Value-added ERP information into information goods: an economic analysis

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Keywords

Resource management, Electronic commerce, Competitive strategy

Abstract

E-businesses using enterprise resource planning systems as the information infrastructure generate a tremendous amount of information, including information about customers, suppliers, markets, transaction costs, the prices at which products are bought and sold, and order-fulfillment rates, etc. To turn the information contained in these systems into marketable information goods would be a key to gaining a competitive advantage and optimizing market exchange efficiencies. Treating involved organizations as an end-to-end network and applying an economic analysis, five propositions are developed to capture this value-added process. Conditions for market equilibriums are specified.

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Introduction

Enterprise resource planning (ERP) can be considered to be the price of entry for entering into the business-to-business, or B2B, electronic market, and for being connected to other enterprises in a network economy. ERP provides a platform for integrating applications such as executive information systems, data mining (Kumar and Hillegersberg, 2000), supply-chain management (SCM) (Tarn *et al.*, 2002), customer relationship management (Willis and Willis-Brown, 2002), and e-commerce systems (Frank, 2004). ERP used for B2B online exchanges are said to cut the cost of paperwork and bookkeeping associated with organizations doing business with each other. However, online exchanges are not only hubs for collaborative commerce, but also make goods available and serve as electronic markets. Through online exchanges organizations can exchange proprietary data, jointly manage projects, and cooperate on the design of new products. Many large companies (companies with more than 1,000 employees) have already adopted ERP systems and use the installed ERP infrastructures as foundations for e-business (Everdingen *et al.*, 2000). The integration of ERP and non-ERP systems, along with the use of Web-based technologies, has been demonstrated to optimize an overall B2B value chain and e-business change management with six international organizations, including Dell Computer Corporation (Ash and Burn, 2003).

To use ERP as the platform for electronic markets, network infrastructures to integrate buyers, sellers, distributors, brand manufacturers, and original manufacturers in end-to-end e-business networks are required. The extensive databases generated by ERP systems can then be transformed into value-added information goods to be exchanged in the markets. Based on Achrol and Kotler's (1999) network organization theory to capture the network characteristic of electronic markets, and applying the supply and demand principles of economics, this study shows how viable electronic markets for ERP information can be created. The traditional ERP realm of internal and vertical networks is proposed as the supply-side of the market. The new e-commerce realm of intermarket and opportunity networks is considered as the demand-side of the market. The propositions developed show how ERP information can be value-added into marketable information goods and exchanged for strategic purposes and profits in the electric markets where ERP serves as the platform.

Key concepts defined

Enterprise resource planning

Extending Kumar and Hillegersberg (2000) definition of ERP to electronic markets, we define ERP as enterprise resource planning systems that are configurable information systems integrating information and information-based processes within and across organizations. ERP provides a centralized repository of information for the massive amount of transactional detail. The main benefits of ERP systems are seen as the production of real-time data shared across the organization and consequently, the integration and automation of business processes (Spathis and Constantinides, 2003).

Though ERP is originally designed to provide an organization with integrated, consistent and concurrent information that is available across the organization, it has gone beyond this. Integrated with electronic data interchange (EDI), it is used to streamline business processes in vertical markets, giving organizations, the control and management of their resources (Truman, 2000). With the arrival of Web applications, ERP can now extend to the electronic markets. It can be integrated with the supply chain through B2B e-hubs for supply-chain partners to integrate their own operations with other functions, and to manage, monitor, and execute all transactions in real time (Zeng and Pathak, 2003). ERP systems can also be used to integrate manufacturing and marketing functions that have been demonstrated to determine the competitiveness and profitability of organizations (Hsu and Chen, 2004).

ERP enabled electronic markets

Electronic markets are network-based locations where business interactions and relationships occur and information goods are exchanged (Senn, 2000). The markets are characterized as the means by which organizations share information, exchange transactions, and coordinate processes over telecommunication networks with other organizations (Truman, 2000).

In electronic markets, networks are formal governance structures (Achrol and Kotler, 1999) used to coordinate operations to arrange the relationships among business units and organizations (Markus *et al.*, 2000). This net-centric feature renders the markets a fundamental economic characteristic: the value of connecting to the markets depends on the number of other organizations already connected to it (Shapiro and Varian, 1999, p. 174).

