

# A Taxonomy of Market Mechanisms for Information Sharing in Crisis Response Coalitions

**Tim Grant**

Netherlands Defence Academy  
[tj.grant@nlda.nl](mailto:tj.grant@nlda.nl)

**Ariën J. van der Wal**

Netherlands Defence Academy  
[AJ.vd.Wal@nlda.nl](mailto:AJ.vd.Wal@nlda.nl)

## ABSTRACT

Information sharing is crucial in responding to and managing crises. A great variety of organizations respond to crises, ranging from international organizations, through non-governmental organizations, commercial suppliers, government ministries, and the media, to individual volunteers. At best, they collaborate to combine their respective strengths in creating synergy. At worst, they deconflict their operations so that the one does not get in the way of the other. In either case, the organizations must communicate with one another. Previous research has shown that this communication takes the form of an information market. This paper considers the possible mechanisms for information markets in humanitarian and military coalitions. While there has been work on market mechanisms in the economics literature, this needs to be adapted for the exchange of information and information services instead of physical goods and services. This paper proposes a taxonomy of market mechanisms that is tailored to information sharing within coalitions.

## Keywords

Information sharing, crisis response, crisis management, collaboration, coalition operations, information market.

## INTRODUCTION

Information sharing is crucial in responding to and managing crises. A great variety of organizations respond to crises, ranging from international organizations, through non-governmental organizations, commercial suppliers, government ministries, and the media, to individual volunteers. A key issue that coalition partners face is how to communicate with one another. At best, they collaborate to combine their respective strengths in creating synergy. At worst, they deconflict their operations so that the one does not get in the way of the other. In either case, the partners must exchange information, starting with finding their right place in the coalition. Once in place, partners have to synchronize their mutual activities with other partners. At a later stage, they evaluate their achievements, negotiate (re-)allocation of responsibilities, and leave the coalition, gracefully if possible. For the purposes of this paper, we define information sharing as the process of making information available to other individuals, teams, or organizations in a coalition. Information is a set of explicit data objects that is acquired or generated, identified, protected, stored, retrieved, and/or exchanged by coalition partners.

Previous research has shown that information sharing in coalitions may be described as an information market (Grant and van den Heuvel, 2010). A market may be defined as a set of procedures or rules whereby parties engage in the exchange of goods and services. For simplicity, we restrict our research to goods. The procedures or rules are mechanisms determining how economic decisions are made, how economic activity is coordinated, who owns and controls the means of production, and what incentives there are to induce economic agents to engage in productive activity. Markets in which physical goods are exchanged are well known in economics. However, information markets differ from economic markets, because information has a number of characteristics distinguishing it from physical goods (Stewart, 1996). Nevertheless, many of the underlying mechanisms may be the same. The purpose of this paper is to identify the types of market that could exist for information sharing in coalitions. We achieve this by constructing a taxonomy of economic markets found in the literature, and then eliminating those that are inappropriate to information markets, to coalitions, or to crisis response. Our approach is necessarily qualitative. The ultimate goal of our research is to apply this taxonomy in developing a simulation tool to support coalition partners in constructing and running coalitions. This paper describes one step towards this goal. Its contribution is to propose a taxonomy of market mechanisms that are both tailored to information markets and applicable to information sharing within crisis response coalitions.

In the rest of this paper, we review the meaning of information, of information sharing, and of information markets. In the third section, we compare the variety of economic systems documented in Wikipedia. This leads to the identification of a set of market mechanisms in the fourth section, which we prune according to their

applicability to information sharing, to coalitions, and to crisis response. Finally, we draw conclusions, identify the limitations of our work so far, and propose areas for further research.

