

The Telegraph's Effect on Nineteenth Century Markets and Firms

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The second half of the nineteenth century was a period of extensive, seemingly contradictory change in the economy of the United States. Until that time, the economy was characterized by small, predominantly single-function firms operating in local and regional markets. Then, under the influence of improved communication and transportation, local and regional market areas merged into larger national ones. In some industries, fast and efficient national markets arose to coordinate related economic activities within the expanded market areas. In others, small firms grew, merged, and vertically integrated into large, multifunctional firms coordinating various functions or stages of economic activity internally. Since integrated firms were a new development in the US, there was a relative shift towards firm coordination and away from market coordination, though in absolute terms markets were handling more transactions than ever.

Many developments affected the trade-offs between the integrated firm and the market as modes of coordinating various functions. This paper explores the telegraph's seemingly contradictory effects on these trade-offs. By radically reducing the time and cost for long-distance communication, it facilitated the emergence of large and efficient markets. In addition, however, it provided an important method by which large firms could efficiently coordinate various activities previously coordinated by markets.

The role of the telegraph in the economic expansion of the second half of the nineteenth century has frequently been mentioned, but rarely studied. Alfred Chandler [2] has examined it more closely than most general business

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historians, though in the context of a much broader argument, and I will draw on his analysis here. While a few specialized historians have chronicled the evolution of the telegraph network [7, 11], they have considered its impact on the economy only superficially. Only Richard B. DuBoff [4, 5], as far as I know, has directly and seriously addressed the question of the telegraph's influence on markets and firms. He formulated and analyzed the seeming paradox of the telegraph's role in the development of both more efficient markets and larger, monopolistic firms. He has not, however, really explained when and why each of the potential roles of the telegraph predominated in a given industry.

This paper explores the effects of the telegraph on the economy of the mid and late nineteenth century, focusing on the trade-offs between markets and integrated firms (rather than between markets and monopolistic firms) as coordinating mechanisms. Drawing on recent work on the effect of current technological innovations on firms and markets as well as on the historical analyses mentioned above, I analyze the origin of the telegraph's opposing effects both historically and theoretically. Then I present a framework helpful in categorizing the industries in which markets and integrated firms were likely to predominate and, consequently, the way in which the telegraph was likely to be used.

In brief, I will argue that the telegraph encouraged the growth and efficiency of markets by reducing communication time and costs and that it encouraged the growth and vertical integration of firms by forwarding the emergence of national market areas to absorb local and regional market areas. The outcome of these opposing forces in a given industry, especially in cases involving telegraphic communication, can be explained, to a great extent, by looking at two characteristics: the *asset specificity* of the product or process, and the *complexity of the product's description*. In those industries with non-specific products and processes and with simple, standardized product descriptions, the telegraph provided the mechanism for efficient coordination in national markets. Conversely, in industries with highly asset-specific products and/or complex product descriptions, the telegraph facilitated and favored the growth and functional integration of firms.

In the following sections, I will examine first the origin of the telegraph's pro-market influence, then the origin of its pro-firm influence. Finally, I will present the framework for identifying the industries in which it was likely to play each role.

THE TELEGRAPH'S PRO-MARKET INFLUENCE

The telegraph's influence in encouraging the development of larger and more efficient markets is easy to see and understand, though ultimately that influence was less strong than the opposing influences of the telegraph and many other factors towards the growth and integration of firms. First of all, by radically enlarging effective market areas, it simply made *possible* the emergence of efficient, nationwide markets. In addition, by reducing the effective cost of communication over distances, in many cases it favored markets over integrated firms. In this section I will look at this pro-market influence both as it evolved historically and as it looks in a theoretical model of the trade-offs between markets and firms.

Before the telegraph was introduced to the United States in 1844, information could only travel as fast as people could. Although between 1800 and 1840 improvements in transportation had gradually reduced travel times for human travel, the slow speed of travel beyond the northeast section of the United States effectively prohibited the growth of nationwide markets. Travel time between New York and Boston, for example, had been reduced from four days in 1800 to just over half a day in 1840 [10]. However, travel time to New Orleans, another major commercial center, was still measured in weeks, with normal travel time about two weeks in 1830 and express time just under one week. Travel time to California, which was not yet part of the United States, was still measured in months. These speeds prohibited the free exchange of information necessary for efficient nationwide markets. Thus markets tended to be local and regional in scope, with relatively few transactions taking place between those markets.

