

THE IMPACT OF TECHNOLOGY ON COMMERCIAL REAL ESTATE

by

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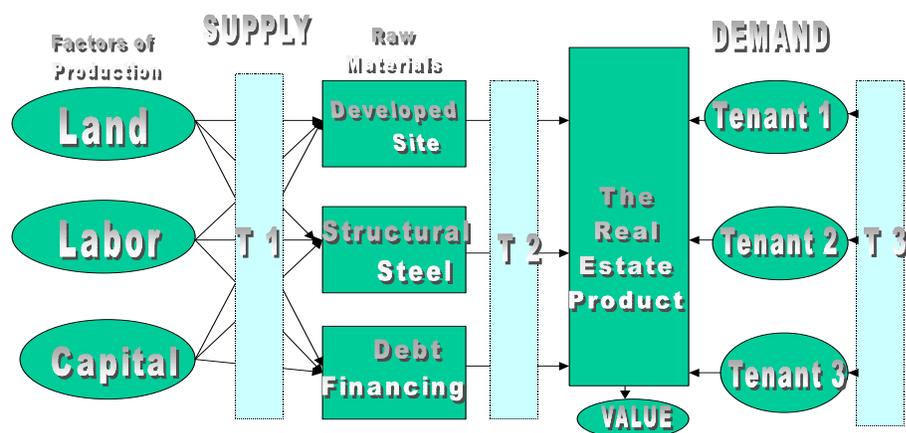
The meaning of "technology" has evolved significantly over the years, reflecting changes in the nature of production systems. Whereas, in 1828, *Webster's Dictionary* defined technology as a "treatise on the arts," by 1962 *Webster's New World Dictionary* definitions reflected a new industrial era: "the science or study of the practical or industrial arts," and "applied science." In 1996 the *Academic Press Dictionary of Science and Technology* extended this meaning to "the application of scientific knowledge for practical purposes; the employment of tools, machines, materials, and processes to do work, produce goods, perform services, or carry out other useful activities."

Economists have a broader, yet more rigorous definition of technology. All economic goods, including real estate, are assumed to be created from a set of raw materials, or factors of production. These factors are land, labor, and capital (including physical, human, and financial capital). These factors of production are transformed into

economic goods and services through a process economists call the production function. To use a real estate example, the production functions for an office building are: the site (land); the labor efforts of construction workers, architects, developers, financiers, public officials, and brokers; steel, brick, cement, insulation, glass, and other materials; and, financial capital. All these functions are directly influenced by technology.

Figure 1

Technology's Influence on the Real Estate Production Process:
A Schematic Representation



Technology thus defined, influences real estate through three different routes (see Figure 1). First, by affecting the production function for the inputs to the production of real estate product (T1). Examples of such "upstream" inputs include piping and insulation, specialized construction labor, and financial capital. In each case the net result is increased efficiency of the factors of production, which in return lowers the cost of production. Second, by altering the production function for the real estate product (T2). This means that some amount of the land, labor, and capital are combined in new ways

that allow a higher level of production at equal or lower cost. This shift in the production function reflects the application of technology to the construction and operation of real estate. An example is the development in the 1960's of construction management techniques that allowed for the more efficient development of commercial buildings. Third, by affecting the production functions of tenants and unrelated firms (T3). Here the focus is on the downstream users of real estate and with other firms in the economy. Such technology may apply to their inputs, the production of their products, or downstream users of their products. A recent example was a San Francisco office rent increase driven by dot.com firms. Technology in this case exerted demand side pressure on real estate markets. Enterprises enjoying the fruits of technology that are not themselves tenants in a particular real estate market may nonetheless benefit the market because they create wealth in the broader economy, which indirectly serves to increase demand for real estate stock and services.

This characterization of technology identifies and categorizes technological interventions, which helps to analyze and predict the consequences of technological change on real estate markets. There are six key manifestations of technology in real estate that have been highlighted in the popular press or in academia.

NEW AND IMPROVED CONSUMER GOODS

The development of new, improved, and cheaper goods, is driven by competition among producers to provide new outlets for consumer demand. Occasionally new goods will provide utility unavailable in existing products; however, usually "new" goods are more

accurately described as "improved," such as the telephone, which provided communication and information more completely and rapidly than the post or the telegraph. Some goods are neither new nor improved, but because of manufacturing efficiencies are simply cheaper to produce. Examples include foodstuffs, which are cheaper thanks to expanding world trade markets, the introduction of new production technologies, better crop rotation, and sustainable fertilizing practices.

