

# Bilateral information asymmetry in a Supply Chain: a review and a coordination mechanism analysis

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**Abstract:** Supply Chain coordination is an essential aspect of managing Supply Chain networks, which involves aligning the interests of multiple parties to achieve common objectives. However, coordinating a Supply Chain can be challenging, particularly when the parties involved have different information, which can lead to different bargaining powers and bilateral asymmetry of information. Despite its relevance to the current production context, few works focus on the bilateral asymmetry of information. To stimulate research in this vein, the main objective of the work concerns the identification of the main factors to set a problem statement for Supply Chain coordination problems in the presence of bilateral asymmetry and then analyse the coordination mechanism proposed in the literature for this research area for the identification of the main problem to be addressed with bilateral asymmetry of information. To achieve this goal, a literature review is presented. The analysis that the main issue concerns the lack of trust of the individual actors in the sharing of information in each with the strategic and financial motivations. Such an approach is justified by the local vision of the individual actors who fail to fully perceive the advantages of a global optimisation, and thus of the entire Supply Chain.

**Keywords:** Supply Chain; bilateral; asymmetric information

## I. INTRODUCTION

The system of organisations, people, activities, information, and resources involved in moving goods from their point of origin to their point of consumption is known as the Supply Chain. The Supply Chain covers the entire production process, from obtaining raw materials to delivering the finished product to the customer. The significance of considering the entire Supply Chain rather than just the individual actor becomes an increasingly necessary requirement in the current production context, which is marked by such competitiveness. Industrial and commercial businesses today operate in a complex environment that necessitates the participation of all supply network participants in order to generate value in the form of goods and services for the end consumer, regardless of their industry or competitive position. In order to meet customer expectations, manufacturers, suppliers, distributors, and all other Supply Chain participants have moved from adversarial relationships to established partnerships [1].

As a result, no organisation exists in isolation; rather, it is a component of a larger network of connected companies. Companies must coordinate their actions with those of other companies in the same Supply Chain in order to accomplish their goals. However, these interdependencies also raise overall risk, endangering the accomplishment of common objectives. This reality and the requirement for careful risk management are highlighted by the significant developments in recent years in all sectors, with increased collaboration between Supply Chain levels [2]. Integration needs to be both technically and strategically sound. Industry 4.0 has brought advancements to industrial plants, including the ability to monitor processes in real-time and control them online through feedback based on parameters considered crucial for the system's proper functioning. The system collects and centralizes peripheral data from the process, transforming it into usable information using state-of-the-art simulation tools like Digital Twin and Cyber-Physical Systems[16][17][18]. In this context, the Digital Supply Chain plays a key role

in enhancing knowledge throughout the entire Supply Chain, through the multiple platforms installed, such as ERP-Enterprise Resource Planning, MRP-Material Requirement Planning, and CRM-Customer Relationship Management [3].

Due to the industry's intense competition, sharing certain information actively is necessary for such optimisation, but this can be challenging. As a result, rather than achieving a global level of optimisation, optimisation efforts might be restricted to a local level. In fact, one of the main challenges to achieving global coordination and integrated optimisation of the entire Supply Chain coordination is the lack of information sharing among the various actors and levels of the Supply Chain. In this regard, Supply Chain Coordination is a branch of research that has as its objective: the search for the optimum in a Supply Chain; the improvement over an uncoordinated solution; the search for a feasible solution that takes the entire system into account. As a result, Supply Chain Coordination becomes a key aspect when it comes to information asymmetry, which although it is true that on the one hand ensures competitive advantages for the actor with greater bargaining power, and allows for the development of different commercial strategies and bargaining; on the other hand given the increasingly uncertain market and higher and higher capacity costs, having even just a coordinated management of stocks on the various actors could considerably reduce costs and optimise the overall performance of the Supply Chain. This type of reasoning, however, would presuppose, as anticipated, an active exchange of certain information of the individual actor that is difficult to share, leading to a limited and local rather than global type of optimisation [4]. In order to resolve this gap, the literature has opened up to different strands of research aimed at identifying and studying different coordination mechanisms that could overcome the information asymmetry. Coordination and the different mechanisms proposed are structured according to different case, when it comes to a centralised Supply Chain, optimisation is of all Supply Chain members. When, on the other hand, coordination is of a decentralised Supply Chain, coordination is of the overall objectives but optimisation of the individual. In general, the study of coordination mechanisms to get around information asymmetry's limit has received a lot of attention in the literature. Numerous studies specifically address the unilateral asymmetry of information: where one party involved in the Supply Chain has