## LITERATURE

### Information as an asset

We make no distinction between data, information, and knowledge, using “information” as our portmanteau term. To the possessor, information is an asset with a value that depends (amongst other things) on the cost of acquiring it, on its quality, on the situation within the coalition and its wider environment, and on the extent to which the information enables action in that situation. We distinguish three levels of information as a tradable good: (1) the information content itself, including any meta-data; (2) information on where and how such content can be obtained (i.e. the information source); and (3) information that such content exists, even if neither content nor source is known. This paper focuses on the first level.

### Information sharing

On the basis of interviews with 47 experienced military officers in a NATO setting, Grant and van der Heuvel (2010) have shown that information exchange in military coalitions is more complex than a simple, one-way process of transmission from sender to receiver. The information that can be shared depends on security regulations. These give information a scarcity value, although personal trust may allow the regulations to be waived in certain circumstances. Grant and van der Heuvel conclude that information sharing in such coalitions often has the characteristics of an information market (McGee & Prusak, 1993), involving barter or the exchange of information for loss of power. A better model is needed of information sharing in coalitions. Simard (2006) proposed a cyclic model, but this is not applicable to coalitions. He and Wei (2009) suggested combining information seeking and sharing processes, but did not develop this further. Grant (2011) proposed a model combining information seeking and sharing in network-based operations. With such a model, an agent-based simulation could be developed to serve as a decision support tool for coalition designers and commanders.

### Information markets

An *information market* is a mechanism for distributing information resources (Stewart, 1996). This assumes that a *source* has information available for distribution, that someone (an intended *recipient*) wants it, and that the market’s purpose is to connect the two and make the exchange possible. There are two views on such mechanisms: in one, organizational constraints make the information a *scarce resource*, and, in the other, information is regarded as a *public good* and should be shared freely. There is no consensus among researchers on the relative merits of the two views, and the Wikileaks saga demonstrates how the views can conflict.

McGee and Prusak (1993) note that people barter information, trading it for information of greater value, or use it as an instrument of power. Grant and van den Heuvel (2010) showed that these characteristics were to be found in the transcripts of interviews with experienced military officers in NATO settings. Security regulations restrict the sharing of information across organizational boundaries. The currently-prevailing security principle of “need to know” means that the source determines how the information should be protected and with whom the information may be shared. This gives information a scarcity value.

Stewart (1996) observes that information is very different from physical goods. Because information can be readily copied, a piece of information can be in more than one place at a time. When information is viewed as a scarce resource, selling it does not diminish the supply, buyers generally purchase it once only, and, once sold, it cannot be recalled. Information can be easily combined to create new information. These differences imply that information markets are different to markets that trade physical goods.

Barter has a number of limitations in economic markets (O’Sullivan & Sheffrin, 2003). These limitations include the absence of a common measure of value, the indivisibility of certain types of goods, the lack of standards for deferred payment (e.g. debt), and the difficulty in storing wealth, especially when the goods are perishable. In coalition operations, these limitations are compounded. Coalitions are typically smaller than economic markets. This reduces the chance of two parties meeting that each have some information that the other wants. Moreover, the information to be shared is often perishable, being time- or situation-specific. If two parties do meet, the chance that they each have information that the other wants *at the same time* is still lower.

## ECONOMIC SYSTEMS

Economics is the part of the social sciences that is concerned with the study of the production and consumption of goods and services. For simplicity, we will restrict our discussion to goods. An economic system is a set of mechanisms (typically known as “institutions”) that structure the allocation of inputs to production, the production process, and the distribution and consumption of the outputs. These mechanisms are identified with a social purpose and with the making and enforcing of rules governing cooperative behaviour.

Even with the help of an expert in economics, we were unable to find a book or survey paper on market mechanisms applicable to information goods. Instead, we took Wikipedia as our source of knowledge on the generally-recognized variety of economic markets, their names, and their definitions<sup>1</sup>. For example, the Wikipedia page on Economic System – itself part of a series of Wikipedia pages on Systems and Systems science – provides links to other pages on closed (autarky), digital, dual, gift, informal, market, mixed, natural, open, planned, subsistence, underground, and virtual economic systems. Further search disclosed Wikipedia pages on traditional, participatory, barter, decentrally planned, and money-free economies, and on information and knowledge markets. Table 1 lists these economic systems, grouped so as to assist in identifying a taxonomy.