Production of these goods influences the optimal level of space consumption by real estate tenants (T3). The creation of new markets and the expansion of existing markets through efficiency gains require additional real estate infrastructure, as well as labor, management, and capital. Thus, demand has been generated for video stores, expanded electronics products stores, and agribusiness facilities, as well as production and distribution facilities for these products. The greatest positive impact will be felt in those geographic areas that provide production or distribution facilities and those local markets most prepared to demand the new goods.

An offshoot of the production of new, improved, and cheaper goods is the creation of wealth among both the creators of the technology and entrepreneurs. This generates additional consumption, together with the real estate infrastructure to support it. There is often geographic concentration of such wealth, depending upon where these communities exist, whether they are biotechnology agglomerations surrounding Madison, Wisconsin or Silicon Valley in northern California.

TRANSPORTATION TECHNOLOGY

From a historical perspective, one of the principal purposes of cities is the enhancement of trade. Trade takes a variety of shapes: manufacturers need suppliers, merchants need customers, and perhaps most important, employers need employees. Cities and their development boundaries are shaped by transportation technology. According to Joel Garreau, the maximum tolerable one-way commute has historically been 45 minutes. This simple fact has affected the size and shape of cities over time. The great cities of ancient China and Mesopotamia were typically about one mile square, reflecting the principal mode of transportation—walking. Suburbanization was driven by the first major technological change in transportation--the horse. In the fourth century AD, the development of horseback-riding, together with Constantine's vision, extended the radius of the city of Byzantium by more than a mile. The next important public transportation development was the horsedrawn coach in the seventeenth century, which enabled Versailles to grow on the outskirts of Paris.

Since horsepower was available only to the relatively small classes of nobility and gentry, most people continued to walk. In 1870, the city of London, with 80,000 residents covered only one square mile. To gain access to employment, Londoners lived at higher densities than the inhabitants of modern skyscraper cities such as Tokyo, New York, and Paris. People crowded into tenements and row houses in a manner scarcely imaginable today. Employers clustered together for similar reasons. Until the mid-nineteenth century, high costs kept transportation either pedestrian or water-based, and required manufacturers and merchants to cluster in cities and towns. As industrialization brought improvements in living standards, and the development of an urban middle class that could afford more living space, transportation technology was dramatically changing in

ways that allowed cities to spread out. In London the Metropolitan Line, the world's first subway, opened in the 1860s. This was the beginning of urban public transit, allowing workers of all income classes to commute as far as ten miles to work. The impact of this change was immediate—densities in central London fell dramatically. By 1890 the density of the city of London was half its 1870 level; today, the density is roughly one twentieth of its 1870 peak.

The interaction of transportation technology and urban form continued during the twentieth century. An examination of the urban densities of the four major census regions of the United States reveals a strong correlation between a region's urban density and its "vintage." (A rough proxy for vintage is the median age of its housing stock: in the Northeast, the average age is almost fifty years, in the West it is about thirty.) The old Northeast is the densest region, the young West is the least dense. Even after decades of declining population, the least dense large city in the Northeast, Pittsburgh, has more than 6,000 persons per square mile. In contrast, the densest city of the Southwest--Las Vegas--has about 3,000 people per square mile. The principal reason for the dramatically lower densities of Western cities such as Denver, Salt Lake City, Phoenix--and to a lesser degree, Los Angeles--is that these cities have grown primarily in the automobile age. A 45-minute commute by car can be as far as thirty miles. The combination of safer and more comfortable automobiles, good highways, and inexpensive land and gasoline, have contributed to the spreading out of cities.

It might seem that a limit has been reached in terms of transportation technologies shaping cities. For example, traffic congestion has become a serious problem. The Texas Transportation Institute estimates that in Los Angeles, Boston, Atlanta, Seattle, Detroit,

and Washington, D.C. the social cost of traffic exceeds \$1,000 per automobile. Yet suburbanization continues at rapid pace. The suburbs in most metropolitan areas in the Northeast and Midwest continue to grow while the older, large central cities lose population. In the overwhelming majority of metropolitan areas suburban population growth now exceeds that of central cities. There are even signs of exurbanization, city people building houses on rural land far from their places of employment.

