

**THE IMPACT OF NATIONAL DATA NETWORKS  
ON FIRM PERFORMANCE AND MARKET STRUCTURE**

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**ABSTRACT**

An open data network is one that allows firms to exchange information with outside entities, and a national data network is one that provides virtually universal access, interconnecting most businesses and private citizens in a country. Establishing a national data network is very costly and must be justified by its economic, service, and societal impact. France with its Teletel system is close to having a national data network, whereas the United States is not. Using data from 619 businesses in France and the United States we examine several claims: 1) open networks have improve firms' productivity, efficiency, and quality of service; 2) national open networks allow relationships among firms to be based on an electronic marketplace; and 3) national open networks differentially benefit small and medium sized firms. The results show that firms using open networks are more efficient and profitable and have more stable relationships with their customers. The natural advantage that large firms have to exploit new technology has been moderated in France, since small and medium-sized firms who used the national network

have gained the same advantages as large firms. However, even in France, the use of open networks by the general population of firms is still relatively low, thus arguing for a long diffusion constant for the beneficial effects of open networks.

# THE IMPACT OF NATIONAL DATA NETWORKS ON FIRM PERFORMANCE AND MARKET STRUCTURE

## INTRODUCTION

### National versus industry specific open data networks

Open networks allow firms to share computerized data with customers, suppliers and others outside the firm. Businesses invest in these data networks to gain competitive advantage. Creating ubiquitous open networks that interconnect most businesses and citizens in a country will cost many billions of dollars of public or private money. While policy makers call for this level investment<sup>1</sup>, to date there is little empirical evidence to justify it. Much of the prior literature is theoretical rather than empirical (e.g., Bakos, 1991; Gurbaxani & Wang, 1991; Malone, Yates, & Benjamin, 1987). This article provides some relevant data by examining how a cross sectional sample of businesses use open data networks. We examine whether the use of these networks is associated with better productivity, efficiency, and quality of service as well as with different types of relationships among firms and their customers. By comparing the use of networks in France and the United States, we provide evidence about the possible effects of a national infrastructure as opposed to proprietary and uncoordinated networks.

A national data network is both ubiquitous and interconnected. As a former head of DARPA and current CEO of the research arm of the US Regional Telephone Operating Companies has argued, "Building a national ... information infrastructure is simply the entry fee for participation in the global economy. It is not enough for a nation's leading companies to participate by building their own private information networks. First-rank nations will see to it that homes, schools, and small businesses as well as large corporations have access to the global information system." (Heilmeier, 1992, p. 50). Policy makers argue that such networks are necessary for reasons of both economic effectiveness and fairness. Network externalities drive economic effectiveness: as more entities have access to networks, the benefit to any entity increases. Fairness is an independent motivation for advocating national networks. To the extent that

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<sup>1</sup> In justifying funding for the High Performance Computing and Communications Initiative, Senator A. Gore (D-Tenn) argued, "Properly harnessed and directed, massive computing power [including high speed national data networks] can change the way America does business and conducts research ... We cannot afford to hesitate in crafting a blueprint to position ourselves for the next century (Gore, 1988)."

networks benefit their users, fairness argues that these benefits should accrue to both small and large users.

The purpose of this paper is to examine the evidence for four propositions about the business use of open data networks. These propositions are: (1) open data networks improve firm performance; (2) national networks magnify the benefits that firms derive from using open networks; (3) small and large firms differentially use and derive benefit from open networks, but national networks diminish large firms' natural advantages in exploiting these networks; and (4) national data networks foster the formation of transaction-based electronic marketplaces.

*Open data networks improve firm performance.* An open data network allows organizations to exchange data with firms, individuals, or other entities.<sup>2</sup> By electronically exchanging data with their customers or suppliers, firms can handle transactions with less staff, ship orders more rapidly or with fewer errors, operate with lower inventories, or coordinate complex processes more easily (Hart & Estrin, 1991).

As in many other domains of information technology investment (Strassman, 1990), rigorously identifying whether these uses of open data networks improve important business outcomes is difficult. It is sometimes possible to establish that information technology investment has had positive local effects on the tasks that the technology was explicitly designed to support. In the case of data networks, for example, Mukhopadhyay (1992) found that EDI networks in the automotive industry decrease the error rates in transactions between suppliers and a large manufacturer. However, identifying downstream effects of new information technology on productivity, profitability or market share is more problematic (Roach, 1991). Given the paucity of the prior evidence about the effects of open networks, one goal of the present article is to examine correlates of open data networks and firm performance.

However, the argument is not simply that open networks improve data transfer tasks and firm performance, but that the ubiquity and interoperability of a national network adds incremental value. A national network might have incremental effects in three ways: 1) by changing the effects that networks have on firm performance, 2) by changing who uses networks, and 3) by changing the relationships among firms and their customers. We address these hypotheses below.