Network organizations are the major players in the electronic markets. According to Achrol and Kotler (1999, p. 148), a network organization is an

interdependent coalition of task- or skill-specialized economic entities that operate without hierarchical control but are embedded, by dense lateral connections, mutuality, and reciprocity. They identified four categories of network organizations:

- (1) The Internal network refers to the internal functional units of an organization designed to reduce hierarchy.
- (2) The Vertical network comprises supply-chain organizations aiming at maximizing the productivity.
- (3) The Intermarket network is a group of organizations that operate in several related and unrelated industries seeking to leverage horizontal synergies across industries.
- (4) The Opportunity network is a body of organizations organized around a central infomediary that mediates business activities on behalf of its participating organizations.

ERP systems creating IT intensive networks enable the formation of network organizations and the electronic markets where network organizations serve as buyers, sellers, or both. ERP in the electronic markets serves as the information processing function to generate and exchange information. Taking an open system perspective, Truman (2000) views each organization as part of an open system of other organizations that collectively makeup this environment. As part of the system, organizations serve as information processing entities to exchange information and resources within this environment.

The ERP enabled electronic markets are comprised of supply and demand networks to facilitate information exchange. For the four network organizations identified by Achrol and Kotler (1999), the internal and vertical ERP networks constitute the supply side and the intermarket and opportunity ERP networks create the demand side of the markets.

ERP generated information goods

Information goods are anything that can be digitized, such as a book, a movie, a record, or a telephone conversation (Varian, 1998). The development of information goods involves a high level of fixed costs for implementing information systems, and these costs of production remain constant. Though most costs for producing the first copy of information goods are sunk, information goods can be distributed and reproduced with zero marginal costs. That information goods can be distributed and reproduced with zero or very low marginal costs is well recognized (Bakos and Brynjolfsson, 1999, 2000; Shapiro and Varian, 1999), and this is the major driving force for deriving ERP value. ERP enables an organization to

share common data and activities throughout the entire enterprise, and generate and access information in a real-time environment (Willis and Willis-Brown, 2002). As ERP can connect electronic markets and is itself a big data repository, its information outputs can be value-added into information goods that make them available in the electronic markets without additional costs.

Information supply networks

The information supply networks include the internal and vertical networks. Both networks are the main organizations implementing ERP. The apparent advantage to supply value-added ERP information to electronic markets is to leverage the investments in ERP (Kremers and Dissel, 2000), and to gain network externality of production.

ERP was restricted to intra-organizational process support, serving as the information backbone providing the plumbing and wiring for an enterprise information system. Figure 1(a) illustrates ERP as the information infrastructure and the information generated in the internal network extending from Porter (1990) value chain model. In this model organizations create value for their customers through performing value chain activities, including logistics, operations, marketing and after-sale services. All of these value-added activities are supported and integrated by ERP and various categories of information generated, including cost benefit information, resource optimization and coordination, and market and service support, etc. Empirically, Everdingen *et al.* (2000) surveyed criteria used by European midsize companies for investing in ERP systems. They found that companies clearly aimed at using ERP's main strength: integrating several functional areas.

The core competency of ERP within an enterprise can be expanded to vertical networks. Sharing information is what transforms ERP into the backbone of a supply chain, and not just the backbone for internal networks. The benefits are magnified from the same internal advantages with better coordination and optimization by eliminating external uncertainties.

We identified two types of ERP-enabled vertical networks. In the reciprocity model, organizations are linked in a reciprocal and parallel manner, as shown in Figure 1(b). The reciprocal links can be extended to more than two organizations. Linking ERP systems with customers' and suppliers' ERP systems can make these reciprocal links. These connections form proprietary e-business conduits, establishing mega-ERP systems that meld the

supply chains of business partners. ERP links are expected to bring the same efficiencies in purchasing, shipping, and manufacturing that ERP is meant to bring to individual companies (Mullin, 2000). The integration of ERP and SCM serves as one example for this reciprocity model where, through information sharing, SCM enables supply-chain partners to work in close coordination to facilitate supplier-customer interactions and minimize transaction cost (Tarn *et al.*, 2002).