The size of metropolitan areas from centers to boundaries is no longer the relevant measure of tolerable commuting distances. The central business districts of Los Angeles and Dallas, for example, are home to only small fractions of regional employment. Today, most metropolitan area workers both live and work in a suburb. As a result, automobile commutes remain quite bearable for most households. Even where commuting distances have increased, improvements to driving comfort such as air conditioning, power brakes and steering, adjustable seating, CD players, and mobile phones, have made previously oppressive distances more tolerable. Equally important, telecommuting has made it possible for workers to live in large houses on cheap land at the periphery of cities without bearing the full cost of commuting time, since a worker who telecommutes just one day a week can afford to spend 25 percent more time commuting on the remaining days without increasing his total commuting time. The Midwest Telecommuting Institute estimates that the number of telecommuters (defined as those who worked off-site for an outside employer at least once per month) increased by 80 percent to 20 million between 1997 and 1999.

The telecommuting trend is driven by three conditions: first, the rising cost of commuting; second, the rapid improvements in telecommunications technology; and

third, the change in the makeup of the labor force. Improvements in technology have made it easier for people to work together even when they are separated by substantial distances. Far-flung corporations are not possible without the telephone and telegraph, while data delivery via ftp protocols makes it possible for financial institutions to have remote back-office locations. The proliferation of the Internet, Email, and instant messaging enable people in different cities to work closely with each other. Yet telecommuting technology remains relatively primitive. Teleconferencing still does not work particularly well, and bandwidth remains a major constraint, although over the next decade, improvements in teleconferencing, bandwidth, and perhaps even the development of wireless computing are likely.

At the same time, technological advances have created a labor force that is ever less reliant on manufacturing for employment, and more dependent on the service sector. This change is often inaccurately characterized as a shift from “good-paying jobs” to “poor-paying jobs,” or from “producers” to “burger-flippers.” Yet the average wage that is paid to service jobs is in fact *higher* than the average wage that was paid to the manufacturing jobs that were replaced. Physical labor has become less important while knowledge has become more important. In 1970 only one quarter of the American labor force had education beyond high school, compared to one half the labor force today. This allows workers to be used more flexibly. Many of the services produced for today's economy do not require large teams to be in the same place every day. Unlike the manufacturing assembly line, which concentrated people in one place, the office is becoming a place where people need to be together only intermittently.

The implications of this on the demand for and productivity of office space are profound. Since it is no longer necessary for everyone to use an office every day, the amount of necessary office space per worker may fall in the coming decades. Some researchers have even suggested that cities are obsolete, and that population dispersion will continue, with people choosing to live as far apart from one another as possible. However, such an outcome is unlikely. While large cities are much more spread out than ever, increasingly people have chosen to live in large metropolitan areas, not only in the "old" Northeast but to an even greater extent in the "new" Southwest. The New York City metropolitan area, for example, makes up about half the population of New York State; while metropolitan Philadelphia has less than half of Pennsylvania's population. On the other hand, three-quarters of the population of Arizona lives in two metropolitan areas, and substantially more than half lives in one. Nearly three-quarters of the population of Nevada lives in its largest metropolitan area, and more than 65 percent of the population of Utah lives in its largest metropolitan area. Similarly, more than half of Alaska's population lives in metropolitan Anchorage. While the topography of the West partially explains this extreme clustering of populations, if cities really were truly becoming obsolete, we would expect that the fastest growing states would be less--not more--reliant on them.

Cities will survive for a number of reasons. The fact that we are reducing "face-time" at the office does not mean that we can eliminate it. Writing in the *Journal of Urban Economics*, Gasper and Glaeser argue that technological change brings about more face-to-face contacts, not fewer. The telephone allowed people to have immediate contact even when they were in different neighborhoods, cities, or countries, and though

the real cost of telephone contact has fallen dramatically over time, the steady increase in airplane traffic would suggest that there has hardly been a reduction in the need to meet distant colleagues face-to-face. In fact, face-to-face meetings, particularly among those who live in different places, have been increasing. This is because while telecommunications is a substitute for meetings, it is also a stimulant, enabling people to interact with wider networks of people, both in business and socially. While one might meet face to face less often with the average person one knows, one will know more people, and consequently the total number of face-to-face meetings increases.