The telegraph reduced to almost nothing the time to communicate information across great distances. By 1851, only seven years after the inauguration of the pioneer Baltimore-to-Washington line, the entire eastern half of the US up to the Mississippi River was connected by a network of telegraph wires that made virtually instantaneous communication possible. By the end of another decade, the telegraph had reached the west coast, as well [4]. Although the railroad was spanning the continent at the same time, it followed rather than led the telegraph in the westward movement [11, pp. 203-04].

In conjunction with the railroad, the telegraph expanded market area, that is, the area within which goods could be bought and sold under the influence of market forces. For the first time, market participants in distant parts of the country could interact almost instantaneously to gather information and make transactions. As one observer pointed out in 1847,

Operations are made in one day with its aid, by repeated communications, which could not be done in from two to four weeks by mail-enabling [businessmen] to make purchases and sales which other-

wise would be of no benefit to them, in consequence of length of time consumed in negotiation" (De Bow, as cited in [5, p. 263]).

Although the telegraph was more expensive *per word* than letters, it effectively made communication less expensive. Postal rates dropped significantly beginning in 1845, from up to \$0.25 for a one-sheet letter to \$0.03 per ounce by 1851. Telegraph rates were much higher per word, at \$2.05 for the first 10 words between Chicago and New York in 1869, for example, dropping to \$0.50 by the 1870s and 1880s [12]. However, the time difference between the two modes of communication was so enormous as to preclude direct comparison. The telegraph allowed parties to exchange several messages rapidly, thus making it almost interactive; a much more expensive and time-consuming personal visit would be required to improve on it. The rapid exchanges offered by the telegraph were so much more valuable than communication by letter that the communication cost was, in effect, if not per word, radically lowered.

Many merchants and producers rapidly took advantage of this expansion of market areas. The effectively lowered communication costs encouraged them to seek more market information over a greater area to realize greater gains in market transactions. Even before the railroad's influence was very extensive, DuBoff [5] has shown, the telegraph broke through "spatial and temporal barriers," bringing about "pervasive and often dramatic reductions in intermarket price differentials, information costs, and transactions costs." In many cases these reductions thus encouraged increased market interactions over wider markets.

Theoretical Explanation

This force favoring markets can be explained in a more theoretical way if we draw on recent research on organizational structure and modern information technology. Building on the work of such transaction cost analysts as Coase [3] and Williamson [13, 14, 15], Malone and Smith [8, 9] have summarized the trade-offs between markets and integrated firms as coordinating mechanisms in terms of three types of costs: production costs, coordination costs, and vulnerability costs. Using a model that represents only efficiency factors, they compare these costs for several types of firm and market organization. Table 1 illustrates the relevant comparison.¹

¹I have used the model's relative values for the product hierarchy to represent the integrated firm. As Malone [9] comments, since the model for the product hierarchy does not consider any connections between the various product organizations, it is essentially equivalent to an economy with many functionally integrated firms.

Table 1
TRADE-OFF IN COSTS BETWEEN INTEGRATED FIRMS AND MARKETS

Organizational Form	Production Costs	Coordination Costs	Vulnerability Costs
Firm	H	L	H
Market	L	H	L

L = Low costs

H = High costs

Compare only within columns, not between rows

In general, the model tells us, market coordination of functions provides lower production and vulnerability costs but higher coordination costs. We can interpret the lower production costs in two ways. First, when the manufacturer buys a service (e.g., the distribution of its goods) on the market, it can examine many possible "producers" of that service and choose the lowest cost provider, rather than accepting its own internal cost of providing the service, which may not be as low. Alternatively, we can see the market's advantage as provided by load-sharing. That is, in theory a market provider of a service can balance the loads of multiple buyers to use its facilities to best advantage and thus to minimize production cost. In contrast, an internal provider cannot balance the uneven load of internal demands.