*National networks diminish large firms' natural advantages in exploiting open networks.* Generally, organizational size and wealth strongly determine use of new technology and other innovations (Tornatzky & Klein, 1982). Larger organizations typically have spare resources in the

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<sup>2</sup> We use the phrase *open data networks* analogously to the phrase *inter-organizational networks* (Hart & Estrin, 1991), but recognize that organizations can use networks to connect to individuals, households, or other entities as well as to other organizations.

form of both expertise and money that allow them to experiment with and deploy innovations. However, as a technology becomes more widely used and standardized, its price declines and the expertise to deploy it becomes available in the market place and does not need to reside within a deploying firm. Moreover, in the case of communication networks, the costs are shared across users. For these reasons national scope should make open networks more available to small firms (France Telecom, 1990).

In the United States where data networks are comparatively rare and incompatible, communication applications must be written on an industry or even firm specific basis. In contrast, in France, the national Teletel videotex system provides a relatively ubiquitous data network and display standard. Reports based on interviews with several Minitel business users indicate that the presence of the Teletel system greatly facilitates the development of communications-intensive data applications (France Telecom, 1990; Kraut, Lucas, Streeter, unpublished data).

*Open networks promote electronic marketplaces.* How firms use networks is likely to vary, depending both on the firm's competitive strategy and on the maturity and ubiquity of the networks. In general firms that compete on the basis of product and service distinctiveness are likely to use networks to establish proprietary links to their customers, while firms that compete on the basis of price might use networks to lower costs and to broaden their customer base. Similarly, early in the evolution of networks, when only a few firms are using them, entry and exit costs are likely to be high and the networks are likely to be used to establish proprietary relationships with customers. As network usage becomes more general, customers are likely to use networks to instill competition among suppliers (Malone et al., 1990). Because national networks lower switching costs and connect many more parties, customers can more easily shop among suppliers to best meet their product, price or service needs. The ubiquity of national networks means that suppliers have data access to national and mass markets, rather than being restricted to niche markets.

### Research Strategy

There have been few empirical studies of the impact of open data networks, particularly the role of national networks. This article examines propositions about the use of open networks through a cross-national survey of 619 firms that differ in the degree to which they use open networks. To examine the role of open networks across a wide range of industries, this article focuses on sales and order processing among firms in the tangible goods industries (wholesale, retail, and manufacturing). Sales and relationships with customers are important elements of success in all business. Moreover, since sales and fulfillment functions are often initial targets of

automation, this domain is a likely site for examining effects of open networks across a wide range of industries.

To test propositions about national networks, we compared firms in France, where the Teletel videotex system provides a rudimentary national data network, with firms in the United States, where networks are isolated and industry specific.

### National Networks in France and the US

*France's national data network.* Teletel, the French videotex system, provides a national data network for businesses as well as information services for consumers. Teletel consists of widespread deployment of the Minitel data terminal, an electronic telephone directory, and over 17,000 information and communication services and business applications. In 1992, there were over six million Minitel terminals in France with a growth rate of approximately 10% per year. About 20% of French households have Minitel and about 80% of businesses have at least one Minitel. Altogether about 40% of the non-retired French population has access to Teletel either at work or at home (France Telecom, 1992). Although a minority of services are password protected, for most services any member of the public can access the them on a non-subscription basis; either the customer or service provider is billed on a usage sensitive basis.

Whereas Teletel began as a mass market service, growth is shifting from mass market entertainment and information services to business-oriented information services and internal operation applications. In 1990 nearly 50% of the services were business-oriented. About 15,000 companies have created their own internal videotex services.

It is relatively easy to create Teletel services, and many service bureaus exist to aid in their development. Reports based on interviews with several Minitel users indicate that the presence of the Teletel system greatly facilitates the development of communications-intensive business applications. Common commercial applications include inventory control, order-entry, electronic catalogues and listings of available products, electronic mail, and on-line company directories.

*The United States as a collection of isolated data networks.* In the United States there is no widely available videotex service for the mass market. Videotex systems in the United States are limited to an estimated 5% of households with both home computers and modems. In 1992 approximately 3 million people subscribed to some form of on-line computer service targeted for home consumers (Arlen, 1992). On-line databases such as Mead Data Central and Dialog have been successful by appealing to the business and scientific niche market. While there are some national data networks (the Internet, Bitnet, Tymnet, etc.), they are fragmented, serving different client communities. Businesses subscribing to one network cannot easily exchange data with



businesses subscribing to another, except through electronic mail gateways. The general public has virtually no access to any of these business or scientific networks.

While many business applications using open networks exist, they typically are industry or firm specific. Perhaps the most common use of open networks in US industry today is Electronic Data Interchange (EDI), the standard many manufactures and their suppliers use for ordering, billing, and inventory control. Except for the rare special purpose network designed for mass market access (e.g., the banking industry's Automatic Teller Machine network), these industry specific networks connect only a relatively small number of well defined entities (e.g., Chrysler and its 17,000 suppliers ).