This is not to say that cities will continue to grow. There is a point at which economies of scale become exhausted. While the length of the commute people are willing to endure might get longer, it will not be infinite. Anecdotal evidence comes from Santa Clara County, home of Silicon Valley, whose population has grown no more rapidly than the nation as a whole during the 1990s, because home prices have grown beyond the reach of those earning less than \$150,000 per year, and because the county now has one of the worst commutes in the country.

CONSTRUCTION TECHNOLOGY

Technological innovation through T1 and T2 (Figure 1) has influenced the efficiency of the production of the real estate product. The most important technological changes in building construction have included steel frame construction, the elevator, air conditioning, and the application of mass manufacturing methods to construction. The combination of the steel frame and the elevator in the late nineteenth century made the

modern skyscraper possible. Before skyscrapers--and modern telecommunications--it was important for all office functions to be physically proximate. On Wall Street, for example, brokers took orders from customers and then gave them to “runners,” who would take the orders to stock exchange traders, returning to confirm that the trade had been executed. With the invention of the skyscraper, brokers, runners, and traders, were in closer proximity, which added depth to the marketplace, increasing efficiency. It also meant that some locations became particularly desirable for the development of large office properties. Users of office space regularly outbid residential users for downtown space. Although modern zoning reinforced the prevalence of areas with single uses, when the market value of one use so dominates others, the marketplace will tend to create single-use areas. Thus, as Wall Street redeveloped in the late 1800s and early 1900s, it became a business district with only a small amount of residential development. Much the same story applies to London, where at its peak in 1870, the City had over 80,000 residents, but now has only 4,000.

With notable exceptions, such as parts of Manhattan and Chicago's Gold Coast where high-rise apartment buildings predominate, residential real estate has generally moved toward the periphery. Part of the reason for this is that metropolitan land in the U.S. remains inexpensive, and that most American cities have roads with sufficient capacity. In most Sunbelt cities land on the periphery is plentiful and costs only the amount necessary for conversion from farmland. Moreover, wood-frame single-family houses, and low-rise buildings, are much cheaper per square foot than high-rise steel-frame buildings. At the same time, on a national basis the average daily commute remains

about 20 minutes. It is only when land and transportation costs are very expensive that vertical residential construction makes economic sense.

The other major construction technology change has been the development of mass manufacturing techniques such as the use of prefabricated materials and standardization. Before the 1930s, houses were built by craftsmen builders, one house at a time. The most famous pioneer of these techniques was William Levitt, who profoundly changed the homebuilding industry, greatly reducing the cost of single-family houses through mass production techniques and standardization. These are now common in all types of real estate construction.

The speed at which space can be constructed and the flexibility with which it can be used have made commercial real estate a more efficient product. The amount of time it takes to build an industrial building is a fraction of what it was 30 years ago. This reduces the carry cost during construction as well as the risk that a development started in a strong economy will be completed in the middle of a recession. Further, modern industrial buildings can be easily retrofitted into back office and display space, so they can be used in ways dictated by current economic conditions. Modern buildings are also designed to be updated with new technology at relatively low cost.

FINANCIAL ENGINEERING

Changes in real estate capital market technologies have also impacted real estate markets. In the 1970s financial institutions that originated and held mortgages faced a severe financial crisis. "Regulation Q" prevented these institutions from offering interest

rates to depositors above a modest rate set by the Federal Reserve. This meant that in periods of high interest rates households would withdraw their money and place it in higher yielding Treasury securities. The 1970s were just such a period, as the rate of inflation cycled into double digits over the decade. Money flowed out of depository institutions, resulting in mortgage rationing. In addition, long-term fixed-rate mortgages constrained earnings and reduced mortgage portfolio values.

This problem was addressed in several ways, including removal of Regulation Q, deregulation of the depository institutions (which carried its own special risks), the introduction of adjusted rate mortgages (ARMs), and--most importantly from the standpoint of technology--the introduction of the mortgage-backed security. By bundling mortgages into a pool backed by a security that could be diced up, capital markets were better linked to mortgage markets. The transformation of the Federal National Mortgage Association (FNMA or Fannie Mae), from a government entity into a government-sponsored private company, along with the creation of a second government-sponsored institution, the Federal Home Loan Mortgage Corporation (FHLMC, or Freddie Mac), and the spin-off of a new public sector institution, the Government National Mortgage Association (GNMA, or Ginnie Mae), jump-started the mortgage-backed securities market. These institutions led to the invention of the Pass-through Certificate, which passed cash flows from mortgages to investors, and Collateralized Mortgage Obligation, which allowed investors to sort themselves by risk tolerance with respect to payment seniority, prepayment risk, and maturity. This financial technology has given U.S. homebuyers unprecedented uninterrupted access to mortgage capital for nearly twenty years.