Markets also have the advantage in vulnerability costs. In the market, the manufacturer can easily shift from one supplier of a function (for example one sales agent) to another. Thus it is less vulnerable to the failure of a supplier or to losses if its needs change than it would be if it were tied to a single, internal supplier of that function.

These advantages in production and vulnerability costs, however, come at the price of higher coordination costs. The manufacturer that secures services through the market must communicate more to gather information from many possible suppliers and to negotiate contracts, thus having higher coordination costs than if it simply used an internal supplier.

Using this model, we can examine the effect of the telegraph's lowering of communication, and thus coordination, costs. The telegraph lowered coordination costs for both markets and firms, but this lowering had a propor-

tionately greater effect on communication-intensive markets than on firms, thus favoring markets. Or, to put it another way, the telegraph reduced the overall proportion of costs allocated to coordination in both forms, thus making coordination costs less important than before and making the lower production and vulnerability costs offered by markets more important.

If we look just at the effects of the telegraph in lowering effective communication costs, then, the telegraph favored markets over firms. But the telegraph, along with several other major factors, had other effects that favored firms, thus encouraging the emergence of integrated firms in the second half of the nineteenth century.

THE TELEGRAPH'S PRO-FIRM INFLUENCE

Ironically, while the telegraph's role in the enlargement of market areas made possible the larger and more efficient markets discussed above, it also had a contradictory effect in favor of integrated firms. I will present both a complex historical argument with several intervening influences, based on Chandler [2, Ch. 8], and a simpler theoretical argument based on the Malone and Smith model shown above.

The first stage in the historical argument is that the growth of market areas as a result of the telegraph and railroad was a factor promoting the growth (but not yet integration) of manufacturing firms. Larger market areas meant a larger total number of potential buyers of a given manufacturer's goods. This increase in demand encouraged many manufacturers to find ways to increase production. The technology of mass production, including continuous process and large batch process production lines appeared in a series of industries in the second half of the nineteenth century. These technological improvements, along with the growth and organizational innovations necessary to make use of them, created economies of scale that allowed firms to decrease their production costs radically, thus giving them a clear market advantage over small firms with older production technology. At this point, the larger firms were producing more units, but not yet coordinating transactions between different stages in the flow of goods through the economy.

The next step, according to Chandler, was forward integration of some large manufacturing companies into distribution, thus internalizing some stages previously coordinated through market transactions. The initial forward integration was sometimes undertaken because the existing distribution methods could not support the high-volume throughput necessary to realize the economies of scale offered by continuous process machinery (for example, in the tobacco industry). In other cases, the integration resulted from particular distribution needs, involving either specialized equipment (for example,

refrigeration cars to distribute perishable meat) or specialized human expertise (for example, training necessary for selling and maintaining complex machinery). Whatever the motive, many of the large companies internalized their own distribution, eliminating independent sales agents. For similar reasons, many also took over their own purchasing, eliminating independent purchasing agents on the other end of their production process, as well.

Thus in the historical argument based on Chandler, the enlargement of market areas promoted by the telegraph was the necessary first step for the eventual integration within single firms of several functions previously coordinated through market transactions. Other factors, such as the development of mass production technology and the inadequacies of the distribution system, played significant roles, as well.

Theoretical Explanation

While the historical argument depends on the actual sequence of events, the theoretical argument based on the Malone and Smith [8, 9] model again is more abstract. It depends, in this case, on the increase in market area. When the market area or scale of the economy, as the model terms it, increases significantly, the amount of communication necessary to gather information from all possible suppliers in a market increases much more than the amount of communication necessary to coordinate internal transactions in a larger, integrated firm. Thus the growth in market area promoted by the telegraph favored integrated firms over markets.

FACTORS AFFECTING TRADE-OFFS BETWEEN MARKETS AND FIRMS

We have now seen that the telegraph exerted opposing forces in favor of markets and in favor of integrated firms. By lowering communication costs over distances, it favored markets over integrated firms. Conversely, however, it helped expand market areas, thus favoring integrated firms over markets. The ultimate outcome in a given industry depended on the relative magnitude of these two forces, along with various other forces favoring one form or the other. In some industries, efficient nationwide markets arose; in others, large integrated firms grew up.