access to information that the other parties do not possess. This can lead to an information advantage for one party over the others, thus creating inequality in the information available. However, wanting to extend this issue with reference to today's market, perhaps it would be more correct to speak of bilateral or multilateral asymmetry: where both (or multi) parties involved in the transaction or interaction have information that the other party does not have [4]. In other words, there is a lack of transparency and equality of knowledge between the parties. Despite some features close to the actual context, few studies have been discussed in the literature about coordination mechanisms with bilateral asymmetry. In light of this, the main goals of this paper are a literature review of the principal coordination mechanisms proposed for bilateral information asymmetry, a definition of the primary deciding factors for formulating a problem statement, and the identification of the principal gaps in the current coordination mechanisms proposed for bilateral information asymmetry.

## II. METHODOLOGY

This work has the overarching purpose to analyse how the literature addresses the problem of information asymmetry in a Supply Chain and what coordination mechanisms have been proposed so far. The study does not aim to overview the wide spectrum of literature related to asymmetric information in a Supply Chain, but specifically, the attention will focus on a very delicate branch: the bilateral asymmetry of the information, little treated in literature. Indeed, nowadays, lack of information sharing could have very negative consequences the single companies and for Supply Chain as an entire system, if it is not considered in advance[4].

To develop this study, a systematic literature review has been conducted as a first step. The literature review has been performed using two different information search engines: Scopus and Google Scholar. Scopus is updated periodically and offers about 25000 articles from more than 5000 international publishers; Google Scholar is a very powerful open-access database that archives journal articles as well as conference proceedings, thesis, and reports [5].

In order to conduct a careful study, the methodology reported in Fig. 1 has been adopted. This methodology is characterized by three essential phases: planning the review, conducting the review, and reporting the review. Each phase is further broken down into steps for a total of six

different steps. In this way, quality and useful results to the achievement of the purpose of the study have been obtained.

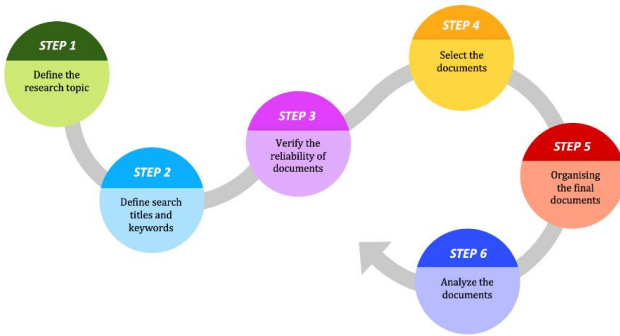


Figure 1. Literature Review steps

First, it is necessary to define the central theme. In this work it corresponds identify which coordination mechanisms are used to overcome the asymmetry of bilateral information in the Supply Chain.

In the second step the keywords and research terms have been defined. This step is very delicate because the choice of keywords affects the usefulness of the results obtained, a balance should be struck between completeness and precision.

At the beginning there was the need to explore the subject more broadly, so the following open-ended keywords were used: “Supply Chain asymmetry information”, “Coordination mechanism Supply Chain” with a result of 855 and 225 documents respectively and “Supply Chain bilateral asymmetry”, with only 23 results. In particular, in order to identify the main coordination mechanisms, these last 225 papers were analysed with the help of the VOSviewer tool, shown in the Figure 2, in which the types of mechanisms and the intensities with which they are repeated in the different papers are shown.

In the third step it was decided which documents should be included for data extraction and analysis, filtering operations are carried out according to inclusion and exclusion criteria to obtain only results relevant to the research aim.