The fallout from financial institution deregulation, combined with other factors permitted the extension of securitization to commercial real estate debt and equity. The combination of overbuilding financed by insolvent savings and loans (among others), changes in the tax treatment of real estate depreciation and passive losses, a prolonged reduction in the rate of inflation, the financial crisis in Japan, and a recession that affected office workers, led to a depression in commercial real estate markets in the late 1980s. Average vacancy rates for office buildings approached 20 percent, and property values plummeted by as much as 50 percent.

This crisis in commercial real estate led to profound changes in the way business was conducted. Before the 1990s, commercial real estate companies were generally private companies that received the requisite, minimal equity financing from private investors, and high-rate loans from insurance companies and depository institutions. In the early 1990s, private real estate capital dried up as many financial institutions were shut down by regulators. Those financial institutions that survived were subject to new risk-based capital rules that strongly discouraged—indeed in many cases prevented—commercial real estate lending. Further, investors who had lost money in the real estate markets of the early 1990s were gun-shy, reasoning that if mighty Olympia & York was in serious trouble, there were few real estate companies that could be trusted.

As it closed down financial institutions, the government found itself holding large numbers of properties and notes. To liquidate the properties and use the proceeds to reduce the cost to taxpayers of the closure of the depositories, the Resolution Trust Corporation (RTC) was created (See "The RTC: Dispelling the Myths," *WRER* Spring 1997). The RTC turned to commercial mortgage-backed securities (CMBS) as an

effective way to dispose of many of their notes. Unlike residential mortgages, commercial mortgages tend to have prepayment penalties or “lock-out” clauses, which penalize or prohibit prepayment, greatly lessening concerns about prepayment risk. Also, since investors in commercial real estate tend to have long-term liabilities, short-term disintermediation arising from spikes in short term interest rates is not as big an issue as it is for depository institutions.

Credit quality was assigned through credit tranches: the first cash flows from a real estate loan going to a preferred, or A, tranche, with subsequent cash flows going to lower tranches. To attract investors back to real estate required greater disclosure and third-party evaluation of the information being disclosed. Thus CMBS issues were subject to securities laws and rated by rating agencies, who were viewed as more reliable than the for-fee appraisers who were part of the old private deals.

The movement to public markets on the debt side was replicated on the equity side. A variety of public equity instruments arose including mezzanine debt, preferred shares in Real Estate Investment Trusts (REITs), and common shares in REITs. REITs had been around since 1960, when the U.S. Congress passed enabling legislation whose purpose was to create liquidity for commercial real estate. Companies organized as REITs were required to hold real estate as their principal asset and to pay out at least 95 percent of their taxable income as dividends. In exchange for these (as well as other less severe) requirements, REITs escaped corporate taxation. The financial crisis of the early 1990s caused the REIT market to explode between 1992 and 1997, and to grow roughly fifteen-fold in market capitalization until it flattened in 1998 and 1999. The appeal of REITs to investors is obvious: SEC disclosure requirements and third-part analysis by