The telegraph played an important role in coordinating both modes of economic organization. It made possible, as DuBoff has shown, the nationwide commodity exchanges and futures market, as well as enabling the New York Stock Exchange to become a truly national market, absorbing the many regional stock exchanges [5]. On the other hand, the telegraph was critical in enabling meatpackers such as Swift and Armour to expand and integrate into distribution, because it enabled them to coordinate the flow of refrigerated

but still perishable meat from modern slaughterhouses in the midwest to distributors in the east with minimal loss [2, pp. 391-402]. How can we identify the industries in which each form of organization, and consequently each use of the telegraph, was likely to occur?

In this section, I would like to present a matrix developed by Benjamin, Malone, and Yates [1] (and building on the Malone and Smith model) for examining the effect of current technological innovations on firms and markets and then use it to provide guidelines for answering that question. This matrix focuses on two characteristics of products and processes that influenced the trade-offs between firms and markets (though other factors undoubtedly affected it, as well): *asset specificity* and *complexity of product description*. It uses these two factors to suggest which transactions were more likely to be coordinated externally by markets and which were more likely to be coordinated internally by firms. While the telegraph need not be directly involved in the coordination, both factors are susceptible to the telegraph's influence.

After describing both of the factors and their effects on market and firm coordination, I will apply the matrix to late nineteenth century firms and markets.

Asset Specificity

A product used by another firm (or a consumer) is asset specific, according to Williamson's definition [15], if it is not readily usable by other firms (or consumers). That lack of transferability can result from site specificity (for example, a natural resource available at a specific location and not movable except at great cost), physical specificity (for example, a specialized machine tool that has limited applicability), or human specificity (for example, an individual's unique understanding of a technical or organizational issue). Yet a fourth variant of asset specificity, not mentioned by Williamson but related to site specificity and physical specificity, is time specificity (for example, a perishable product that must be used within a limited period of time) [1].

Williamson [14, 15] has shown that highly specific assets are more likely to be obtained within a firm than through a market. Such transactions frequently involve an extended development process to meet the needs of the user. This process requires a great deal of communication, already more extensive in a market, thus favoring the lower coordination costs and better continuity offered within a firm. Also, a highly specific asset in limited demand can support fewer suppliers in a market, thus lowering both the production cost advantages and the vulnerability cost advantages of the market.

Complexity of Product Description

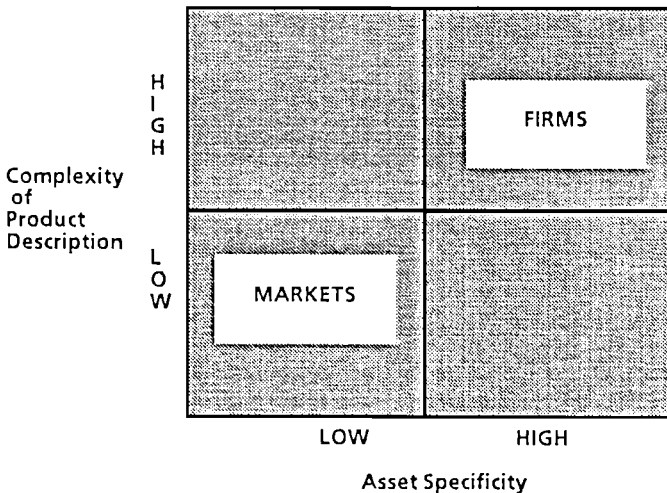
Complexity of product description is the amount of information needed to describe and specify a product to its buyers. In some cases this factor is related to asset specificity. For example, a complex machine tool is both asset specific and complex to describe. In other cases, however, the two are not related. A site-specific natural resource, for example, may be easily describable but not easily transportable to another site.

High complexity of description, the Benjamin, Malone, and Yates [1] framework suggests, favors internalization of transactions within integrated firms. We have seen that market transactions require more communication than internal coordination does. The cost of this additional communication is higher when the product is complex to describe. Conversely, a product that is simple to describe requires less communication, thus decreasing the cost of communication. Moreover, when such products are widely used (and thus not asset specific), even briefer, standardized descriptions can be adopted to lower communication costs in the market even further.

