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Yuliang Yao
California State University

Jonathan Palmer
College of William & Mary

Martin Dresner
University of Maryland

IMPACTS OF ELECTRONIC COMMERCE ON SUPPLY CHAIN MANAGEMENT

Yuliang Yao
California State University
San Marcos, CA USA
yyao@csusm.edu

Jonathan W. Palmer
College of William & Mary
Williamsburg, VA USA
jonathan.palmer@business.wm.edu

Martin Dresner
University of Maryland
College Park, MD USA
mdresner@rhsmith.umd.edu

Abstract

This research empirically examines supply chain structure, price competition, and supply chain performance using data obtained from the GSA's Federal Supply Service. The preliminary results show positive relationships between supply chain performance and implementation of electronic commerce initiatives to support both transaction and distribution channels. The potential contributions of the research include (1) extending transaction cost economics to a supply chain context with use of multiple transaction technologies and (2) providing additional empirical evidence that supply chain performance is improved and price competition is heightened with the use of electronic transaction systems.

1 INTRODUCTION

Competitive pressures have made faster and leaner supply chains a primary goal for manufacturing, distribution, and retail companies. The trends are forcing managers to rethink and reshape their business strategies, use of technologies, and relations with suppliers and customers. Electronic supply chains (ESC) facilitate business-to-business (B2B) electronic commerce activities using advanced information systems, such as electronic data interchange (EDI) and the Internet

This research examines the impacts of electronic supply chains on performance and prices. Specifically, the research compares the performance of electronic channels to more traditional channels (e.g., face-to-face purchases, fax orders, telephone transactions), and intermediated distribution channels to disintermediated distribution channels, utilizing a data set obtained from Federal Supply Service of the General Service Administration. The fundamental research questions are:

> *How do electronic commerce technologies, such as EDI and the Internet, affect supply chain performance and prices?*

> *How does disintermediation affect supply chain performance and prices?*

2 ELECTRONIC SUPPLY CHAINS

ESCs have grown rapidly as firms widely recognize their benefits. ESCs are usually realized in two forms: EDI-based or Internet-based. EDI generally connects firms through proprietary value added networks (VANs), whereas the Internet generally connects firms through open networks. A major advantage of ESCs is that they facilitate the exchange of information between supply chain

members. Chen et al. (2000) and Lee et al. (1997) suggest that information sharing activities, including the sharing of point-of-sales data, the exchange of inventory status information, and order coordination, can help mitigate information distortion in the supply chain, known as the bullwhip effect. Lee et al. (2000) studied the value of information sharing in a two-level supply chain and suggested that the value of demand information sharing can be quite high, especially when demands are significantly correlated over time. Aside from information sharing, other benefits found from the adoption and use of EDI and the Internet for transactions include reduction in shipment discrepancies (Srinivasan et al. 1994); improved buyer-seller relationship (Walton and Marucheck 1997); purchasing transaction facilitation (Sriram and Banerjee 1994); improvement in transportation practice (Crum et al. 1998); and reduction in inventory (Choudhury et al. 1998; Dresner et al. 2001).

The diffusion level of advanced information technologies, such as EDI and the Internet, in supply chains varies depending on many supply chain specific characteristics, such as the nature of transacted products, level of competition, number of suppliers, intermediaries, and customers. The direct consequence of this uneven diffusion level of ESCs is that traditional supply chains (TSCs) and ESCs often coexist in markets. The coexistence of ESCs and TSCs raises the question of how do *parallel* TSCs and ESCs differ in terms of prices and supply chain performance. This research provides an empirical examination of structure and performance of supply chains where transactions are placed by traditional means, EDI, and the Internet, and the physical flow of goods to customers is intermediated or disintermediated.

3 HYPOTHESIS DEVELOPMENT

We develop a set of hypotheses to address the effects of electronic transaction systems and disintermediated distribution channels on (1) supply chain performance and (2) prices and price dispersion.

Electronic interfaces provide firms with an effective way to integrate supply chains, improve supply chain coordination, and better manage inventory (Bakos 1997). A number of supply chain management initiatives, such as vendor managed inventory (VMI), collaborative, planning, forecasting and replenishment (CPFR), and efficient consumer response (ECR), take advantage of electronic interfaces within ESC. Hence, a positive effect from the use of electronic transaction systems on supply chain performance can be expected.

> *H1a:* *Use of electronic transaction channels will result in better supply chain performance than use of traditional transaction channels.*

Disintermediated distribution channels connect suppliers and buyers directly, so that supply chain echelons are shortened and demands are more closely coordinated with suppliers, as compared to intermediated channels (Lee et al. 1997; Simchi-Levi et al. 2002). Hence, a positive effect of disintermediated distribution channels on supply chain performance may be expected.

