

Determination of asymmetric information in multistage agricultural Supply Chains: A sequence of research activity

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Abstract

Due to the increasing globalization and the resulting emergence of new market participants, the issue of information asymmetries is of immense importance. Based on globalization, increasingly complex network supply chains are emerging in which information transparency between the actors is insufficiently pronounced. The occurrence of information asymmetry (IA) is particularly pronounced in agricultural supply chains, where different types and sizes of actors, such as small farmers, large producers, or small retailers etc., are involved in the supply chain. The insufficient information transparency in the food value chain, is the result of IA, which leads to mistrust between the actors involved and ultimately to opportunistic behavior among the actors. In this regard, it was of utmost necessity to identify, define and reduce the IA in food supply chains between the actors. The aim of the research project will be to extend the current state of knowledge regarding the topic of information asymmetries by defining variables influencing asymmetric information and calculating information asymmetries. To be able to achieve the goal of the research project, quantitative (e.g., surveys) and qualitative (e.g., expert interviews) empirical methods were used. Prior to this, an extensive literature review was undertaken to identify possible variables influencing asymmetric information, which also served as a basis for the quantitative and qualitative analysis in which the

entire supply chain, starting from the seed producer to the end customer, was considered. In the course of this, "neutral actors" such as consulting companies, agricultural cooperatives and food networks were also consulted. They were able to provide extensive insight into possible variables influencing information asymmetry. Through the presentation of the research gap as well as the definition of these variables a comprehensive influencing variables model could finally be created. Furthermore, essential future research actions such as the explorative investigation of variables influencing information asymmetry and a possible IA calculation method, which could be useful, were roughly outlined. In conclusion the topic of information asymmetries in food value chains is highly complex, but this research project allows us to structure IA and make it more informative (or: accessible) for science.

1. Introduction

One of the essential realities of today is the emergence of globalization [1, 2]. With globalization, numerous new networks of international markets and the accompanying increase in the interaction of market participants have emerged [3]. Numerous industries, such as the automotive, chemical, electrical, mechanical engineering, and even the food industry, exhibit internationalization of markets [4]. Especially the food industry shows an extensive internationalization of its market, which is driven

by increasing prosperity and urbanization as well as the growing importance [5]. Due to the changing market structures of the food industry, consumers have extensive access to food products which can be sourced out of season [6]. Although globalization brings many benefits to the food industry, it also creates many challenges over time, which are of concern to many market participants. One of the main challenges is the food value chain. In recent decades, the food value chain has evolved from a simple value chain with linear processes, where raw materials and products are delivered directly to the consumer, to a complex network-like value chain, which is characterized by an immense opacity resulting from the multitude of interconnected actors, starting from the seed producer and its associated sub-suppliers to the end customer [7]. Numerous challenges result from this constellation of the value chains, such as guaranteeing the sustainability of the product to the end customer, since the complexity of the value chain makes it difficult to ensure quality and product safety when processed and transported by a multitude of different actors [8]. Consequently, one of the main challenges of the food industry is the emergence of information asymmetries, especially at the level of small low-turnover actors, which have less access to information and resources than larger and more diversified companies [9]. Not only the IA within the food value chain, but also the IA at the level of end consumers is supposed to be very high, which is due to the increasing opacity and lack of transparency in the supply chain. Uncertainty of the end consumer about the food production, the ingredients as well as the origin of the food represent the central and essential causes of the emergence of IA on the part of the end consumer [10]. Basically, IA means that there is an inequality of information on the side of one market participant (e.g., supplier) compared to the other market participant (e.g., buyer). The seller's side is characterized by an information advantage and the buyer's side by an information deficit, which ultimately represents the basic understanding of IA [11]. The emergence of IA and the associated information inequality can bring various consequences for the market. For example, market prices can be based on imperfection of information, which is ultimately a disadvantage for the final customer [12]. Not only is this the consequence of IA, but also the emergence of opportunistic buying behavior, which results in market failure and the emergence of a welfare loss [13]. Several decades ago, the economist Mr. G.A. Akerlof addressed the issue of the emergence of IA and published his book "The Market of Lemons". Ref. [14] established the main structures of information asymmetries. Akerlof stated that there