THE FRAMEWORK AND ITS APPLICATION

When these two factors are combined into a matrix (see Figure 1), they provide a powerful framework for analyzing whether products are most likely to be obtained within a firm or through a market. As Figure 1 shows,

Figure 1
FORMS OF ORGANIZATION LIKELY FOR DIFFERENT TYPES OF PRODUCTS



products that are both asset specific and complex to describe are likely to be obtained within a firm, while products that are neither asset specific nor complex to describe are likely to be obtained through the market. Products in the other two quadrants will vary according to the relative strength of the two factors. All cases, of course, are susceptible to other influences, as well. That is, asset specificity and complexity of product description are not the only two factors affecting the trade-off. But in many cases, especially those involving extensive use of the telegraph, these two factors can account for the form of economic organization adopted.

To illustrate the matrix's usefulness, let us look at the examples that DuBoff [5] cites in which the telegraph was used quite early after its introduction to establish efficient, nationwide markets. Almost all of these cases involve products that were low in both asset specificity and complexity of description. The stocks traded on the New York Stock Exchange when it effectively became the national stock market between 1850 and 1880 were clearly nonspecific assets--that is, they were valuable to a wide variety of potential buyers--that were easily described to these buyers by agreed-upon designations that kept communication costs down. Similarly, the commodities exchanges and organized futures market that emerged in the 1850s and 1860s involved widely used products such as wheat. Before the railroads made them readily transportable, such commodities were still more or less site specific (depending on their location vis-a-vis available waterways), but by the 1850s they could be transported fairly easily and reasonably inexpensively. Moreover, uniform grading of commodities, which (DuBoff tells us) evolved simultaneously with the commodities markets, made the products very easily describable to minimize the telegraphic communication necessary to gather information and negotiate contracts in a market.

The final example that DuBoff cites of early use of nationwide, telegraph-mediated markets--the wire services and business information reporting--involved products low in asset specificity but, in the former case, high in complexity of description. News, unlike information on commodity and money markets, was not easily described in standardized terms, though codes were devised to reduce the number of chargeable words. News was low, however, in asset specificity. Because so many newspapers wanted access to the information, and because the costs of maintaining correspondents in various locations was so high, news service such as the Associated Press served as market providers. Perhaps in part because of the complexity of the product description, however, the number of such providers was always quite low in relation to the number of buyers. Consequently, this market was less competitive and the news services often functioned more like internal suppliers than did suppliers in the other markets discussed.

While in the early national markets the products were low in asset specificity and usually low in complexity of description, conversely, in the earliest integrated firms the products (or, in some cases, the sales processes) were generally high in asset specificity and frequently high in complexity of description. Chandler cites the makers of complex machinery that demanded specialized marketing services as one of the first groups of companies to forward integrate into distribution [2, pp. 302-12]. Machinery made for use by other producers, such as steam boilers, could not be simply described in a form adequate for a buyer. The sales process involved elaborate discussions of the product's capabilities. Moreover, although the products themselves were low enough in asset specificity to be mass produced (though certainly not as low in specificity as commodities), they were specific enough to require an extended sales process as well as an ongoing service relationship, both of which demanded a high degree of human asset specificity. This very need for a specially trained staff to sell and service them was a key reason, Chandler argues, for the forward integration.

Manufacturers of machines sold directly to consumers, such as sewing machines, also internalized distribution after they adopted mass production techniques. While sewing machines were not physically asset specific, the necessary sales and service process was again humanly asset specific. Moreover, while the machines might be easily and briefly described for internal purposes, consumers making a one-time purchase of an unfamiliar machine needed much more descriptive information in order to buy them, as well as instruction on how to operate them and service after they acquired them.

Users of continuous process machinery, according to Chandler, were another early group of businesses to integrate forward into production and backward into procurement, and, in some cases, further backward into raw products. In this case, the products had differing levels of complexity of description and of asset specificity, but the production process itself was, for that period, highly time specific. That is, to make the high capital investment in the production line pay off, throughput (as Chandler calls it) had to be rapid and continuous. Finished products could not be allowed to pile up and stop the production line. The close coordination needed to guarantee that throughput often could not be obtained through a market, but demanded an ongoing relationship and close control over distributors and purchasers. In a company such as American Tobacco, however, where the key input was a graded, nonspecific commodity, the market offered advantages in raw material supply. Thus the company only integrated backwards as far as the purchasing function, not internalizing the tobacco supply itself.