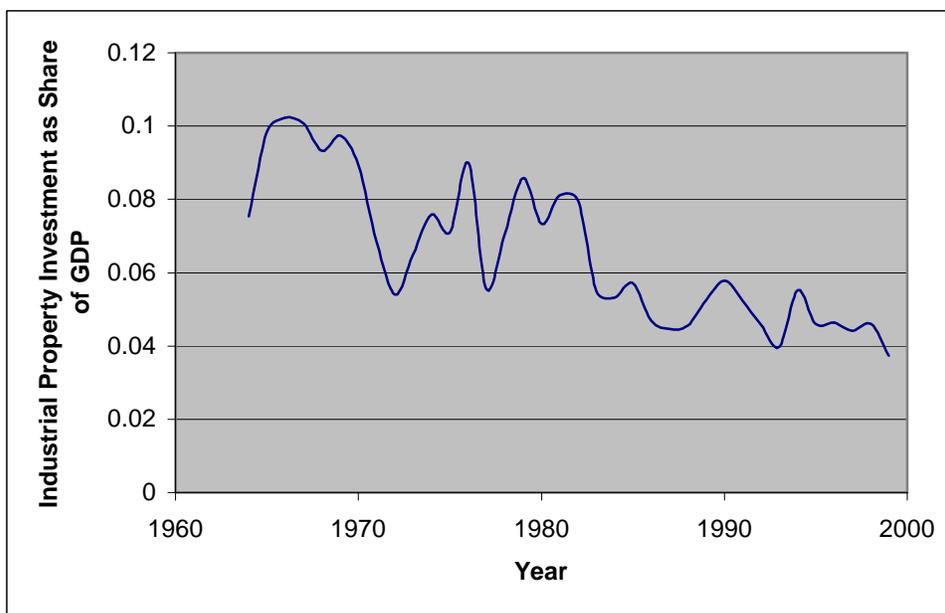
investment analysts. While the vast majority of commercial real estate remains privately owned, the emergence of public markets in real estate had had a profound influence. The new availability of information about real estate companies, markets, and earnings means that real estate investment decisions are more driven by fundamentals.

These financial instruments have been an important technological change in real estate markets. But there was also an underlying financial technology behind these innovations. Without the portfolio models of Harry Markowitz and William Sharpe, and the option pricing models of Fisher Black and Myron Scholes, none of the debt instruments would have been possible. Further, without high-speed computing power, we would still be completely at sea as to how to effectively price mortgages, since many expressions for pricing mortgages do not have “closed-form” solutions and must be numerically solved and simulated. Only the speed and brute-force computer power allows such simulations.

MANUFACTURING SYSTEMS

Figure 2

Industrial Building Investment as Share of GDP: 1964-1999



Changes in manufacturing represent another technological innovation that has exerted a fundamental impact on industrial real estate. Supplier-producer relationships are key determinants of the geography of industrial buildings. Just-in-time inventory methods have led the economy to need less industrial space per unit of manufacturing output, and, as a consequence, to more productive industrial space. Finally, downsizing and outsourcing have led to specialization, in companies as well as in building tenant improvements, which again tends to produce greater efficiency.

A good example of the importance of agglomeration economies arising from supplier-producer relationships is the automobile industry in 1980-2000, when product mix and a move toward “lean” manufacturing influenced the location of parts and assembly plants. At one time, when there were relatively few automobile models, identical automobiles would be produced in a large number of plants. As models multiplied and sales per model declined, it was sensible for all manufacturing of a particular model to be placed in one plant. As this happened individual plants became centrally located, so as to minimize transport costs to markets. For example, the share of light vehicle assembly plants located in the Midwest increased from 47 percent in 1979, to 67 percent by 1996. Suppliers followed producers, and the Midwest’s share of parts

suppliers also increased. Thus, the variety of products turned out by the industry had an effect on where industrial buildings located.

Improvements in distribution networks, made possible by quality management techniques and just-in-time inventory have reduced the number of idle plant and industrial buildings. The scope of this is shown in Figure 2, which illustrates the history of investment in industrial property improvements relative to GDP. The trajectory of this relationship is downward, with the secular nature of the trend overwhelming cycles.

THE INTERNET

The Internet may be the most important technological innovation to impact real estate since the invention of the automobile and the elevator. This is in large part because it influences the production function for real estate at all points--T1, T2, and T3. The Internet provides four different levels of product to the real estate market.

The first level is the provision of information, the most basic product of the Internet. Information provision over the Internet has become a core product line for a whole host of online information and data providers, including consulting firms, trade associations, and government agencies. Such data include information on firms, market conditions and performance information such as rents, asking and sales prices, property and submarket characteristics, vacancies, transaction volume and terms, demographic and socioeconomic conditions in the market, broader economic indicators, portfolio characteristics, historical returns, and underlying mortgage characteristics.

Such data provision lowers the cost of transactions and improves the quality of decision making. A high degree of competition currently exists among data providers, resulting in consolidation of the industry and survival only of those with the best--most reliable and frequently updated--products, the easiest access to capital for expansion and acquisition of competitors, and a broad infrastructure of relationships within the industry. The data that is relied on by multiple parties is becoming standardized and consolidated into only one--or very few--portals that will dominate within individual information product sectors. This revolution in information provision for the real estate market is not confined to public information that is important across firms, it also relates to private information within a firm, or available only to paid subscribers. Although most information will be passively provided and one-way, two-way channels of active communication via public or private chat rooms, and e-mail exchange, will grow.