### **The research model.**

Figure 1 shows the model underlying our analyses. Although establishing causation in a cross sectional survey is impossible, based on the reasoning described previously, we assume that some variables, such as firm resources, and the availability of a national network, are likely causes of the extent to which and manner in which a firm uses open networks. (In the short run it is unlikely that network usage would lead to changes in firms' resources.) We also treat a firm's competitive strategy as a possible cause of network use, although the availability of networks may change firms' competitive strategies and the way they attempt to deal with their customers (Steinfeld & Caby, 1990). Other variables, including firm performance, firm efficiency, and customer relationships, are more plausibly seen as outcomes of using open networks. We treat the industrial sector in which a firm is located as an important control variable. A regression analysis is used to identify characteristics of firms and their business environment that predict their use of open networks and to predict associations of using networks, holding constant these characteristics



of the business environment.

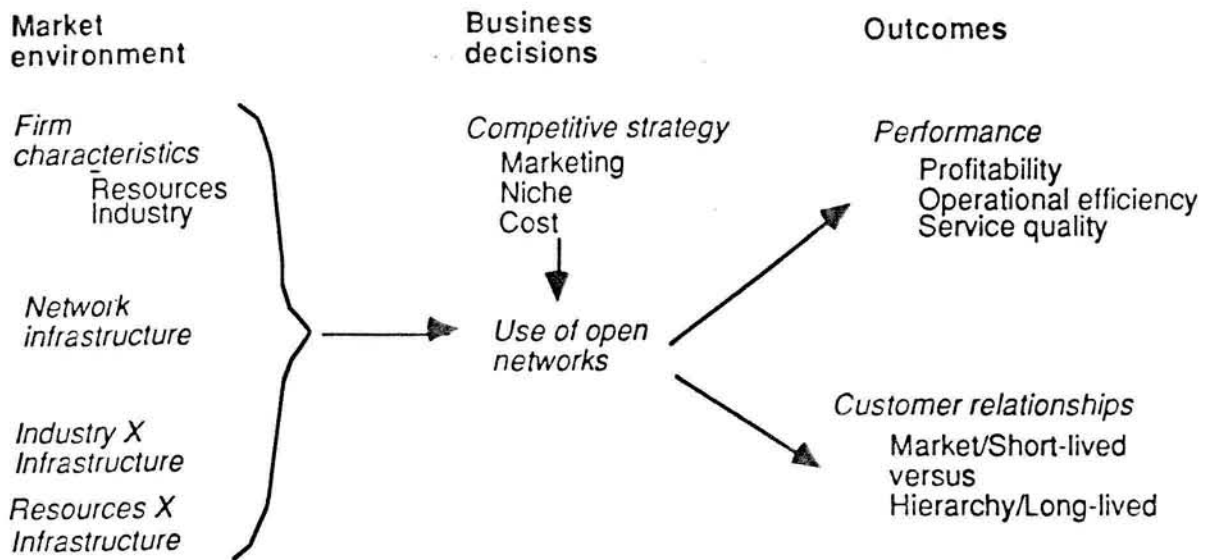


Figure 1: A model of open network use.

The analyses test the following propositions:

- 1a. Firms with greater resources will use open networks more.
- 1b. Firms for which a national data network is available will use open networks more.
- 1c. The correlation between firm resources and network usage will be reduced, if a national data network is available.
  
- 2a. Firms that are aggressively marketing oriented will use open networks more.
- 2b. Firms that compete by reducing costs will use open networks more.
  
- 3a. Firms that use open networks more will be more profitable.
- 3b. Firms that use open networks more will operate more efficiently.
- 3c. Firms that use open networks more will provide customers with better service quality.
- 3d. Firms that use open networks more will have more market-like relationships with their customers if a national infrastructure is available, but will have more hierarchical relationships with their customers if a national infrastructure is not available.

## Methods

### Sample

This article compares three samples of firms in the France and the United States, matched on industry and firm size: a Teletel sample, a French general sample, and a US general sample.

The Teletel firms represent a random sample, stratified by number of employees, of all 4,585 commercial<sup>3</sup> firms identified by France Telecom as using Teletel for at least one business application. Prior to sampling, the nature of the application was not known, nor was it known whether the application was strictly internal (e.g. allowing company field representatives to access an on-line price list) or involved people outside the firm (e.g., allowing customers to order from a firm). We determined the number of employees in a firm and its 4-digit Standard Industrial Code [SIC] from International Dun's Market Identifiers. For the approximately 30% of the Teletel sample not listed in the International Dun and Bradstreet database, we used an interview to determine number of employees and industry (based on descriptions of the firms' primary and secondary products).

The French general and the United States samples were drawn as random samples from the International and US Dun and Bradstreet databases, stratified to reflect the size and industry (4-digit SIC codes) distributions of the Teletel sample. The French general sample was selected with replacement. That is, if a firm had been included in the Teletel sample and was randomly selected for the French general sample, it was included in both samples. There were 31 such firms. To have sampled without replacement would have underestimated the true business usage of Teletel in the French population of businesses.

Each of the samples was stratified with respect to size. There were four size categories: (1) from 6 to 20 employees; (2) 21 to 100 employees; (3) from 101 to 500 employees; and (4) greater than 500 employees. Since pretest interviews showed very small firms used virtually no networking technology beyond the telephone, the sample excluded firms with fewer than six employees.