In the dominant organization model, organizations are linked centrally around a dominant organization, shown in Figure 1(c). The dominant organization in a vertical network tends to position itself as an information pivot in the network. Integration can be achieved through the extension of traditional EDI practices initiated by the dominant organization. EDI in this context creates computer-to-computer exchanges of standard business documents, generally referred to as a class of inter-organizational information systems that reduce costs by improving the quality and business value of standard document exchanges (Masseti and Zmud, 1996). The case examined in Ash and Burn (2003) illustrates this model, where Dell Computer serves as the dominant organization integrating its ERP systems with its international customer organizations using Web-based technologies.

The network externalities of production

Most costs for implementing ERP systems are sunk (Shapiro and Varian, 1999, p. 22), but the information produced can be distributed and reproduced with zero marginal costs (Bakos and Brynjolfsson, 1999). This unique cost structure leads information supply networks to exhibit positive network externalities of production.

In networks, an organization's action to link to the ERP system improves another organization's information integration and output efficiencies, which constitutes positive externalities of production (Varian, 2003, p. 608). As more organizations join the ERP system, all organizations that have already linked benefit additional cost efficiencies because the zero or very low marginal costs for information reproduction reduces the high ERP implementation costs, a situation of positive network externalities. For example, Zhu *et al.* (2004) found that the impact of network technologies on financial institutions depends on size variables (assets, number of employees, and number of branches) and network system variables. When procurement is integrated with inventory management through ERP, the marginal costs of production can be reduced, as

Figure 1 The information supply networks

only just essential materials must be kept on hand. Similarly, as more supply-chain partners become integrated with the ERP system, the management of the entire supply chain can be more streamlined, and the marginal costs of production decreased. Zeng and Pathak (2003) demonstrated that when

the supply chain is integrated with ERP through B2B e-hubs, supply-chain partners could integrate their own operations with other functions in real time. Thus transaction costs would be reduced.

The supply curve with network externalities of production is given by its cost structure. Supply

networks can be connected using a constant returns to scale ERP system, coupled with the zero marginal costs of information goods. The supply curve would start at a price equal to the average cost of connecting to the ERP system, and then decrease with the marginal costs of information reproduction approaching zero. It has been observed with online stock trading that the cost for commissions and transaction on electronic exchanges will tend toward zero (Teschler, 2000). *P1* captures the positive network externalities of production.

P1. The costs of ERP generated information start at a price equal to the average fixed cost of production, and then decrease with the marginal costs of information reproduction approaching zero with the number of organizations connected to the supply network.

Commoditizing ERP information

The value of ERP in information supply networks lies in the cross-functional integration in order to streamline business processes and increase the utility of standardized information. Palaniswamy and Frank (2000) studied five ERP applications, including SAP, Baan, and Oracle, and found that in all five cases, better cross-functional integration was a critical success factor. Soh *et al.* (2000) surveyed the misfits between the functionality offered by ERP and that required by the adopting organization, and concluded that misfits contributed to scale back the ERP projects, accept minimal benefits, or even abandon the implementation of ERP projects.

ERP information is structured. This is due to the requirement for integrated ERP functional units and supply-chain partners to achieve cost efficiencies, as depicted in *P1*. Structured information generated by ERP is a commodity or near-commodity. When information is commoditized, its substitutability is enhanced, permitting lower search costs for information exchanges, which results in more efficient electronic markets (Grover and Ramanlal, 1999). Commoditizing ERP information increases cost efficiencies for information exchanges, and facilitates the free flow of information (Shapiro and Varian, 1999, p. 24). Krumwiede and Jordan (2000) thus suggested that organizations implementing ERP should pursue a low-price/high-volume strategy such as manufacturers of mass merchandise items. The cost efficiencies of commoditizing ERP information leads to *P2*:

P2. The costs of ERP generated information decreases with the degree of information commoditization.

Information demand networks

Information demand networks include the intermarket and opportunity networks, which represent the demand side of the ERP-enabled electronic market. Organizations in the demand networks are not limited to supply-chain partners. Connecting to the demand networks offers organizations the flow of information to disparate ERP systems.

Figure 2(a) shows a possible demand network link through the mediation of an infomediary. With the infomediary, the chain of reactions in the ERP network ripples out to each related organizations and rebounds back to provide for the needs of the customers. In this pattern, each organization enjoys approximately total local autonomy. Information sharing among organizations will be governed by a pre-defined protocol. The B2B e-hubs examined in Zeng and Pathak (2003) serve as one example where e-hubs intermediate the integration of information, resources, and organizations.