Producers of perishable products made up a final category of firms that integrated into distribution early. Here, as in the case of meat packers such as Swift and Armour, time specificity was particularly crucial. Even though

meat could easily be graded to create a simple, standardized terminology, its perishability made it very time specific. Even with the refrigerator cars (which were also quite specific physical assets at the time), the meat was still susceptible to spoilage if movement from plant to final destination was somehow interrupted. Thus the telegraph was used to coordinate the flow of meat within the firms. In fact, Chandler tells us, the telegraph was so crucial to this internal coordination that both Swift and Armour used around \$200,000 worth of telegraphic communication a year [2, p. 396].

The telegraph clearly played a significant role in coordinating the integrated meat packing companies and, we can assume, in coordinating any time specific product or process. The mails would simply be too slow to provide the necessary coordination. The telegraph surely also played a role, but perhaps a less crucial one, in coordinating internal sales organizations when the process or product were less time specific.

In many cases requiring rapid communication about complex-to-describe products, telegraph codes provided a mechanism for further favoring internal over external coordination. Since telegraph companies charged by the word, companies had a great incentive to reduce the number of words in their messages. Moreover, for opportunistic reasons firms wanted privacy for their messages. General business codes were publicly available very soon after the telegraph was introduced [4]. They both reduced costs and, to a limited extent, improved privacy. Private codes, however, could be tailored to the specific needs of a company to reduce costs even further, as well as to increase privacy. The private code used by Du Pont in the 1880s reduced costs by half over those incurred with the general code used previously, according to one comparison [6]. Although Du Pont had not yet really integrated into distribution at that time, it used the code in coordinating with its agents and with new plants built elsewhere in the country. Other firms, especially those with widely distributed sales organizations, undoubtedly used such codes, as well. These private codes, then, reinforced the advantage of internal coordination, especially in cases where the product was relatively complex to describe to buyers, but more readily described adequately for internal purposes.

CONCLUSION

The telegraph, along with other factors, significantly affected the forms of economic organization prevalent in the mid nineteenth century. In some cases, it favored the formation of large and efficient markets; in others, it favored the emergence of large, integrated firms. By functioning, along with the railroads, to enlarge market areas, the telegraph created the possibility of relatively efficient nationwide markets. Moreover, by effectively lowering the cost of communicating over distances, it favored markets over firms. On

the other hand, both historical and theoretical arguments suggest that by enlarging market area, it indirectly favored integrated firms over markets. These contradictory forces, along with other forces at work in the economy, balanced out in different ways in different industries. Clearly, however, the overall shift was in favor of integrated firms, which emerged in the United States for the first time during the period following the telegraph's introduction.

The matrix of asset specificity and complexity of product description may be usefully applied, then, to explain which industries were more likely to be characterized by firms that integrated various functions internally and which were more likely to be dominated by large and efficient markets. The two factors affected both the amount and the nature of communication required to coordinate adjacent economic stages, and thus the way in which the telegraph itself could most advantageously be used. Complexity of product description clearly affected the amount and therefore the cost of the communication necessary to coordinate activities involving that product over distances. Thus communication-intensive markets were more likely to dominate when complexity was low and universal standards for product description could be adopted, as in the case of graded commodities, and integrated firms were more likely to dominate when complexity was high. Asset specificity of the product or process could also affect the amount, nature, and frequency of the communication necessary to coordinate related activities. In general, the higher the asset specificity, the more communication was required to coordinate related activities, and thus the more likely integrated firms were to emerge. Moreover, private telegraph codes provided a direct mechanism by which integrated firms were favored over markets when products were complex to describe or processes were specialized.

Thus the matrix provides a way to categorize the contradictory effects of the telegraph noted by DuBoff at the same time that it suggests an explanation of the mechanisms behind some of the effects. It may also illuminate our understanding of the emergence of integrated firms in the late nineteenth century.

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