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<sup>3</sup> The "commercial" classification was based on the French industrial classification known as APE codes. Since the French APE codes do not map directly to US Standard Industrial Codes (SIC), 13% of the Teletel sample were in banking, finance, real estate, or services, rather than in the wholesale, retail, or manufacturing sectors.

Because of differential non-response rates across industries and countries and occasional administrative problems, the comparability of the three samples is only approximate. Table 1 shows the distribution of the three samples across industry and size. To control for these differences among samples, four industrial categories (Manufacturing, Wholesale, Retail, and Other) are included as controls in all the analyses that follow.

		US	Teletel	French general	Total
<b>N</b>		225	193	201	619
<b>Industry</b>	<i>Manufacturing</i>	99	55	67	221
	<i>Wholesale</i>	87	69	61	217
	<i>Retail</i>	18	39	46	103
	<i>Other</i>	21	30	27	78
<b>Number of Employees</b>	<i>6-20</i>	44	46	52	146
	<i>21-100</i>	50	53	49	153
	<i>101-500</i>	61	42	52	157
	<i>&gt; 500</i>	70	52	48	170

Table 1: Sample attributes

### Data collection

Data were collected through telephone interviews. The controller or other senior financial manager of each firm selected for the sample was sent a letter explaining the project. After approximately one week, an interviewer called to arrange the interview. Interviewers made up to 10 call backs before discarding a firm. The effective response rate was 69%. At the appointment time, the interviewer administered a 15-30 minute long, computer-assisted survey. After answering questions about general firm functioning, competitive strategy, and financial performance, the financial manager was asked to recommend the most senior manager in the firm who could best answer questions about the firm's sales and the order fulfillment procedures. This individual was contacted for an additional telephone interview. If the financial managers felt comfortable answering questions about operations, they were given the second interview; 87% of financial managers completed both halves of the survey, with this tendency greater among small firms and in France.

The survey was originally constructed in English, translated into French, and translated back into English to insure comparable wording. Interviews were conducted in the Fall and Winter of 1991-92, over a three month period in France and a five month period in the United States.

## Measures

Appendix 1 shows the items used to measure variables from Figure 1, and their internal reliabilities, if appropriate. The paragraphs below provide an overview of these measures.

*Industry.* Based on a firm's 4-digit SIC code, firms were classified into one of four industry groups: wholesale, retail, manufacturing and other.

*Network infrastructure.* National network infrastructure was determined by the sample: Teletel, French general and US. All firms in France had the Teletel network available to them, although only the Teletel firms were known to be using it for business applications. In addition, firms in France had other open networks available, including firm specific and industry networks. In the US sample, firms had access to the and non-interconnected data networks with no coherent national data network available. The clearest case for demonstrating the importance of a national infrastructure would occur if the French general and Teletel sample were similar to each other and different from the US sample in the variables that predict network usage and in the variables that network use predicts. The interpretation is clouded to the extent that the two French samples differ.

*Firm resources.* To provide an estimate of firm resources, two highly correlated variables were combined, company sales and number of employees in 1990. Data on employees comes from Dun and Bradstreet or the interview if not available from Duns. Data on sales came from the financial managers' interview or Dun and Bradstreet if the respondent refused to answer. Because both measures are non-normally distributed, we took the log of each variable before creating this scale. The log of each variable was standardized, with a mean of 0 and variance of 1, and then the results were averaged.

*Network use.* The network use scale consists of 16 items, listed in Appendix 1, that describe the extent to which the firm use data networks to communicate with individuals and firms outside of their own business. For example, respondents described whether their data networks were open to any outsiders, whether they could communicate with customers by computer, and the percentage of orders from large and average sized customers they receive by computer. These items were standardized to a mean of 0 and a standard deviation of 1 and then averaged.

*Competitive strategies.* The scales for competitive strategy were constructed, based on prior work by Dess and Davis (1984), Miller (1987; 1988) and Weill (1990). Items in the scales were intended to measure the extent to which firms compete by distributing a wide range of goods and services, by selling to niche versus mass markets, and by being the low cost producer in a market. Firms with a product/marketing orientation focus on rapidly developing new products and advertising them aggressively. Firms with a niche orientation focus on developing new specialized

markets for their products rather than selling to the mass market. Firms with a cost orientation compete by trying to be the lowest cost producers in a market.

*Firm performance.* The firm performance measures include variables directly connected to order fulfillment -- order processing efficiency, quality, and speed -- and a broad measure of firm profitability. We include three measures of order processing efficiency: *Orders per employee* is the number of orders in 1990 divided by the number of employees, expressed in quintiles. *Employees per order* is the respondent's estimate of the number of people who handle an order as it is being processed, not counting production personnel. *Cost per order* is the respondent's estimate of the direct cost to process an order.

We included four measures of service quality. *Returns, backorders, and errors* are respectively the percentage of all orders that are returned for any reason, are backordered after once being in stock, and are in error for any reason. *Order processing speed* is the length of time an order is in house before being shipped.

Finally, *profitability* is the respondent's estimate of the firm's 1990 profits or losses, expressed in quintiles.