are two main types of IA, namely ex-ante information asymmetries (information asymmetries that occur before a contract is initiated; he called them 'adverse selection') and ex-post information asymmetries (information asymmetries that occur after a contract is initiated; he called them 'moral hazard'). In line with the above-mentioned types of information asymmetries, Akerlof defined some possible solutions that could lead to a reduction of IA. Ex-ante information asymmetries should be counteracted by signaling, self-selection or screening and ex-post information asymmetries by monitoring or bonding [14]. One of the most important theories, which is essential when considering information asymmetries, is the principal-agent theory. The principal-agent theory enables the characterization of the cooperating market sides. Thus, the principal represents the market side that has an information deficit (e.g., buyer) and the agent represents the market side that has information advantages (e.g., seller) [15]. Thus, the current state of research can define the types of prevailing IA as the associated solution approaches, which can be invoked to reduce each type of IA. Not only this, but also the characterization of the pairs of actors cooperating with each other and the occurrence of the IA can be enabled by the principal-agent theory. However, the current state of research neglects this essential point in the consideration of information asymmetries, namely the identification of the information asymmetry influencing variables (IAIV), in other words, those variables which are responsible for the development of IA. Not only the aspect of the identification of the IAIV received insufficient or even no attention, but also the aspect of finding a possible computation model aimed at computing the IA between the pairs of actors as well as the entire creation of value chain. Calculating the IA could help to determine the concrete level (degree) of the foreseeable IA, making statements about its intensity between the pairs of actors and enabling a more precise approach of possible solutions in order to reduce the prevailing IA [16]. Thus, this paper describes an advanced research project considering the following points:

- Identification of the Research Gap.
- Definition of the IAIV based on the literature available.
- Explorative investigation of the IAIV.
- Formulation of the model to calculate the prevailing IA.

The aim is to present the research project in terms of divided stages (see above) of the procedure as well as the individual results achieved and still to

be achieved in order to enable a theoretical treatment of the following research questions (1-3):

1. Which influencing variables can lead to the development of information asymmetries within a supplier-buyer relationship?
2. What impact do certain influencing variables have on the frequency and intensity of information asymmetries in supplier-buyer relationships within the food industry?
3. How can information asymmetries that may occur in the context of food industry be identified within supplier-buyer relationships?

Finally, from the results already achieved so far and the research results yet to be achieved, the basic understanding towards IA can be enhanced. This paper is organized as follows: First, the procedure of literature review to identify the research gap and its results are presented. Subsequently, the procedure of identifying IAIV and the resulting outcome of the influencing variable model is summarized as well as empirically verified. Finally, a hypothetical view of the IA computation model is provided following a critical discussion and a summary.

2. Research Methodology

The topic of information asymmetries belongs to the most complex as well as intangible theories, which finds its existence in almost every research area [17]. Due to the complexity of the topic of information asymmetries, the current state of research only deals with the definition of the types of information asymmetries, the appropriate assignment of solution approaches and the use of the principal-agent theory for the more accurate characterization of the cooperating actors [14, 15]. In order to make the topic of information asymmetries more understandable, tangible, and accessible to the scientific community, a structured approach is targeted, as in Figure 1, as well as a comprehensive research methodology is applied, see Table 1.

