairness depend on the influence individual actors have on their outcomes. Prominent factors impacting such perceptions are power dynamics, environmental uncertainty, and coordination strategies.

4.3. Suggested Simulation Model Indicators of IOF

To be applicable for use as a proxy measure of IOF in food systems, a factor needs to be strongly correlated with either distributive or procedural fairness and be quantifiable in such a way that it can be made operational in a simulation model. Two factors, financial outcomes and power, meet these conditions. The link between financial outcomes and perceptions of distributive IOF have been repeatedly confirmed in research on interorganizational relationships, and their monetary nature makes them easily quantified. In particular, profit margins, as a measure of financial outcomes, are especially suitable as proxy measures of distributive IOF. This is due to the way in which they concern not just outcomes but outcomes relative to inputs and thus can be compared to the outcomes of other chain partners of different types and sizes.

Power in interorganizational relationships, both in the form of market power and bargaining power, has been strongly linked to procedural fairness. Most recently, the pass-through report by the European commission specifically highlighted the importance of power in relation to UTPs in European agri-food chains [2]. Well known measures of market power (e.g., mark-up and mark-down models) exist in the economics literature, and bargaining power in buyer-supplier relationships has been quantitatively measured in terms of the relative strategic significance of actors and their available alternatives (i.e., [55]). Bargaining power, measured as company size (i.e., total assets or total revenues) and number of available suppliers/buyers, and market power, measured by the Lerner index (for seller power) and a mark-down index (for buyer power), are suggested as proxy measurements of procedural IOF.

The Lerner index of monopoly power is a widely adopted metric which provides an estimate of seller market power in an industry, measuring the price-cost margin through the difference between the output price of a firm and its marginal cost (e.g., the cost of producing one additional unit) divided by the output price. The greater the difference between the price and marginal cost (e.g., the price mark-up) the greater the monopoly power [77]. The Lerner index is used for the output market (e.g., seller market power) but analogically, a price mark-down index can be defined for the input market (e.g., buyer market power) [78]. Both indices can be used as measures of the departure from perfect competition, and as such, they can be considered as proxy measures of procedural fairness. The indices range from a high value of 1 to a low value of 0, with a higher number implying greater market power, hence, less procedural fairness.

The measurement framework for IOF resulting from this research is presented in Figure 5. This is a quantitative model operational definition of distributive and procedural IOF in the form of proxy variables and quantitative indicators.

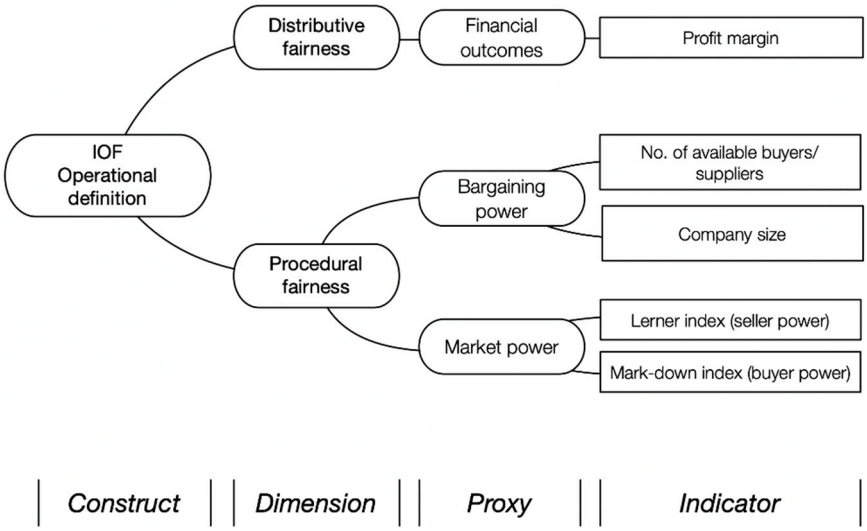

Figure 5. Resulting measurement framework of IOF.

To be able to use these indicators to estimate IOF in a simulation model, there is a need to establish how the indicator outcomes will be interpreted. Research suggests that fairness perceptions are based on comparisons. Hence, the perceived fairness of an outcome is not only related to the level of that outcome but rather the way in which the outcome compares to the outcomes of others. Therefore, in order to estimate overall fairness, the distribution of the suggested indicators can be analysed in terms of its central tendency and spread (e.g., variability). If it is presumed that the highest level of distributive IOF would occur when all actors in a chain of businesses have the same profit margin the symmetry and spread of the profit margin distribution can be used as a measure of the overall distributive IOF. More symmetry can be interpreted as more fairness. Full symmetry occurs when the mean (average), mode (most frequent), and median (middle) values of a distribution fall on the same point (i.e., normal distribution). Skewness is a measure of the deviation from symmetry e.g., the larger the difference between a distribution's median or mode (depending on data) and its mean, the more skewed and hence asymmetrical it is [79]. In a chain of businesses where the most frequent level of profit margins (mode) and the median profit margin are lower than the average profit margin (mean), it would mean that few actors have considerably higher profit margins than the bulk of the actors. The closer the average profit margin is to the most frequent level of profit margins, the fairer the distribution of profits can be presumed to be (see Figure 6). In a similar manner, variability can indicate unfairness. Spread is used to measure the variability within a sample or a population. The more spread out the distribution of profit margins in a chain of businesses, the more likely it is that the actors in the low range perceive their position as unfair.