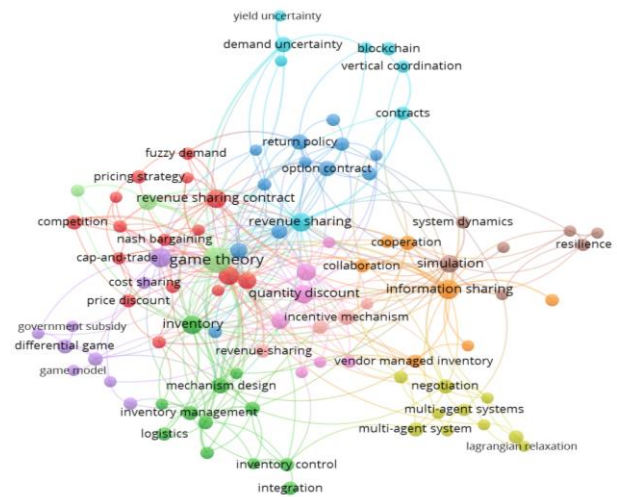


Figure 2. VOSviewer of coordination mechanism with asymmetric information

The selection of documents was conducted in three different stages:

- First stage: analysis of the titles. The analysis of the titles served as a coarse sieve. From the title, if the document seemed to reflect the study object, then it was saved in a dedicated folder. Titles were examined for terms indicating inventory management and models.
- Second stage: examination of abstracts. A careful reading of abstracts served to make a further assessment, going a little more in detail. If the abstract did not contain clear information, in case of doubt the article was saved the same.
- Third stage: preliminary reading of the documents. At this point, only potentially relevant articles had remained. In conclusion, for these last, the introduction, the third chapter and the conclusions of all the remaining files were examined for final selection in order to obtain even more valid results. Regarding the exclusion criteria used in the selection phases, all duplicate and the articles not adherent and relevant to the research were excluded.

The fourth step is focused on quality and eligibility assessment. This step represents a final check, all the operations act as a fine sieve. Only articles and books published by reputable publishers as high-quality research were considered. A correct evaluation was carried out with the help of a bibliometric indicator, ScimagoJR. Through an algorithm, the degree of scientific influence of academic journals is measured; it uses the number of citations received from a journal and the

importance or prestige of the journals from which such citations come.

After all the useful documents have been saved, they were arranged in different folders according to the specific aspect on which they focus. In this way it is easier to quickly find the required documents.

In conclusion, in the last step, the entire papers are studied and analysed to obtain as much information as possible and to extract data.

### III. ANALYSIS

The analysis of the literature revealed that the problem of information asymmetry in the Supply Chain is an issue that has been dealt with extensively as far as unilateral information asymmetry is concerned. Few works, to the authors' knowledge, deal with bilateral information asymmetry. For this reason, the aim of the following paper is to identify which are the main factors which might be considered when setting up a problem statement concerning this issue, and which are the main coordination mechanisms dealt with information asymmetry. In particular, starting with three criteria considered by the authors Vosooghizaji et al. [4] for information asymmetry, and reported in Table 1, this work will begin with the analysis of the sub-criteria revised and updated in this paper to address the issue of bilateral information asymmetry.

#### A. Sub- Criteria

The study and analysis of the papers related to the proposal of coordination mechanisms to overcome the asymmetry of information in the Supply Chain led to the identification of the main decision-making factor (i.e sub-criteria), shown in Table 1, common to all the selected documents, and the related options found for setting up a problem

statement.

In this work, other factors, not common to all documents, are added as main decision-making levers with coordination through negotiation: the order quantity, the setup cost, the order cost, the production quantity, the inventory cost, the inventory level.

#### B. Coordination mechanism

The second objective of this work concerned the identification of the coordination mechanisms proposed for bilateral information asymmetry. To this end, the following Table 2 was initially compiled from the literature analysis and with the graphical aid of the VOSviewer in Figure 2, containing the main coordination mechanisms used in information asymmetry in the Supply Chain, listed in descending order of use.