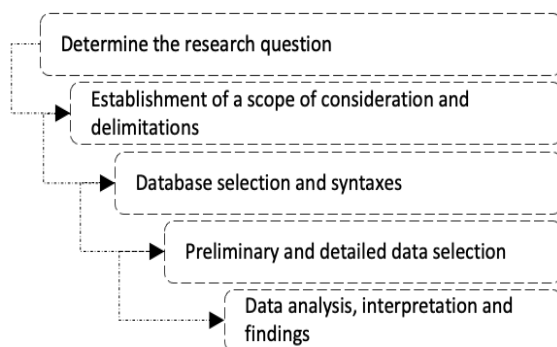


Figure 1: Systematic Approach of the Methodology

Table 1: Methodology depending on the sub-research project

(1) Research Gap Analysis		
Paper-Title	Methodology	Phase
<i>Asymmetric Information in Agriculture Supply Chain Management</i>	<i>Structured Scientific Paper Content Analysis</i>	<i>Done</i>
(2) Identification of Asymmetric Information in Agricultural Supplier-Buyer Relationships: A Theoretical Analysis		
Research Question	Methodology	Phase
<i>Which influencing variables can lead to the development of information asymmetries within a supplier-buyer relationship?</i>	<i>Structured Scientific Paper Content Analysis</i>	<i>Done</i>
(3) Empirical Analysis of the Identification of Asymmetric Information Variables in Agricultural Supplier-Buyer Relationships		
Research Question	Methodology	Phase
<i>(1) Which influencing variables can lead to the development of information asymmetries within a supplier-buyer relationship? (2) What impact do certain influencing variables have on the frequency and intensity of information asymmetries in supplier-buyer relationships within the food industry?</i>	<i>Qualitative and Quantitative research methodology based on expert interviews from seed producer to retailer</i>	<i>In Progress</i>
(4) Calculation Method of Potential Information Asymmetries		
Paper-Title	Methodology	Phase
<i>Quantifying of Asymmetric Information in Multi-Level Value Chain through the operationalization of information</i>	<i>Algorithmic information content calculation method</i>	<i>Off</i>
<i>"How can information asymmetries that may occur in the context of food industry be identified within supplier-buyer relationships?"</i>		

Figure 1 shows the basic procedures for the consideration of the individual research steps, but each sub-research project has a minimally different methodological approach, which was defined for the achievement of the goal. In Table 1, the individual sub-research projects with the

associated methodology are presented in broad terms, which will be discussed in more detail in the course of the paper.

Ultimately, the last research question presented can be answered through stages 1-4, Table 1.

How can information asymmetries that may occur in the context of food industry be identified within supplier-buyer relationships?

The following is a detailed examination of each research stage and its sub-results, beginning with the research gap analysis.

3. Results and Discussion

3.1 Sub-Result 1: Research Gap Analysis

In order to analyze the information asymmetries in the field of the sustainable food industry and its value chain, an extensive research of possible research gaps in this field is required. Thus, sub-result 1 presents the approach as well as the results of the research gap.

In Paper 1, problems caused by asymmetric information in food value chains, especially in the organic food market, will be investigated in a comprehensive analysis.

- The main reason for considering sustainable food is the exponentially increasing consumption of sustainable food and consequently the ever-increasing demand for sustainably produced products [18].
- Another major reason for considering the food value chain is the presumed complexity of the value chain, justified by the numerous different actors from seed producers to retailers, as well as processes such as processing, packaging, storage, transportation, and sales. This complex design of the considered supply chain makes it difficult to obtain a comprehensive understanding of the food value chain as well as to identify possible problems [19].

Thus, the transparent design of the food value chain is of utmost necessity to make the problem of IA in the organic food market tangible to the scientific community. In order to provide comprehensive information on the topic under discussion, the paper intends to introduce the principal-agent theory as a basic model for understanding IA in the food value chain. In order to gain a comprehensive insight into the current research in the field of information asymmetries applying the principal-agent theory, a structured literature review was conducted, and significant sources are shown in Figure 2.

3.1.1. Sub-Results 1

The topic of information asymmetries based on the principal-agent theory has gained immense progress in recent decades, as the topic of information asymmetries is becoming increasingly important, and its study is considered a necessity [21]. Nevertheless, the extensive literature review has revealed numerous research gaps that the current scholars have insufficiently considered:

- In order to keep the complexity of the IA in check, the principal-agent theory was only used for the analysis of a pair of actors and neglected the application in complex multi-stage value chains [22].
- The basic model of the principal-agent theory neglects in its analysis neighboring disciplines, such as the transaction cost theory or game theory approaches, which makes the principal-agent theory insufficient [23].
- Numerous literature sources take up the topic of the IA quite extensively, however, mostly on a theoretical basis and neglect the empirical view [24].
- What is completely neglected in literature is the identification of variables influencing IA as well as the possibility of calculating the IA between the actors in order to receive information about whether the IA present represents a low, middle, or high characteristic of the asymmetry.

3.1.2. Future Research

In section 3.1.1, several points were identified which can be defined as potential research gaps. Future research should be dedicated to the identification and calculation of information asymmetries on the level of multi-stage food value chains and to disprove them by means of an empirical investigation.

A detailed consideration of the literature analysis for the identification of IA influencing variables follows in section 3.2.

3.2. Sub-Result 2: Identification of information asymmetry influencing variables

Paper 1 (see above) has laid down a directional path with which scholars should look at information asymmetries in future. Paper 1 could show various research gaps which can only be analyzed by a structured approach. Thus, as a subsequent step, the identification of IAIV is required. Information asymmetry influencing variables are factors which affect the characteristic of the IA by their presence or nonexistence both on the part of the supplier and on the part of the buyers.