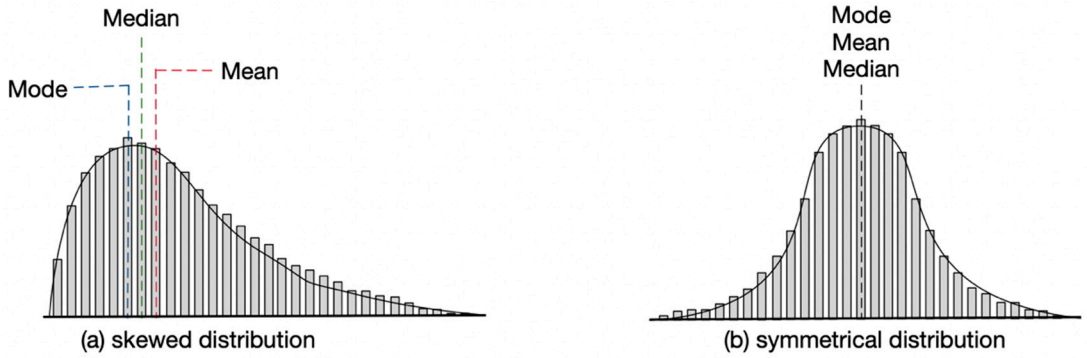

Figure 6. Examples of (**a**) skewed and (**b**) symmetrical frequency distributions of profit margins; (**b**) would be considered fairer than (**a**) as more actors have a profit margin that is close to the average profit margin.

Correspondingly, the overall procedural IOF can be estimated using the distribution of the number of available suppliers/buyers and total sales/assets (for bargaining power) and the distribution of the Lerner and mark-down indices (for market power). In Table 3, the indicators and the interpretation of their results are described in more detail. Every one of these indicators may be used independently to measure a single aspect of fairness, or alternatively, more than one measure can be combined to estimate fairness along both the distributive and procedural dimension.

Table 3. Resulting indicators of IOF including computational method and result interpretation.

	Proxy	Measure	Computation	Result Interpretation
Distributive fairness	Financial outcomes	Profit margins	Revenues less expenses divided by revenues.	More skewness and spread of the distribution of profit margins (e.g., more difference between the distribution mean and median/mode and more variability) means less overall distributive IOF.
Procedural fairness	Bargaining power	No. of available suppliers/buyers	The number of suppliers (buyers) the individual buyer (supplier) can do business with.	More skewness and spread of the distribution of available suppliers/buyers (e.g., more difference between the distribution mean and median/mode and more variability) means less overall procedural IOF.
Procedural fairness	Bargaining power	Company size	The total sales/assets of an individual actor.	More skewness and spread of the distribution of total sales/assets (e.g., more difference between the distribution mean and median/mode and more variability) means less overall procedural IOF.
Procedural fairness	Seller market power	Lerner index	The difference between the output price of a firm and its marginal cost divided by the output price.	More skewness and spread of the distribution of price mark-up (e.g., more difference between the distribution mean and median/mode and more variability) means less overall procedural IOF.
Procedural fairness	Buyer market power	Mark-down index	The difference between the input price of a firm and its marginal cost divided by the input price.	More skewness and spread of the distribution of price mark-down (e.g., more difference between the distribution mean and median/mode and more variability) means less overall procedural IOF.

5. Discussion and Conclusions

The aim of this study was to operationalize IOF in an effort to facilitate research on the topic using quantitative modelling. Due to the topicality and policy relevance of fairness it is valuable to explore the subject further using quantitative methods (i.e., simulation modelling), especially in the context of food systems where fairness issues are prominent. By analysing the immediate factors leading to and from IOF, certain aspects of interorganizational relationships have been identified as being more important than others when it comes to perceptions of fairness. Financial outcomes are closely related to the fairness of the distribution of rewards among chain partners and the fairness of the procedures leading to the distribution of these rewards is dependent on the perceived influence of individual actors over their resulting outcomes. Prominent factors impacting such perceptions are power dynamics, environmental uncertainty (i.e., in terms of supply, demand, and price), access to information, and coordination strategies. Based on these factors that have been linked to fairness perceptions, five quantitative proxy indicators that can be used to estimate the level of both distributive and procedural fairness in interorganizational relationships have been identified. Statistical analysis (e.g., measuring skewness and spread of a frequency distribution) is used to translate the indicator outcomes into levels of fairness.