When direct reciprocal links between organizations are established (Figure 1(b)), an end-to-end network can be formed, as shown in Figure 2(b). The foremost benefit of this type of ERP networks is that it can glean information from many-to-many networks across industries. It has been proposed that network integration would be most useful to organizations when the entities sell to each other as well as to external customers. In this network, each organization has access to each other's information, allowing for lateral coordination without a high degree of centralization or top-down control (Markus *et al.*, 2000). The benefits extracted from the entirety of the network will become more powerful than the sum of its parts. For example, Frank (2004) developed architecture for integration of distributed ERP and e-commerce systems where an e-commerce server is an ordinary sales location with or without its own stock, and, therefore, the e-commerce system is totally integrated into the high-performance, readily available ERP system.

The network externalities of consumption

The demand-side networks exhibit positive network externality of consumption, or the demand-side economics of scale, with the value of connecting to the network depending on the number of other organizations already connected (Shapiro and Varian, 1999, p. 174). The greater the number of organizations connected to the networks, the higher the value that can be derived from the networks.

Following Varian (2003), the demand curve for information demand networks with externalities of

Figure 2 The information demand networks

consumption is hump-shaped, showing the function of the price of information goods and the number of organizations that are connected to the networks, as shown in Figure 3.

The marginal organization $\hat{v}$'s reservation price for the information good v is equal to the price of the information good p . The price of the information good is given by:

Figure 3 Supply and demand curves with network externalities

$$p = \hat{\nu}n. \quad (1)$$

where n is the number of organizations that are connected to the network. At price p , some organization is indifferent to connecting or not connecting to the network to obtain information goods, so its willingness to pay for the information good equals its price, as given in equation (1).

Since this marginal organization is indifferent, every organization with a higher value of ν than $\hat{\nu}$ must want to connect. This means that the number of organizations that want to connect is

$$n = N - \hat{\nu}. \quad (2)$$

where N is the total network size. Putting equations (1) and (2) together, we can obtain the demand curve for the information good.

If the number of organizations that connect is low, then the willingness to pay of the marginal organization is low, because there are few organizations out there that this organization can exchange information. If a large number of organizations are connected, then the willingness to pay of the marginal organization is again low, because every organization that valued it more highly has already connected. Thus an organization's demand for the information goods is determined by its marginal willingness to pay.

P3. The reservation price for information goods is determined by the marginal willingness to pay, which at first increases and then decreases with the number of organizations connected to the demand network.

Customizing ERP information goods

Though commoditizing information in supply networks can decrease the cost of generating such information, commoditized information can only be sold at marginal costs, which will lead to price competition. Differentiating information goods to add value to the raw information is one approach

to avoid price competition (Shapiro and Varian, 1999, pp. 23–5), and increase the value of the information goods to customers.

To differentiate ERP information in order to value-add it into information goods, three “filters”, aggregation, time, and variance, are applied. The aggregation filter data-mines information, the time filter classifies real time from historical information, and the variance filter identifies the changes in information. Table I illustrates how differentiated advantage can be obtained through applying the three proposed filters to typical information generated by ERP, including financial, human resources, operations and logistics, sales and marketing information (Davenport, 1998).

Customization increases the dispersion of buyer valuations for information goods (Bakos and Brynjolfsson, 1999), and the variation reflecting each organization's individual needs.

Organizations typically place a higher value on the information goods that are customized to their needs (Grover and Ramanlal, 1999). *P4* captures the high valuation of customized information goods.

P4. The reservation price for information goods increases with the degree of information customization.

Market dynamics

Bringing information supply and demand networks together forms ERP enabled electronic markets where ERP generated information can be value-added into information goods to be exchanged. Organizations not only exchange information internally to meet their own corporate needs, but also exchange information externally to satisfy the needs of other organizations through entire networks. The boundaries between the supply and the demand networks are flexible. An organization may demand one category of information but supply another category. In the electronic markets when an organization supplies information, it is connecting to the supply networks, while it is connecting to the demand networks when it demands information goods.