**Table 1. Wikipedia definitions for economic systems.**

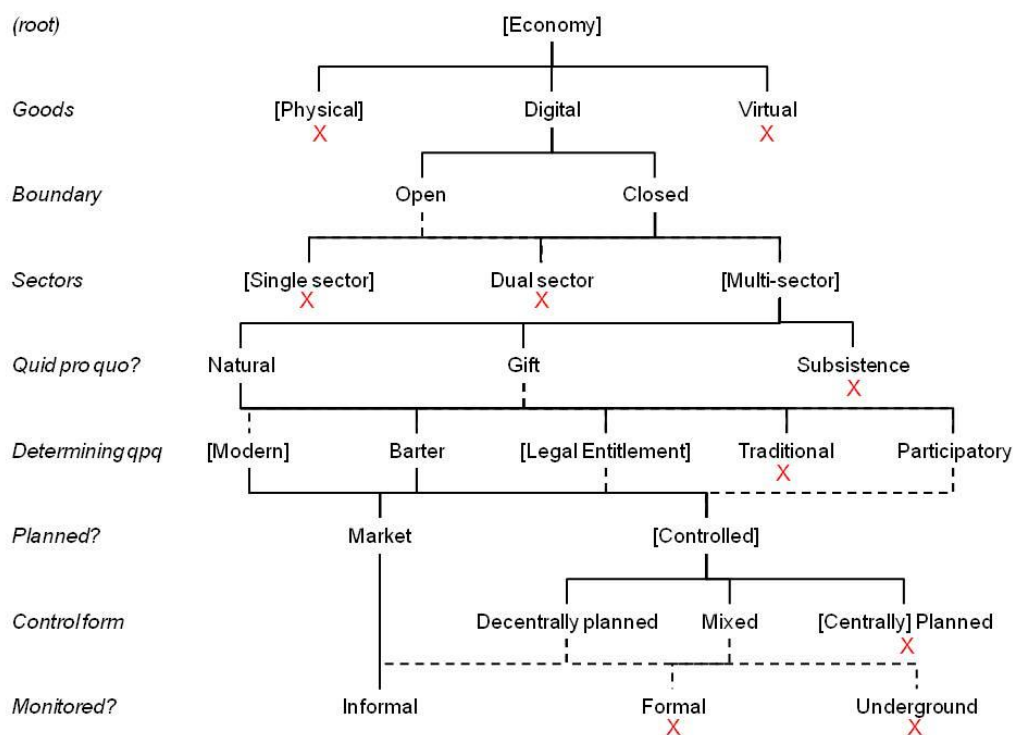
Name	Definition
Open	An economy in which economic activities take place between a domestic economy (typically within a particular country) and outside.
Closed (autarky)	Autarky is the quality of being self-sufficient, i.e. an entity can survive without external assistance. Hence, a closed market would be one in which economic activities are confined to the domestic economy.
Planned	A planned economy (a.k.a. command, centrally planned, or command and control economy) as one in which the state directs the economy.
Decentrally planned	An economy in which members of society, acting with equal economic power, democratically plan economic activity.
Mixed	A mixed (or balanced) economy is one that includes a variety of private and public control, reflecting characteristics of both capitalism and socialism.
Participatory	An economic system that uses participatory decision making to guide the production, consumption, and allocation of resources in a given society.
Market	An economy in which the prices of goods are determined in a free price system. This is often contrasted with a fixed price system. The terms fixed and free refer to whether or not there is a central authority that controls the price. There is no such authority in a free price system.
Money-free	An economy in which people exchange goods for intangible non-monetary credits, such as reputation.
Gift	A society in which goods and services are regularly given without any explicit agreement for immediate or future rewards, i.e. no formal <i>quid pro quo</i> exists.
Natural	An economy in which money is not used in the exchange of resources. Resources may be allocated through direct barter (see Barter), by legal entitlement, or by sharing according to traditional custom.
Barter	A method by which goods or services are exchanged directly for other goods or services without using an exchange medium such as money.
Traditional	An economic system that pertains in societies with extensive subsistence agriculture. Attempts to give the term a specific meaning present the traditional economy as one based on family or community custom.
Subsistence	A subsistence economy is one which simply gathers or amasses objects of value, providing little or no surplus for economic activity.
Dual	An economy in which two separate economic sectors exist within one country, divided by different levels of development, technology, and patterns of demand, e.g. colonial economies.
Information / Knowledge	An information economy is one that emphasizes informational activities, information industry, and providers and users exchanging information instead of buyers and sellers trading physical goods. People barter information, trade it for information of a greater value, or use it as an instrument of power.  A knowledge economy is one that focuses on the production and management of knowledge or the use of knowledge technologies, such as knowledge engineering or knowledge management, to produce economic