Research suggests that fairness perceptions are based on comparisons. Hence, the perceived fairness of an outcome is not only related to the level of that outcome but the way in which the outcome compares to the outcome of others. Indeed, fairness issues in food value chains seem to relate to the asymmetric distribution of power and profit [6]. In agri-food chains in particular, few actors, mainly retailers and some processors, have exceedingly more power and higher profit margins than a mass of farmers that are often barely profitable and thus perceive their position as unfair. The asymmetry of these distribitions reflects the consolidated market structures that are well known in modern food systems. Excessive concentration brings with it power imbalances within a chain of businesses, potentially leading to UTPs and other fairness issues [1]. In fact, fairness issues were brought to the political agenda mainly by the pressure from farmers to enforce "fair" prices and to protect them against abuse of power by large food companies [2].

Complicating the task of dealing with fairness issues is their inherently subjective nature. The perceived level of fairness is dependent on both the context and the perspective. While market power and unequal bargaining between farmers and more concentrated market segments can undeniably negatively affect farmers, research has indicated that the relationship between concentration and power is complex. Moreover, the concentration can have positive welfare effects such as efficiency gains, transaction cost reductions, countervailing power, and investment in research and development, eventually benefitting consumers through lower prices [80]. Moreover, while the interests of farmers and consumers might not be aligned, reserch on the negative consequences of market concentration and resulting power asymmetries for farmers are not inconclusive either. Swinnen and Vandeplas [80] point out that the benefits for small farmers in developing countries of inclusion in modern supply chains to some extent outweigh the negative consequences of concentrated market power. Research has also indicated that imperfect competition is not the only reason for the widening margin between consumer and farm gate prices of food. Alternative contributing factors have been suggested, such as an increased degree of processing resulting from more focus on product differentiation, the implementation of standards and regulations relating to safety, quality and sustainability, differences in productivity growth across sectors, agricultural policy reforms, and increased international trade [81].

While, the extent of the negative effects of excessive concentration in food markets and the resulting power asymmetries is debatable, the fact still remains that, at least to some extent, the less powerful agents in European food chains perceive their position as unfair [2]. According to research on fairness in interorganizational relationships, the indicators resulting from this study are linked to these perceptions, as antecedents, consequences,

or both. Although, the perfect level of fairness for all actors in a food system will never be reached, there is value in using these factors to guide us towards a food system that is fairer for more agents. Further limitations of his research relate to the constraints of quantitative modelling in terms of the types of data that can be operationalized within a model in a meaningful way and restrict opportunities for measuring IOF. The conceptual analysis of the construct resulted in a number of factors whose causal relation to fairness have been confirmed by research. However, it was concluded that only two of those factors, financial outcomes and power, could be made model operational. This creates limitations as it means that each dimension of IOF is only measured based on one of many known aspects. Nevertheless, in an effort to further knowledge on the subject of IOF, it is valuable to study it using quantitative modelling even within those limitations. The advantage is that the fairness indicators are very general and can therefore be used to study different types of food systems and in fact any system of interfirm relations.

Although food systems share many important characteristics, they differ in some aspects affecting the prelavence and extent of fairness issues including power asymmetries and profit distribution. Therefore, the distribution of the selected indicators of fairness within distinct food systems will vary. A notable example concerns the position of farmers in agri-food chains compared to the primary producers in aquaculture. The disadvantaged bargaining position of farmers, partly resulting from extensive concentration at the processing and retail end, is well dcoumented [1]. The position of the primary producers in aquaculture value chains, who benefit from favourable market conditions (e.g., demand far exceeding supply) and typically claim a proportionally large share of the value distribution is vastly different [72]. Even different sectors within agri-food vary in terms of power asymmetries and profit distribution. Such differences can to some extent be attributed to differences in the extent of horizontal coordination within individual chains. Cooperative and producer organization membership is one of the main mechanisms used by farmers to improve their bargaining position [55], and research has indicated that members are less likely to be subject to UTPs [2]. Furthermore, a strong cooperative presence in the market has been found to result in higher prices for all farmers, including those who do not belong to a horizontal alliance [64].

The operational definition of IOF resulting from this study in the form of indicators enables the exploration of problems related to fairness in food value chains and the development of possible solutions. In relation to policy, these results provide indications of where policy intervention efforts aiming to increase fairness perceptions should be concentrated and give opportunities to test these intervention options using quantitative methods such as simulation modelling. Furthermore, the process of operationalizing a social construct for use in a simulation study can be replicated for other social constructs that are interesting to study using simulation, in particular policy relevant constructs.

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