Depending on whether a certain factor

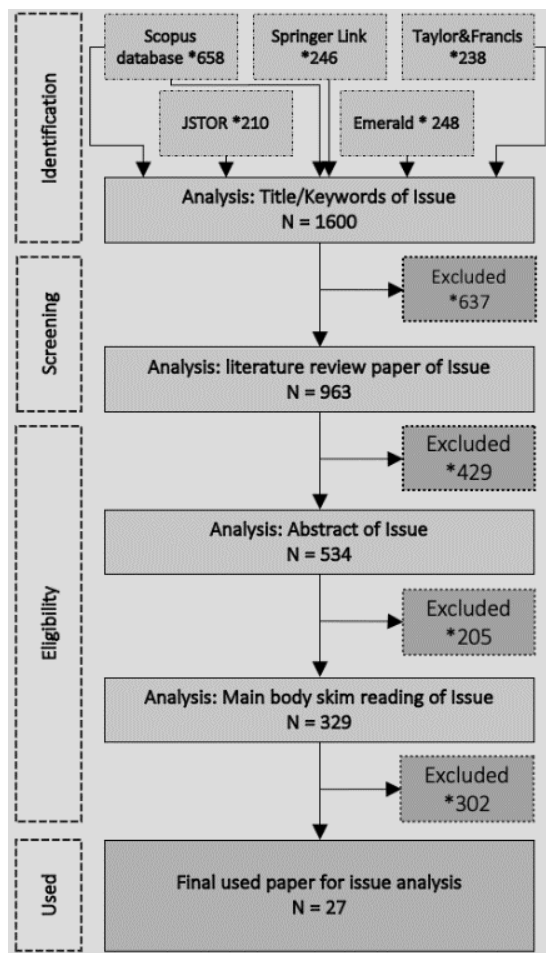


Figure 2: Systematic literature review to find the research gap (Modified from [20])

(e.g.: the presence of ERP systems with the supplier or vice versa) is of importance to the seller or the buyer and is not observed by the supplier or buyer, it can be assumed that this leads to a pronounced IA on the side of the supplier or buyer concerned. In order to be able to identify the described hypothetical consideration of the IA influencing variables, an extensive, detailed literature analysis was carried out. In order to use the Scopus data base purposefully and finally to receive the necessary literature, 17 syntaxes (e.g.: Information AND Asymmetry AND Food) were provided, which finally resulted in a structured literature analysis, figure 3.

3.2.1. Sub-Results 2

In the analysis of the individual papers, it already became apparent that the IA and its emergence can be attributed not only to the food value chains, but also to various other areas such of physics, computer science, etc. [17]. In this regard, an operationalization model had to be created as framework to select the necessary literature from the set. The framework model consists of three factors, namely the (1) measurement method of direct and indirect survey methods (social behavior), (2) management systems (3) further

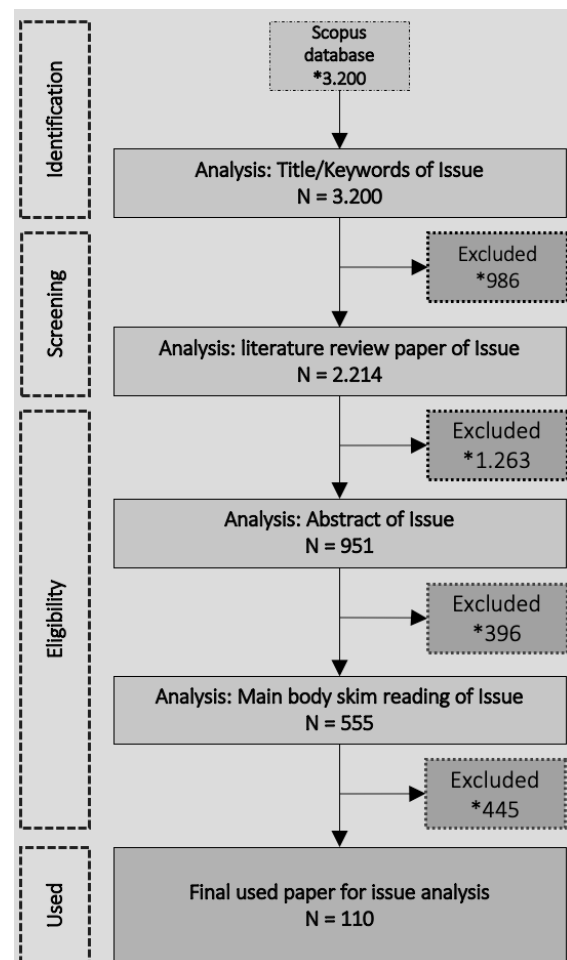


Figure 3: Systematic literature review for identification of information asymmetry influencing variables (Modified from [20])