<sup>1</sup> In essence, we are exploiting crowd-sourced knowledge. All Wikipedia pages accessed 19 April 2011.

	benefits and job creation.
Digital	An economy in which electronic goods and services are produced by electronic or computer science production and management processes and transactions are conducted through information technologies. Electronic goods and services are weightless and virtual and can be moved worldwide instantaneously.
Virtual	An economy existing in a virtual persistent world, usually governing the exchange of virtual goods in an internet game. Virtual goods are non-physical objects with no intrinsic value, although there have been attempts to monetarise them in the real world, e.g. by legal action over the possession of virtual property.
Underground / Black	Wikipedia gives a large variety of alternative terms for the underground economy: subterranean, hidden, grey, shadow, informal, clandestine, illegal, unobserved, unreported, unrecorded, second, parallel, and black economy. What they have in common is that those engaged in underground economic activities circumvent, escape, or are excluded from institutional systems of rules, rights, regulations, and enforcement penalties that govern more formal systems of production and exchange.
Informal	That part of an economy that is not taxed or monitored by any form of government nor included in GNP.

**TAXONOMY OF INFORMATION MARKETS FOR CRISIS RESPONSE COALITIONS**

By grouping together the economic systems found in Wikipedia, we see that an economy may be constrained by rules or norms. It is these rules or norms that we regard as our market mechanisms. Looking at open and closed economies, we see that one rule concerns whether or not the economy should be open to exchange of goods with other economies. Another rule concerns whether or not inputs, production, distribution, and consumption are planned. Planning may be done centrally by the state, decentrally by private organizations, or by involving all the participants in the market (i.e. all the information providers and users). A third rule concerns pricing.



**Figure 1. Proposed taxonomy of information market mechanisms.**

Such rules are normally set by an authority. The definitions show that this authority can be the state, private organizations or institutions, or the market participants themselves. It is also possible for there to be no authority at all, as in a free market in which supply and demand balance one another. Participants are normally assumed to comply with the rules. However, the underground market and its many variants show that some market participants may ignore some or all of the rules. Grant and van den Heuvel’s (2010) observations also show that, in some circumstances, authorities or individuals may permit some rules to be waived.

Figure 1 shows our proposed taxonomy of market mechanisms for information sharing in coalitions. Some nodes not found in Wikipedia have had to be added for completeness; these are shown within square brackets, as