*Customer relationships.* Two variables are designed to measure the extent to which firms have relatively transient, market-like relationships with their customers, or more stable, hierarchical relationships. *Customer longevity* is the number of years the largest customer has been ordering from the company. *Repeat ordering* is the percentage of both large and regular customers who place more than two orders a month. A high score on these variables indicates less market-like relationships between firms and their customers and more stable, hierarchical relationships. If a supplier faces a competitive market, customers will not display high loyalty: customers will search the market for the best prices and, as a result, will not have done business with any firm for very long, and fewer customers will place multiple orders during the year.

*Control variables.* Because the way and efficiency with which firms process orders depend on the average price of an order, this was included as a control variable in analyses predicting customer relationships and operational efficiency.

## Analysis

The results described in the next section are a path analysis based on ordinary least squares regression. First, we use network infrastructure, industry, firm resources, competitive strategy and their interactions to predict the extent to which a firm uses open networks. Second we use these variables, the control variables, network usage, and the interaction of network usage and network infrastructure to predict customer relationships and firm performance.

## Results

The first column in Table 3 shows the statistical main effects of industry, network infrastructure, and firm resources on network usage. In terms of our predictions, firms with more resources -- more employees and sales -- use open networks more. Surprisingly, the prediction that a national infrastructure would be associated with the use of open networks was only partially supported by the data. While the Teletel sample used open networks more than did the US sample, the French general and US samples did not differ from each other. Tables 4 and 5 show this phenomenon more concretely. Table 4 shows the proportion of orders that come into firms by several routes, including electronically (either by computer or Teletel). While the Teletel sample has more electronic ordering than the US sample, it also has more electronic ordering than the French general sample, which in turn does not differ the US sample. Rather the two French samples use text based ordering (i.e., mail and fax) more and phone ordering less than the US. Electronic ordering is a minority strategy in all samples.



	Structural main effects	Structural main effects + interactions	Structural main effects + interactions + strategy
N	619	619	610
Adjusted R <sup>2</sup>	.14	.17	.19
Independent Variables			
Intercept	.22	-.21	-.23
Infrastructure			
US	.02	.06	.09
Minitel	.58***	1.24***	1.20***
French general	.00	.00	.00
Industry			
Manufacturing	-.43***	-.11	-.11
Wholesale	-.24**	-.02	-.03
Retail	-.12	.40*	.33
Other	.00	.00	.00
Firm resources	.27***	.40***	.34***
Firm resources X infrastructure		***	**
US		-.09	-.03
Minitel		-.26**	-.26***
French general		.00	.00
Infrastructure X industry		***	***
Marketing orientation			.06*
Firm resources X marketing orientation			.08*

Note: For variables with one degree of freedom the table entries represent standardized beta weights and their significance levels. For variables with more degrees of freedom, the table shows significance levels only.

\*\*\* p <= .001

\*\* p <= .05

\* p <= .10

Table 3: Predicting use of open networks

Route	US	Teletel	French general
Mail	21 <sup>a</sup>	32 <sup>b</sup>	36 <sup>b</sup>
Telephone	43 <sup>a</sup>	24 <sup>b</sup>	19 <sup>b</sup>
Fax	12 <sup>a</sup>	20 <sup>b</sup>	22 <sup>b</sup>
Person	18 <sup>a</sup>	28 <sup>b</sup>	31 <sup>b</sup>
Electronically	4 <sup>a</sup>	9 <sup>b</sup>	3 <sup>a</sup>

Note: Numbers within a row with different superscripts different significantly from each other at the .05 level.

Table 4: Percentage of orders entering by different routes



Table 5 shows the percentage of occasions respondents reported using data networks for other business functions. The items in the top pane of Figure 5 represent external communication, and have been included in the open network scale. The items in the lower pane represent internal communication. Again the data show that across a number of tasks, the Teletel sample is more likely to use data networks than either the US or French general sample, which generally do not differ from each other.

Task	US	Teletel	French general
Order from suppliers	6 <sup>a</sup>	14 <sup>b</sup>	10 <sup>a</sup>
Customer track orders	2 <sup>a</sup>	6 <sup>b</sup>	3 <sup>a</sup>
Communicate with customers	6 <sup>a</sup>	7 <sup>a</sup>	3 <sup>b</sup>
Distribute documentation to customers	4 <sup>a</sup>	7 <sup>b</sup>	4 <sup>a</sup>
Employees check inventory	69 <sup>a</sup>	90 <sup>b</sup>	77 <sup>c</sup>
Employee-employee communication	11 <sup>a</sup>	26 <sup>b</sup>	14 <sup>a</sup>
Find corporate phone numbers	11 <sup>a</sup>	22 <sup>b</sup>	23 <sup>b</sup>

Note: Numbers within a row with different superscript are significantly different from each other at the .05 level.

Table 5: Percentage of time tasks are done electronically

The second column in Table 3 provides partial support for the prediction that a national network reduces the advantage that large firms have in using open networks. We expected an infrastructure by firm resources statistical interaction, in which the association of open networks with firm resources would be reduced in France. The regression analysis shows a significant interaction of infrastructure by firm resources in predicting network usage. But Figure 2, which plots the overall fitted model, shows that the leveling of the firm resource effect on network usage occurs only for the Teletel sample. In both the French general sample, for which a national network is available, and the US sample, for which no national network is available, firms with more resources use open networks more extensively than firms with few resources.