> *H1b:* *Use of disintermediated distribution channels will result in better supply chain performance than use of intermediated distribution channels.*

ESCs may reduce a buyer's search costs, thereby heightening price competition among suppliers and potentially lead to a "frictionless" market (Bailey 1998; Bakos 1997; Brown and Goolsbee 2002; Brynjolfsson and Smith 2000; Morton et al. 2001). Brynjolfsson and Smith compared prices in conventional and Internet retailing and found lower prices on the Internet in the book and the music markets. Morton et al. found that consumers who used Internet referral services paid 2 percent less for cars than those who bought cars the more traditional way at auto dealerships. Brown and Goolsbee found that the Internet reduced life insurance prices by 8 to 15 percent. Palmer (1997) showed lower prices in electronically mediated channels for a market basket of 120 retail products. Hence, a downward effect on prices through the use of electronic transaction systems may be expected. On the other hand, some research has shown that there are transaction inefficiencies, reflected by price dispersion, that do exist in electronically mediated supply chains (Bailey 1998; Bailey et al. 2001; Brynjolfsson and Smith 2000; Clemons et al. 1998). Nevertheless, electronically mediated supply chains may still be more efficient than paper-based supply chains due to lowered costs in transacting the same products. Hence, a downward effect of use of electronic transaction systems on price dispersion may also be expected.

> *H2a:* *Use of electronic transaction channels will result in lower prices and narrower price dispersions than use of traditional transaction channels.*

Disintermediated distribution channels offer buyers opportunities to purchase products from suppliers directly, generating price savings due to the elimination of intermediary mark-ups (Benjamin and Wigand 1995; Sarkar et al. 1995). Moreover, the logistics costs, including transportation and inventory costs, may be lower since the costs of shipping to and from intermediaries, and the

warehousing costs incurred by intermediaries, are saved. These cost savings would be especially true for those products that can be shipped in sufficient volumes. Therefore, a downward effect on prices from the use of disintermediated distribution channels can be expected after controlling for shipment volume.

> *H2b:*   *Use of disintermediated distribution channels will result in lower prices than use of intermediated distribution channels.*

4   DATA AND METHODOLOGY

Data were provided by the Federal Supply Service (FSS) of the U.S. government's General Services Administration's (GSA) covering transaction and fulfillment records of goods shipped during fiscal year 2000 (October1999–September 2000). FSS's transaction and fulfillment records were chosen because they encompass products procured by traditional systems and by electronic procurement systems (EDI and the Internet) with goods shipped through intermediated and disintermediated channels. Source data include details of each transaction and order fulfillment, including selling price, purchase cost, volume, purchasing agency, product, transaction channel, distribution channel, shipping mode, and fulfillment status. Data consists of approximately 4 million records.

4.1 FSS Supply Chain

As an intermediary agency between federal government consumers and supplying vendors, the FSS provides supply and procurement services for more than 2 million products. FSS has 312,000 registered users, with the number of browsers using the catalog sites estimated at 1,250,000 annually (Laurent 2000).

4.2 Variable Operationalization

Transaction Channel: There are three transaction channels in the FSS supply chain, Internet (GSA Advantage), EDI (MUFFIN), and traditional (face-to-face purchases, fax orders, phone orders, etc.). Federal purchasers can procure products through any of these three channels. In our models, transaction channel is operationalized using separate dummy variables for Internet and EDI transactions. Traditional transactions are coded zero (as the base case).

Distribution Channel: There are two distribution channels in the FSS supply chain, disintermediated (direct) delivery and intermediated (non-direct) delivery. The disintermediated channel encompasses those items shipped directly from a vendor's warehouse to a government user. The intermediated channel encompasses those items shipped to government users from an FSS warehouse. A dummy variable is coded 1 for disintermediated shipments, leaving intermediated shipments as the base case.

Price and Price Dispersion: Price is the amount the federal purchaser paid for one unit of the item shipped.[1] Prices are normalized to allow for comparisons across products. Price dispersion measures the spread of prices for products in the FSS database for the period for which data have been collected. (Note, each product is given a unique product number in the FSS system.)

Transaction Volume: Transaction volume is the quantity shipped to a purchaser and is used as a control variable in the models.

Supply Chain Performance: The FSS data allows us to measure supply chain performance in three ways: (1) complete shipment (an indicator variable coded 1 if the shipment was complete and 0 if there was a short shipment), (2) short shipment quantity (coded 0 if there was a complete shipment and the number of items short-shipped, otherwise), and (3) order cycle time.[2] Better supply chain performance implies more complete shipments, smaller short shipment quantities, and shorter order cycles.