The supply curve with network externalities of production starts high and decreases toward zero, given in *P1*. The demand curve for information goods with network externalities of consumption is hump-shaped and given in *P3*. According to Varian (2003, p. 633–634), there are two possible intersections in the demand and supply curve. There is a low-level equilibrium where only a small number of organizations are connected to the markets and information good exchanges are

Table I Value-added ERP information into information goods through the aggregation, time, and variance filters

Information	Aggregation		Filters		
	Aggregate	Disaggregate	Real time	Time Historical	Variance
Marketing	Profiling	Segmentation	Capacity allocation	Seasonal pattern	Market volatility
Operations	Industry outlook	Efficiency	Industry benchmark	Suggesting technical advancement or process changes	Strategic movement
Logistics	Upstream and downstream commitment	Cost structure	Synchronization	Change in materials used	Product Modification

Note: Entries in the table are the information goods illustrated

limited. Owing to the high fixed costs to connect, the supply curve will intersect with the demand curve at the increasing reservation price range. At this point an organization's willingness to pay for the information goods is equal to the high fixed ERP costs. This is an inefficient market because the small size of the market demands the few organizations in the network must pay a high price for information goods.

The high-level equilibrium has all organizations connecting to the electronic markets. Here the equilibrium price is zero because all organizations serve as suppliers and customers; therefore, there is no additional price to pay for the information goods, only the costs to connect to the markets. The high-level equilibrium represents efficient markets where all organizations connect to the electronic markets and all supply and demand information goods.

P5. When the size of an electronic market is small, information goods will reach their equilibrium price at the increasing reservation price range. As the size of the electronic market increases, the information goods will reach their equilibrium price at the decreasing reservation price range.

Discussion

With the high implementation costs of ERP, the ability to value-add ERP information into marketable information goods would increase the overall value of ERP investments and bring additional profits to organizations.

Through an economic analysis, this paper has shown that the information generated by ERP can be value-added into information goods to gain differential competitive advantages in electronic markets. Electronic markets exhibit both the production and the consumption sides of network externalities. The prediction that the information supply curve will decrease to zero with the size of electronic markets suggests to organizations implementing ERP a new approach for leveraging

their vast investment gain cost efficiencies. The argument that the information demand curve first increases and then decreases with market size urges organizations to connect to ERP in order to obtain information goods for strategic purposes. Five propositions represent our preliminary attempt to assess and predict ERP value and its impact on organizations used an economic analysis. These five propositions contributed to the insights for realizing the potential value of ERP. The following discusses issues worthwhile for further endeavor.

First, electronic markets are networks in nature, which brings new insight to the traditional economic view of market structures. Traditional economics equates market structures with the number of suppliers. However, in information economy where network organizations are the backbone, the internal relationships and interactions between suppliers must be considered in deriving market equilibriums. In electronic markets, suppliers can enjoy both production and network externalities to achieve substantial cost efficiencies, which may not be explained satisfactorily using the traditional economic view of market structures.

Second, the unique cost structure of ERP systems and information goods makes the supply curve for information goods more likely to have increasing returns to scale in ERP systems. The high fixed costs of implementing ERP can produce returns from the information goods that can be reproduced and distributed with zero or very low marginal costs.

Third, both commoditized and customized information can be exchanged. Commoditized information increases the cost efficiencies of organizations and is highly valued in the supply markets. Alternatively, customized information is valued high in the demand markets because it is tailored to organizations' needs and avoids price competition. Applying the three information filters, aggregation, time, and variance, the

commoditized ERP information can be value-added into customized information goods.

Finally, the market equilibrium derived in this paper provides motivations for organizations to implement ERP and exchange information. When the ERP-enabled electronic markets are small, i.e. ERP remains within the boundary of an organization or a supply chain, the high market price of information goods can make up the high ERP implementation costs. When the market size reaches economy of scale, i.e. ERP extends to horizontal organizations, any copies of the information goods sold can bring in additional profits to the organization since information goods can be distributed and reproduced with zero or very low marginal costs.

Conclusions

Our economic analysis of the ERP information value-adding process shows that the cost efficiencies of information goods can make up for the cost inefficiencies of ERP implementation, as the electronic markets ERP enable demonstrate both the production and the consumption sides of network externalities. Through implementing ERP and connecting to the electronic markets, organizations not only can supply, but also demand information in the markets. Efficient markets thus can be achieved with organizations selectively deciding which markets (the supply or the demand markets) to play to better fit their corporate goals.

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