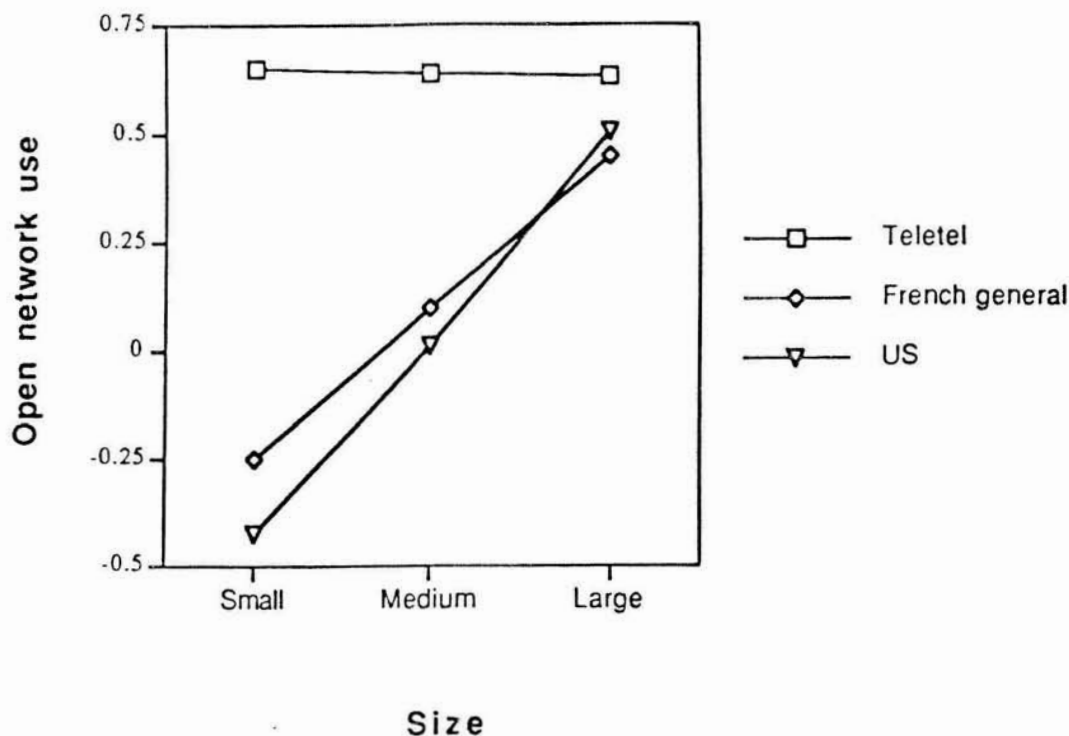


Figure 2: Association of firm resources and use of open networks by sample

Column 3 in Table 3 adds the product/marketing orientation scale to the structural variables already examined. It shows that the more firms have a product/marketing orientation, the more they use open networks. Surprisingly, a cost reduction orientation was unrelated to the use of open networks, and this variable was dropped from the model. These findings suggest that firms are using open networks to make it easier for customers to do business with them, rather than to increase their efficiency.

#### Effects on Firm Performance

In this section we test the hypotheses that greater use of open networks is associated with better firm performance. Table 4 shows the results the multiple regression analyses, controlling for variables that the previous analysis suggested were associated with network use. Results show a marginally significant association of network usage with profits in the expected direction. Firms that use open networks more were more profitable in 1990.

	Profits	Orders per employee	Cost per order	Errors	Customer longevity	Reorders
N	360	376	381	561	319 <sup>a</sup>	556
Adjusted R <sup>2</sup>	.27*	.48***	.27***	.05***	.12**	.09***
Independent Variables						
Network usage	.09*	.21***	.06	-.02	.18**	.13**
Intercept	.36	-.47	-.23	-.32	.14	1.18
Infrastructure	-	-	*	***	**	***
US	-.47	-.27**	-.34**	1.34**	-.60	-.91***
Minitel	-.27	-.23***	-.58**	.10	-.54*	-.08
French general	.00	.00	.00	.00	.00	.00
Industry	-	***	**	-	**	-
Manufacturing	-.10	-.34**	.09	.33	.52	-.08
Wholesale	-.32	-.63**	.59**	.10	-.27	-.11
Retail	-.24	-.82	.13	.16	-.34	-.52**
Other	.00	.00	.00	.00	.00	.00
Firm resources	.73***	-.12	.47***	.03	.15*	.05
Firm resources X infrastructure	-	-	**	-	-	*
US	-.26*	.06	-.38**	-.04	.10	.13**
Minitel	-.13	-.00	-.02	.03	-.06	.12
French general	.00	.00	.00	.00	.00	.00
Infrastructure X industry	-	*	-	-	*	-
Marketing orientation	-.05	.07	-.05**	-.03	-.05	.03
Firm resources X market orientation	-.05	-.07	-.07	.04	.06	-.01
Cost of average order	NA	-.47***	.32***	NA	NA	NA

Note: For variables with one degree of freedom the table entries represent standardized beta weights and their significance levels. For variables with more than one degree of freedom, the table shows significance levels only.