Coordination Mechanism
Wholesale Price
Menu of Contracts
Quantity Discount
Sharing Contract
Proposal Generation
Side Payment
Two Part Tariff
Buyback Contract
Auction
Mediator
Other mechanism

Table 2. Coordination mechanism

The various coordination mechanisms for the

Criteria	Sub-Criteria	Options				
<b>Supply Chain Feature Configuration</b>	<i>Supply Chain Structure</i>	• Convergent	• Divergent	• Dyadic	• Serial	• Network
	<i>Type of Level</i>	• Manufacturer	• Retailer			
	<i>Number of actors for level</i>	• Single	• Double	• Multiple		
	<i>Number of exchange items</i>	• Single	• Multiple			
<b>Supply Chain Planning Feature</b>	<i>Demand features</i>	• Deterministic: Centralized	• Deterministic: Decentralized	• Stochastic: Centralized	• Stochastic: Decentralized	
	<i>Production Policy</i>	• EOQ	• EPQ			
	<i>Performance metrics</i>	• Order Quantity	• Inventory	• Cost	• Turnover	
<b>Supply Chain Information Coordination</b>	<i>Planning period</i>	• Single	• Double	• Multiple		
	<i>Asymmetric Information</i>	• Unilateral	• Bilateral	• Multilateral		
	<i>Estimates of private information</i>	• Discrete Probability	• Continue Probability	• Local Estimates		
	<i>Coordination Mechanism</i>					

Table 1 - Main decision factor

Supply Chain's bilateral information asymmetry will be examined in the paragraphs that follow. The review of the literature reveals that the wholesale price and the choice of contracts used in the following works serve as the primary coordination mechanism proposed:[6], [7],[8], the latter two also combine bargaining with the AGV mechanism (which takes the assumptions of Bayesian probability and Nash equilibrium [9]).[10], [6] resume the wholesale price contract without the AGV mechanism. Conversely,[11] propose the quantity discount while in [12] the coordination mechanism is based on Stackelberg models and [13]) proposes a mechanism based on the trade mechanism. The main gap between the different coordination mechanisms concerns the reliability of the parties and the misreporting that may occur because the individual tends most of the time to optimise his or her own company, in this regard Qin et al. [14] propose a mathematical model that attempts to overcome a misreporting behaviour while for the same purpose Zissis et al. [7] propose the introduction of a mediator who, downstream from the reports of the individual actors, proposes various alternatives to improve the performance of the entire Supply Chain. The authors Fu et al., [15],instead, propose a blockchain model to reduce the element of subjectivity in the reporting of different information. Following this analysis, therefore, the main problem to be faced in identifying a coordination mechanism in a Supply Chain with bilateral asymmetry of information must concern proposals to overcome misreporting behaviour on the part of the individual actors, such behaviour in fact negatively influencing any type of bargaining. In this regard, it should also be noted how the presence of an element of Governance or a mediator whose objective is to optimise the performance of the Supply Chain while preserving the objectives of the individual can be an element of trust for the actors and mitigate misreporting behaviour.

#### IV. CONCLUSIONS

Bilateral information asymmetry represents a significant challenge in Supply Chain management. The literature reviewed highlights the importance of open communication, information sharing strategies and collaboration between all parties involved to address this asymmetry. Mutual trust and the creation of long-term partnerships between the parties involved are critical factors in addressing the bilateral

information asymmetry. Despite the topicality of the issue, there are few studies concerning bilateral information asymmetry, especially when compared to the literature concerning unilateral information asymmetry. In particular, the literature suggests that trust can be fostered through collaboration, transparency and appropriate risk management. It is important to develop appropriate coordination mechanisms to encourage information sharing between different entities in the Supply Chain. This may include the adoption of cost and benefit sharing policies, the creation of financial incentives and the promotion of a corporate culture focused on information sharing. In this regard, in this paper downstream of the literature study, the main decision-making factors for setting up a problem regarding bilateral information asymmetry were identified, and secondly, the analysis of the different coordination mechanisms proposed in order to identify possible gaps. In particular, the willingness of individual actors to protect and optimise their own interests over general interests is reported. This results in unreliable information sharing, which leads to a limitation of the different coordination mechanisms proposed. Hence, it is necessary to identify new strategies and solutions to deal with such behaviour effectively, among which an element of governance, or a mediator, is proposed, whose main objective is to optimise the overall performance of the Supply Chain with attention to the interests of the individual actor to increase the individual actor's confidence in sharing information and thus mitigate misreporting behaviour.

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