The second level of product provision to real estate on the Internet is the provision of analysis, including appraisal methodologies, asset and property management support, accounting, tax planning, construction management tools, and specialized software for statistical analysis. Some of these are fee-based, with the actual application of the analysis package being undertaken by the provider. However, an increasing number are relatively "transparent" so that they can be run directly by the user. Some have become essentially free and are often marketed with other services. Of course, such software has been marketed and used outside the Internet framework, but the Internet has the potential to dramatically accelerate their spread and standardization because of it facilitates availability at low (or zero) cost.

The real estate firms that may profit most may not be large multi-faceted players, but rather the up-and-coming technology-oriented "niche" players, who heretofore have not had sufficient infrastructure or resources to support such an extensive analytic function. Thus, the Internet could become a great equalizer across real estate firms of widely different sizes and stages of development. Consolidation will come to Internet-based purveyors of real estate focused analytical tools, although this component of the industry is still in the start-up phase. The survivors ultimately will be those that provide the most value-added to the most users, are adequately capitalized, and have the best infrastructure to support their product, including a capable user-support network.

A third level of product provision to real estate by the Internet is the facilitation of real estate transactions online. This does not transform the marketplace, but only the location at which the transaction takes place, that is virtual as opposed to physical. This product ranges from providing information for a loan application, to the facilitation of the transaction in real-time over the Internet. These products render the transaction process in real estate faster, cheaper, and more efficient. The agents required for traditional real estate transactions--appraisers, attorneys, title insurance officers, mortgage and insurance underwriters, leasing and sales brokers--could be displaced in the process.

The real estate market is generally far behind the business-to-business (B2B) and the business-to-consumer (B2C) commodity e-commerce markets in terms of going online (and in terms of going bankrupt!). Residential property markets are more advanced, chiefly because of the relative homogeneity of the product and standardization of the transaction process. The primary and secondary residential mortgage markets are perhaps most involved with the Internet, with many aspects of origination, application,

documentation, appraisal, and approval commonly carried out online. The residential brokerage business has made some progress, but chiefly with listings rather than with offers, counter-offers, due diligence, and closing. We anticipate progress will continue to be made, rapidly in the case of the residential mortgage market, more slowly with respect to brokerage. Those firms with established physical presence will dominate in the consolidation that is to come.

The fourth, and highest, level of Internet-based product for the real estate market is the development of online real-time auctions of real estate. The development of a real-time online auction transaction mechanism similar to the stock and commodities markets would be a fundamental transformation of the marketplace, dramatically changing existing market roles and enhancing market efficiency. B2B public e-commerce marketplaces for parts and supplies have been established, but recently have suffered setbacks as large buyers have displayed a preference for private online marketplaces with their suppliers where traditional relationships can be maintained. Some examples of online auctions exist, such as Priceline.com, which provides online bid auctions for surplus plane seats, hotel rooms, tickets, and other "surplus" goods, but the recent troubles of the dot.com sector have affected it also and stalled progress in the B2C marketplace. We have little expectation that transactions representing transfers of fee-simple ownership or leasing rights will be significantly affected by online auctions, due to the heterogeneous nature of real estate and the high level of detailed due diligence necessary. An exception will be distress or bulk sales of properties. Occasionally in extremely tight residential markets sellers may resort to such mechanisms, as they did in the active California market of the 1980s (although then the auctions were "off-line").

Securitized real estate interests are a different matter. On the debt side, residential and commercial mortgages and mortgage-backed securities will become increasingly traded electronically, with the residential market continuing to be furthest along due to standardization. The market for publicly-traded REIT shares is already a real-time online auction.

THE FUTURE

Those in traditional agency positions in the residential primary and secondary mortgage market will be most affected by the wholesale movement of a large share of that industry online, with the commercial secondary mortgage market close behind. The market for residential sales and "bulk" sales of commercial property portfolios will experience movement online with a commensurate reduction in the roles of traditional intermediaries, including appraisers, brokers, advisory firms, consultants, market analysts, and balkanized multiple listing service firms. As REITs and real estate operating companies become a larger share of commercial market ownership, the online electronic marketplace of the stock exchange will penetrate further into the real estate market.