- <sup>a</sup> Of the 356 firms reporting that they had large customers who differed from a typical customer
- \*\*\* p <= .001
- \*\* p <= .05
- \* p <= .10
- p > .10

Table 6: Regression of network usage on outcomes

Network use was also associated with one measure of the efficiency with which orders are processed. As the second column in Table 4 shows, use of open networks was significantly associated with the number of orders the firm handled per employee. On the other hand, more direct measures of ordering efficiency -- estimates of cost and personnel to process a typical order -- did not show associations with open network usage, once the average cost of an order was included as a control variable. Column three shows the results for the estimated costs to process a typical orders. The results for number of employees who handle a typical order were also non-significant.

There were also no associations of network usage with any measures of service quality included in the study. In particular, firms that use open networks more did not have fewer errors in shipping orders (as shown in Column 4,  $\beta = -.02$ ,  $p > .65$ ), backorders ( $\beta = -.03$ ,  $df = 1,558$ ,  $p > .45$ ) or returns ( $\beta = .03$ ,  $df = 1,566$ ,  $p > .45$ ) and were not quicker in shipping orders ( $\beta = 0$ ,  $df = 1,343$ ,  $p > .90$ ).

#### **Effect of Open Networks on the Firm's Relationships to Customers**

We presented two competing hypotheses for the effects open networks might have on relationships between firms and their customers. One is that open networks promote hierarchies: firms use open networks for competitive advantage by binding their customers to themselves. The competing argument is that ubiquitous open networks promote electronic markets: customers use open networks to shop among suppliers, and thus relationships between them tend to be short-lived and market-based.

In this study the hierarchy/market continuum was operationalized as customer loyalty. The data support the hierarchy hypothesis over the market hypothesis. Column 5 of Table 6 shows that firms using open networks more have customers that have traded with them for a longer period of time, and column 6 shows their customers trade with them more frequently.

It is possible that effects of open networks depend on a particular firm and an industry's expertise in using networks. One might expect that open networks would lead to market relationship most when the networks are widely deployed in an industry and when the deploying firms have had substantial experience with them. However, additional analyses, not reported in Table 6, show that the association of open networks with measures of customer loyalty did not differ for industries with higher penetrations of network usage or for firm that had used open networks for a longer time.

## **Conclusions**

*The role of a national network infrastructure.* The results support a weak form of the national infrastructure hypotheses -- that a national infrastructure increases network usage in general and promotes technological participation of small firms by reducing their capital and expertise disadvantages. While these hypotheses are consistent with the data from the Teletel sample, they are not consistent with data from the French general sample. Firms in the Teletel sample used open networks more intensively and for more different business functions than those in the US. Moreover, the association of firm resources on use of open networks was substantially reduced in the Teletel sample compared to firms in the United States. On the other hand, the US and French general sample did not differ in terms of overall usage of open networks or the effects of size and resources on usage.

The results for the Teletel sample have two alternate interpretations, one substantive and one methodological. The substantive interpretation is that the Teletel sample consists of early adopters of technology, and that their behavior provides a forecast of how less advanced firms will operate in the future, when open networks are more ubiquitous, barriers to use are reduced, and experience with them is more common (Urban & von Hippel, 1986). In 1991, when this study was done, use of open network was still low, even in France and even among the Teletel firms, as the data in Tables 4 and 5 illustrate. Truly national data networks (analogous to the US Telephone network) did not yet exist. If the firms in the Teletel sample are indeed lead users, one would expect that once data networks are widely deployed, small firms will be able to exploit open networks almost as easily as large firms, just as they did in the Teletel sample. Given the positive association of network usage with firm efficiency and profitability, one implication is that a national network infrastructure could promote competitiveness of small and medium sized firms, which are responsible for much of the growth in the economy. Future longitudinal or cross sectional research comparing eras, countries, or industries with differential diffusion of open networks is necessary to test this interpretation.

A methodological interpretation of results for the Teletel sample is less informative about public policy. According to the methodological interpretation, the Teletel sample differs from the US and French general sample on some uncontrolled or unmeasured variables, and sample differences in degree of network usage result from these hidden differences. While the samples were matched on many relevant dimensions (e.g., industry at the 4-digit SIC code level, country and size.), the French general and Teletel sample may still differ on other relevant dimensions. It is possible, for example, that Teletel firms use open network and other technological innovations more because they have a more technologically sophisticated work force. This technological preeminence gives them a competitive advantage that we attribute erroneously to the availability of a national infrastructure. This argues that early adopters of technology may not be representative, and it may be dangerous to use their behavior as a basis of forecasting.