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[1]The item price quoted is the "delivered price" including all transportation costs for domestic purchases and the domestic portion of transportation costs for international purchases. Delivered prices are equalized across purchasers, so there is no dispersion in prices due to actual travel cost differentials.

[2]Order cycle is defined as the elapsed time between when an order is placed and when it is shipped.

4.3 Model Specification and Estimation

To test the four hypotheses, we can specify the regression models as follows:

$$\{FILL; SHORT; CYCLE\} = \beta_0 + \beta_1 \text{ INTERNET} + \beta_2 \text{ EDI} + \beta_3 \text{ DISINTERMEDIATED}$$
$$\text{CHANNEL} + \beta_4 \text{ VOLUME} + \beta_5 \text{ PRICE} \tag{1}$$

$$\{PRICE; DISPERSION\} = \gamma_0 + \gamma_1 \text{ INTERNET} + \gamma_2 \text{ EDI} + \gamma_3 \text{ DISINTERMEDIATED}$$
$$\text{CHANNEL} + \gamma_4 \text{ VOLUME} \tag{2}$$

5   FINDINGS

Preliminary analyses were run on a selected data sample for office products shipped during April 2000, representing 2,764 products, 59 buyers, and 104,777 observations. Results are presented in Table 1. These initial findings show support for H1a, with electronic transaction channels (both EDI and Internet) exhibiting better supply chain performance than traditional transaction

Table 1. Regression Results[3]

(Numbers in parentheses are standard errors.)

Independent Variable	Supply Chain Performance			Price and Price Dispersion	
	Equation 1 **Complete Shipment**	*Equation 2* **Short Shipment**	*Equation 3* **Order Cycle Time**	*Equation 4* **Normalized Price**	*Equation 5* **Price Dispersion**
Constant	1.40** (.03)	-321.86** (5.55)	3.35** (.16)	-.01 (.01)	-.59** (.08)
Internet	.71** (.03)	-104.11** (5.53)	-10.49** (.18)	.02[+] (.01)	-.41** (.08)
EDI	.17** (.03)	-14.83** (5.32)	-.22 (.17)	-.00 (.01)	-.49** (.08)
Disintermediated Channel	2.21** (.27)	-228.94* (31.88)	20.51** (.58)	-.35** (.04)	8.72** (.28)
Normalized Price	.08** (.01)	-4.26* (1.53)	-1.18** (.05)		
Transaction Volume	-.00** (.00)	.02** (.00)	-.00** (.00)	-.00** (.00)	-.00** (.00)
Model Statistics N Model Fit	104,777 85480 (-2 log likelihood)	104,777 -93152 (log likelihood)	104,777 -279039 (log likelihood)	104,777 .0013 (adjusted R-Squared)	104,777 .0121 (adjusted R-Squared)

[+]$p < .05$; *$p < .001$; **$p < .000$

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[3]Equation 1 is logit, Equations 2 and 3 Tobit, and Equations 4 and 5 OLS. The base case for all regressions is traditional transaction channel and intermediated channel.

channels. H1b was partially supported, with disintermediated channels (direct supplier to customer shipments) offering more complete shipments and fewer items short-shipped, but longer order cycle times, than intermediated channels. H2a was also partially supported, as electronic transaction channels (both EDI and Internet) showed significantly less price dispersion than traditional channels. The Internet channel, however, had slightly higher prices. Finally, H2b was supported, as the disintermediated distribution channel resulted in significantly lower prices.

The results are in partial agreement with previous research finding ESCs result in improved supply chain performance (Choudhury et al. 1998; Srinivasan et al. 1994) and result in heightened price competition (Lee et al. 2000). However, this preliminary analysis suggests that the relationship between transaction and distribution channel and prices and performance may be more complex than previously thought, given the longer order cycle time for disintermediated shipments and the higher prices for Internet transactions.

6 CONTRIBUTION

The research provides empirical evidence comparing electronic and traditional markets, and intermediated and disintermediated channels, in terms of supply chain performance and pricing. The preliminary findings suggest that the effect of electronic channels and disintermediation on prices, price dispersion, and supply chain performance is complex. Use of the Internet to transact purchases appears to improve performance in terms of cycle time and complete shipments, but does not appear to reduce prices. Disintermediation of the supply chain reduces short shipment and lowers prices, but does not improve cycle time. Clearly, further analysis needs to be performed to verify these results.

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