However, this level of activity is separable from the transfer of fee interests in commercial property in the private markets, which will continue to require a high level of personalized due diligence owing to the thinness of the market and the heterogeneity of the product. Thus, the agency positions associated with larger commercial property transactions will prove the most immune to the Internet.

This does not mean that brokers and other professionals engaged in traditional commercial property transactions will not find their lives disrupted by new technologies. At the margin, their fees will be narrowed by the loss of subsidiary services they previously provided--search, access to financing, analysis, facilitation and coordination of the parties to the transaction. There may be fewer agents, but they will each be able to handle more transactions. Further, the best will take advantage of opportunities to replace their losses with new services -- high-tech searches for and matches of buyers and sellers, sophisticated deal structuring and other higher level advisory functions aided by technical tools, provision of access to the best financing alternatives available. In the end the non-commodity commercial property broker will be more likely to survive than his counterparts in the residential and mortgage markets, but he will not remain unscathed.

Technology will adversely impact second-tier regional malls, power centers, and big boxes to the extent that they do not provide food and entertainment. The highest rates of penetration by e-commerce are predicted to be for computer hardware and software, accessories, music, consumer electronics, and flowers. However, the overall level of penetration into the space-based retail market by 2010 is predicted by a recent study undertaken by Vandell for the International Conference of Shopping Centers to be only a little over 5 percent, significantly lower than many optimistic estimates. Further, a 1997 Census Bureau survey of Internet usage found only an estimated 2 percent of U.S. households were using the Internet to shop online, significantly lower than earlier estimates. The recent decline in the share prices of many e-commerce firms suggests that neither economies, nor a broad base of demand, exist for e-shopping, which may simply be a niche market, like catalog and television shopping, rather than a major new mode of

shopping. Even if e-commerce does take off in popularity, however, the resulting higher rate of economic growth overall may more than make up for the loss, as suggested in a recent study by Patrick Henders Watt.

It is fashionable to predict that technology will enhance the productivity of intellectual capital at the expense of physical capital, including both bricks and mortar and land. According to this argument, advances in information technology and communication channels, as well as advanced transportation systems, will render physical proximity of economic agents largely irrelevant. New institutional structures will emerge, characterized by smaller task-driven teams as opposed to large inflexible divisions, outsourcing and downsizing, independent contracting and telecommuting. E-commerce will rule, freeing households from the time-consuming task of the weekly shopping trip to the local retail center.

In this prediction, the need for costly specialized capital-intensive "class A" real estate facilities will absolutely decline, replaced by functional high-tech cubicle space in low-density back-office settings, home offices, and large warehouse facilities to facilitate the national distribution of goods purchased on line. Once-great properties will become "surplus" space, especially in the office and retail market, and especially in downtowns and other high-density urban settings, creating lowered investment returns, downward filtering and downsizing of the real estate industry.

How realistic is this prediction? Data from the Federal Reserve Board suggest that while the share of total wealth in the economy deriving from real estate has declined in the last fifty years, the real level of such wealth has increased. The combined balance sheets of households and businesses in 1950 and 1997 reveals that the book value of

business structures grew at a compound growth rate of 6.2 percent in nominal terms, lower than the 7.8 percent growth rate for assets overall. During the same time, the book value of owned homes grew at the same 7.8 percent rate as the growth in the value of assets overall. As a share of total assets, however, commercial structures dropped dramatically, from 14.1 percent of total assets in 1950 to only 7.2 percent of total assets in 1997. The compound rate of inflation during the 1950-97 period was 5.5 percent, suggesting that in real terms, commercial real estate wealth still increased, though not at as high a rate as overall wealth.

We expect the supply of productive assets to increase to that point at which their marginal productivity (that is, the productivity of one more unit of production) is the same across all sectors. Because other asset classes have become more productive at the margin than commercial real estate, they have grown in value more than commercial real estate. However, real wealth increases have created higher values for and demand for all asset classes. For commercial real estate to experience both a real decline in value and an absolute decline in demand for product in the face of an increase overall in the value of assets in the economy would require both an absolute decline in the marginal productivity of real estate assets and a very large substitution effect in which non-real estate assets (say, information technology) begin to replace real estate assets in production functions. It is clear that this has not occurred, and is unlikely to occur in the future.

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