*The role of open networks in firms.* This research presents evidence that firms using open networks operate more efficiently, at least in the area of order processing. That is, firms that can communicate outside the company through data networks handle orders with less labor, whether the firm is large or small, in France or the US, or uses Teletel or a proprietary data network. Although the results are consistent with the hypothesis that use of open network leads to efficiencies, no causal order can be established from these cross sectional data. Surprisingly, we found no effects of using open networks on the order processing service quality -- the elapsed time in which orders are processed and the errors associated with them -- although other researchers have (e.g., Mukhopadhyay & Kekre, 1991).



Our data also speak to the controversy about whether data networks change customer-supplier relationships. Economic theory leads to the hypothesis that by lowering the costs of finding and transacting business with suppliers, open networks encourage market relationships between firms. Yet our data show that firms that use open networks more have more stable relationships with their customers; a typical customer trades with them more frequently and for a longer duration. From the cross sectional data, we cannot tell whether open networks encourage customer loyalty or firms deploy open networks primarily when they have loyal customers. In either case, the association of open networks with customer loyalty is inconsistent with the electronic market hypothesis. Together with the finding that firms with a marketing oriented competitive strategy use open networks more, the data suggest that firms are using networks as a competitive tool to tie their customers to themselves. (See also Steinfield, Caby, & Vialle, 1992, for case study material leading to similar conclusions.) Only time will tell whether this is a temporary strategy that will change as networks become more ubiquitous or as customers grow more sophisticated in using them.

*A national infrastructure.* While this research supports the hypothesis that open data networks are valuable to firms, it raises questions about the role of a national infrastructure. Does a national infrastructure make it easier for small firms to reap the advantage of networks? Will it lead to electronic market places? The answers to these questions depend on the degree to which the French Teletel experience approximates a ubiquitous national data network. Our observations suggest that even in France, it may be still too early to see strong effects of a national data network.

If our analysis and interpretation of the data is correct, what do these results and our study of networks in France and the US imply for national policy? The US is currently involved in planning for a dramatically expanded national network. Debate centers around the focus of the network, the role of government and the role of existing communications companies in developing the network. Based on our findings and on our background research, we have the following recommendations:

1. There must be strong central support for a network; the French videotex system, Teletel succeeded partially because the French government provided strong direction and guidance in its development.

2. While the home use of Teletel has been the most successful videotex application undertaken in any country, we think it is unlikely that any special purpose Minitel-like terminal will take hold in the US. Previous videotex efforts in the US have been unsuccessful and audiotex now plays a similar role to videotex in France. While the functionality of audiotex is more limited than videotex, most of the audiotex residential services either do not need this increased functionality or compensate by using human intermediaries. For example, in France, Teletel is used extensively for mail order applications while in the US 800 numbers are used for mail order sales. Evidentially

the demand for more complex services will exist in the residential market place and will probably require more bandwidth than the current Minitel or an ordinary telephone. In the US the "terminal" of choice for these services will probably be a PC or its decendent.. Thus, in the shorter run we recommend that the US focus on education, health care, and business applications. These organizations are likely to already possess the computers and modems necessary to interconnect to the network or are in position to acquire the needed equipment easily.

3. Firms with more resources in the US already make use of data networks. An appropriate role for the government would be to encourage smaller organizations to take advantage of a national data network. This assistance might be provided by government sponsored network consulting firms; these groups would show small businesses, local schools and others how to use the network and what kind of applications might benefit these smaller organizations. This program would be similar to existing government sponsored engineering consulting firms and to the county agent that has done so much to improve agricultural productivity in the US.

This research has convinced us of the value and importance of concerted long-range planning on the part of government and private industry. The Teletel experiment is in its second decade. It was part of an effort that successfully propelled French telecommunications from a far follower to one of the two or three world leaders. The fact that the ordinary French businesses are equivalent to and have not surpassed the ordinary US businesses in network usage attests to the fact that the timescale for reaping the benefits of a massive infrastructure investment is longer than we had anticipated.

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## Appendix 1: Measures

<b>Network use (<math>\alpha=.81</math>)</b>	
% of orders that come in electronically	advertise by computer
% of large & average customers that order electronically	distribute product documentation by computer
customers can order electronically	customers check inventory by computer
customers can track orders by computer	% of average customers that order electronically
customers can access your computers	% of largest customers that order electronically
non-employees can communicate with you by computer	customers can access your network
non-employees can access your network	distribute product documentation by computer
exchange messages with customers by computer	advertise by computer
<b>Firm resources (<math>\alpha=.75</math>)</b>	
log(total 1990 sales)	log(number of employees in 1990)
<b>Product/Marketing orientation: (<math>\alpha=.52</math>)</b>	
Our company has a high rate of new product introduction	We try to beat the competition to the market
We advertise extensively	We offer a large number of products and services
<b>Cost orientation:</b>	
We try to sell products at or near the lowest price in the industry	
<b>Order frequency (<math>\alpha=.70</math>)</b>	
% of large customers who order at least twice per month	% of average customers who order at least twice per month
<b>Order processing quality</b>	
100-% of orders returned	100-% of orders in error
100-% of orders backordered	
<b>Order processing efficiency</b>	
Direct costs to process an order (reversed)	Number of employees handling an order (reversed)
Number of orders per employee	