IAIV. The intensive and detailed analysis of the paper according to these points led to the identification of numerous IAIV. Thus, this analysis resulted in a total of 8 IAIV groups with a total of 63 IAIV. Finally, based on the content analysis, a preliminary influence variable model could be created in which the 8 influence variable groups and selected information asymmetry influencing variables were recorded, Figure 4.

3.2.1. Future Research

After an extensive literature analysis, a detailed influence variable model could be created, which is only based on theory. Therefore, for future considerations of information asymmetries within the supplier-buyer relationship in the food value chain an empirical verification of the model in figure 4 is required.

3.3. Sub-Result 3: Empirical Analysis of the Identification of Asymmetric Information Variables

In the following, after having identified a great number of IAIV on the basis of an extensive literature research, an empirical investigation of

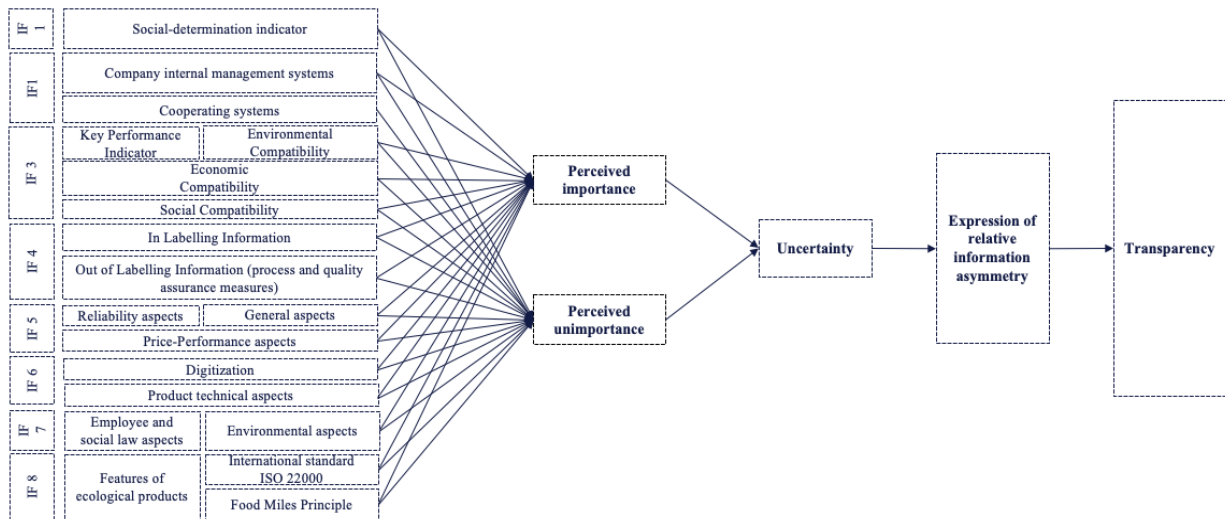


Figure 4: Information asymmetry Influencing variable model

the influencing variables as well as of the entire influencing variable model will be undertaken. The empirical investigation intends to answer the following research question:

“Which influencing variables can lead to the development of information asymmetries within a supplier-buyer relationship?”

3.3.1. Qualitative analysis of the information asymmetry influencing variables

In the qualitative study, the IAIV discovered in literature (Figure 4 no. 1) are to be confirmed and additional influencing variables should be determined. As the prevailing data basis for the determination of information asymmetric variables is small, the Mixed-Methods-Analysis was used for the creation of a new data basis, for which expert interviews as well as surveys are conducted, since this is an explorative research project. In order to gain a comprehensive insight into the influencing variables, expert interviews of an entire food supply chain were carried out, starting from the seed producer to the retailer [25]. In addition, expert interviews were also conducted with so-called "neutral actors", such as consulting companies, food networks and agricultural cooperatives, as they have a more comprehensive overview of the entire food supply chain and have information on both the suppliers and the buyers. Finally, 16 expert interviews and surveys were conducted in total. The expert interviews were recorded for the analysis and transcribed afterwards and analyzed in the WinReLan analysis tool to finally determine interlinked and common statements of the experts regarding the influencing variables [26].