for the root node [Economy]. There are Wikipedia pages for digital and virtual economies, but not for economies in physical goods. Nodes that are inappropriate to information markets, to coalitions, or to crisis response and management are marked with a (red) X. Since we are interested in sharing information in the real world, and not in (say) Second Life, the virtual economy node has been so marked. A coalition generally contains many partners, so single- and dual-sector economies are inappropriate. A subsistence economy excludes sharing. There are no traditions and customs for crisis response, making the traditional economy non-applicable. Coalitions, as opposed to consortia, have no central authority, making centralised planning and formal monitoring inappropriate. Decentralised planning or a mixed form where part of the coalition is a hierarchy (e.g. a military element) are possible. An underground economy is undesirable, but perhaps inevitable. Dashed lines show possible relationships. For example, one may be concerned with information sharing only between coalition partners, in which case a closed economy applies. In reality, coalition partners will also exchange information with organisations outside the coalition, and, if including this sharing is important, then the economy becomes one that is open. Grant and van den Heuvel's (2010) results show that the quid pro quo (qpq) in military coalitions involves barter or a modern economy in which a price is paid. However, legal entitlement could apply when the coalition is underpinned by a treaty or the like, and the participatory economy could apply to coalitions that have a Steering Board or other forum in which all partners participate.

The market mechanisms that emerge from this analysis are named in italics on the left hand side of Figure 1. The first mechanism concerns what kind of goods are exchanged. The second concerns whether or not the economy has a boundary. The third concerns the number of sectors within the economy. The fourth concerns whether or not there is a quid pro quo for the goods being shared, and the fifth concerns how this quid pro quo is determined (by price, by barter, or by some means of determining a fair exchange, such as the law, traditions, or debate among the participants). The sixth mechanism is whether or not the economy is planned or controlled, and the seventh concerns the form of control. Finally, the eighth is whether or not compliance is monitored.

## CONCLUSIONS AND FURTHER RESEARCH

This paper has reviewed information, information sharing, and information markets. Information markets differ from their physical equivalents because information can be readily copied. People barter information, trade it for information of a greater value, or use it as an instrument of power. In this paper, we surveyed the types of economy documented in Wikipedia, grouping them together to form a taxonomy suited to information sharing in crisis response coalitions. We identified mechanisms relating to the kind of goods, whether the economy is bounded, whether it has multiple sectors, whether a *quid pro quo* is exchanged for goods and, if so, how it is determined, and whether the economy is controlled (and, if so, how) and monitored.

Our ultimate aim is to develop a simulation of information sharing for use by coalition designers and commanders. To do so, we need to know what possible mechanisms govern information markets. This paper has reported a step towards this goal. Our next step will be to develop quantitative models of these mechanisms. The first problem to be solved is how to give a value to information. Information has many attributes, both objective and subjective, that are difficult to capture in a single value. The information's source and each of its potential recipients may give it a different value, varying over time as the situation changes. In theory, it would be possible for a central authority to establish the value of information, but there is no such authority in a coalition. If the market model could give information a value autonomously, this would help coalition partners in deciding whether or not to acquire information, when to do so, from whom, and at what cost.

## REFERENCES

1. Grant, T.J. (2011) Combining Information Sharing and Seeking in Networked Coalitions. *Proceedings of the 8<sup>th</sup> International ISCRAM Conference*, Lisbon, Portugal.
2. Grant, T.J. & van der Heuvel, G.G.A. (2010) Modelling the Information Sharing Process in Military Coalitions: A work in progress. *Proceedings of the 7<sup>th</sup> International ISCRAM Conference*, Seattle, WA.
3. He, W. & Wei, K.K. (2009) What drives continued knowledge sharing? An investigation of knowledge-contribution and -seeking beliefs. *Decision Support Systems*, 46, 4, 826-838.
4. McGee, J., & Prusak, L. (1993) *Managing Information Strategically*. John Wiley & Sons, New York.
5. O'Sullivan, A. & Sheffrin, S.M. (2003) *Economics: Principles in action*. Pearson Prentice Hall.
6. Simard, A. (2006) Knowledge markets: More than Providers and Users. *IPSI BgD Internet Research Society Transactions*, 2-2, 4-9.
7. Stewart, T.A. (1996) *Intellectual Capital - The New Wealth of Organizations*. McGraw-Hill.