Sub-Results 3

As the analysis of the expert interviews is still in progress (February 2023), only some of the IAIV identified in literature can be determined at this stage, such as the existence of management systems. In addition, a great number of other influencing variables have been determined, for example political conflicts, but these are currently subject to a more detailed investigation.

Future Research

Since the identification of the IAIV is still at an early stage of the analysis, only hypothetical projects can be undertaken for future research. After numerous variables based on literature have been determined and, in addition, new variables not previously considered have been identified, the future research project requires an empirical analysis of (Figure 4 no. 2), as well as the entire model of influencing variables, in order to ultimately make statements about the extent of IA within a supplier-buyer relationship. This requires answering the following research question:

“What impact do certain influencing variables have on the frequency and intensity of information asymmetries in supplier-buyer relationships within the food industry?”

3.3.2. Quantitative analysis of the information asymmetry influencing variables

Approach and Methodology

The quantitative section of the following presentation is based on a hypothetical analysis since the results of the qualitative analysis from section 3.3.1 are necessary for this. In the quantitative analysis, the individual steps of the influence variable model in Figure 4 are analyzed:

- Perceived importance (IAIV that are perceived as important)
- Perceived unimportance (IAIV that are perceived as unimportant)
- Unimportance (importance (IIV) in relation to presence)
- Expression of IA
- Transparency of the supply chain under consideration

The objective of this analysis is to answer the following research question:

“What impact do certain influencing variables have on the frequency and intensity of information asymmetries in supplier-buyer relationships within the food industry?”

In order to determine the frequency and intensity of the IA and ultimately to confirm the influence variable model, the transcripts and surveys from the qualitative analysis are used and processed for quantitative analysis.

The transcriptions and the surveys are subsequently adjusted with regard to their data structure and made available for the analysis tools R-Studio and Python. Thus, by performing principal component analysis, factor analysis, regression analysis of the IAIV (Figure 4 no. 1), the influences on the factors (Figure 4 no. 2) can become visible. Ultimately, the analysis should allow the adjustment as well as the confirmation of the influence variable model to predict IA.

Future Research

In section 3.2.2, the influencing variables model derived from literature could be determined, starting with the IAIV and ending with the characteristics of the IA. In the analysis of the influence model, only the view of the actors within the food supply chain has been considered so far. Information asymmetry and its possible manifestation at the level of the consumer at the end of the supply chain as well as the possible calculation of the degree of IA in order to determine whether there is a low, medium, or high degree of IA in the supplier-buyer relationship have not been considered to date.

4. Conclusion and future work

The topic of information asymmetries concerns various scientific disciplines in numerous contexts. Ref. [14] has done the fundamental work to distinguish the information asymmetries by their nature and to define a suitable solution approach to reduce the prevailing IA. Furthermore, the principal-agent theory is used by considering the IA which enables for the characterization of the supplier-buyer relationship. The determination of

IAIV as well as the calculation of IA has been insufficiently researched until now and should be the basic objective of subsequent studies on the subject of information asymmetries. Due to progress in current research (point 3) it will be possible in the foreseeable future to determine potential influencing variables which are responsible for the expression of IA in supplier-buyer relationships. Future studies should build on this research status to further analyze the IA at the level of the retailer towards the end-customer and test the following hypothetical assumption: "It can be assumed that the IA along the food value chain is at its peak in the supplier-buyer relationship." In addition, as previously described, future research should address the possibility of calculating IA. The reason for this is the following: If the IA within a supplier-buyer relationship could be determined in terms of its degree, then an appropriate solution can be applied to it in a targeted manner, rather than by arbitrary generalized solution approaches. Furthermore, the exploratively modeled calculation model of IA should be subjected to an empirical analysis based on a multi-stage value chain. Finally, the main research question "How can information asymmetries that may occur in the context of the food industry be identified within supplier-buyer relationships?" should be answered.

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