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A Theory of Services in Product Industries

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Even though services have become increasingly important for firms in many product industries, there lacks theory to explain under what conditions services should be important to product firms. We propose that services embody the product and market-related knowledge that transfer between the producer and customer in activities associated with selling, financing, using, maintaining, and repairing products. Building on the knowledge management and innovation literatures, we propose that the level and type of services provided within a product industry are associated with uncertainty, complexity, and competitive dynamics. Finally, we explore the implications for research in resource capabilities, industry verticalization, and technological change.

In many product-oriented industries, services have become increasingly important. In the case of automobiles, General Motors, Ford, and many other automakers generate the vast majority of their profits from a service activity closely tied to their product offerings – loans and leasing. In the case of software products, companies often begin by emphasizing packaged product sales but, as the industry has matured, many now derive more revenues from maintenance (product patches, product updates, and routine technical support) and other types of services (such as consulting, product customization, and training) rather than from new product sales. Other technology product firms, such as IBM, Cisco, Hewlett-Packard, Sun Microsystems, Dell, and EMC, have also seen large increases in maintenance and other services as a percentage of their total revenues as their product lines mature.

Services and Uncertainty

A given product's core technology may evolve along a number of possible trajectories and design hierarchies, which cannot be accurately predicted in advance. For instance, consider introducing a new technical component within a computer. While it may improve the computer's processing speed, it may come at the cost of increasing the heat emissions leading to other issues. The purely technical dimension is often captured by using the technology "S curve," which plots the evolution of that particular technology along a key performance parameter as more research and development effort is put in (Cooper & Schendel, 1976; Foster, 1986).

The demand side of the market has a different perspective on uncertainty. One aspect relates to whether customers want to purchase a product because they are not sure what the technology is, what functional and technical characteristics really matter, and whether they really need it.

A second aspect of market uncertainty relates to how customers actually use the product and its performance within a specific use context. Customers may be uncertain about the internal changes required to implement the technology and how best to use a technology to achieve desired goals.

It is important to realize that market and technical uncertainty are related but distinct. For example, market uncertainty can occur during periods of technological certainty. Customers may re-introduce uncertainty by changing how they use the technology without being pre-empted by a technological change.

Implementation, training and support services can help customers feel more comfortable as well as improve the "fit" between a new product technology and customer needs. Through services, knowledge and skills about the new products are gradually transferred from the vendors to the buyers via "on the job" and vicarious learning or later through buyers "poaching" talent from the service-providing unit once the new products have proven to be useful. In other words, by lowering the risk of early adoption, services allow firms to "hand hold" potential buyers and educate them on the advantages of the firms' new products or technology.

Variations in how customers use the technology can be an important source of information for future technological considerations. In fact, Tripsas (2008) observed how customers in the typesetting industry

began using the technology to print images, which in turn led to subsequent product innovation. We propose:

- *Proposition 1. The level of technology and market uncertainty will be positively related to the level of services in a product industry.*
- *Proposition 2. The level of technology and market uncertainty will be positively related to the level of customized as opposed to standardized services offered in a product industry.*

Services and Complexity

The level of uncertainty is not the only dimension that influences the nature and importance of services in a product industry. Services may also play an important role in the case of complex product technologies. A new shovel design, with only a few simple parts that are easily assembled, is substantially less complex than an automobile or a computer, with many different parts, many of which require precise assembly.

Also, literature stresses that complex technological products and systems present unique inter- and intra-organization challenges that go beyond those typically considered under a "product class."

However, as with uncertainly, product complexity can also be thought of in terms of its use characteristics. Leonard-Barton (1985) defines complexity in terms of the technology requirements and the criteria and effort required to get the product into use. Products are seldom "plug and play" for buyers, but instead require significant changes of practices and routines at the receiving end as well as integration with other technologies. From the user perspective, a highly complex product may require significant integration with other technologies or organizational changes in order to use the technology. This "use complexity" is important to consider because often customers are oblivious to the technical complexity of a product.

Uncertainty and complexity are often correlated, but they are distinct. Low complexity products in a technical sense can experience high market uncertainty while high complexity products can experience low levels of market uncertainty. Nevertheless, greater product complexity will tend to increase the upfront investment required of buyers if they want to adopt the new product technology, both in terms of financial resources and capability development. As was the case with uncertainty, greater complexity discourages buyers from adopting the new technology. Buyers can also perceive product complexity as increasing the probability that the product may fail due to the sheer number of components and sub-systems as well as possible misalignments during implementation, rendering the investment unproductive. The provision of services by firms in the industry can reduce buyers' reluctance to try a complex product: Training, warranty and maintenance agreements provide assurances that, if something goes wrong with the complex product, the vendor will fix it. Therefore, we propose:

- *Proposition 3. The level of technology and use complexity will be positively related to the level of services in a product industry.*

Similar to uncertainty, the level of complexity also has an effect on the type of services being offered in the industry. The main issue with complexity is that it generates localized knowledge, making it difficult for product companies to offer a more standard services solution. Thus, in general, lowering the technical or use complexity of a product should lead to more standard solutions and less need for customized services but, as we explain below, we believe this effect is more pronounced for use complexity than for technical complexity because the former directly affects the customer.

Services can be standardized even in the presence of technically complex products if these products feature high levels of standardization or modularity. In other words, standardization and modularity should reduce technical complexity. Product standardization allows the production of services to be less product-specific (as in the case of oil changes for automobiles). Greater product standardization generally implies a smaller number of product variations or different components, allowing service providers to gradually develop "service blueprints," i.e. specialized routines to carry out high-frequency services. Modularity may also reduce technical complexity such as by clearly demarcating sub-systems and establishing more standard interfaces between these systems.

Standardization of computing platforms, including elements such as hardware processors, operating systems, and programming interfaces, began with IBM's System 360 in the mid-1960s. This new family of compatible computers made services such as hardware and software maintenance as well as custom programming easier to repeat across different customers – that is, to standardize. This standardization also made it possible to package common features in what had been customized software – so we have, finally, a software products industry emerging during the 1960s where we only had services before.

Let's now explore the relationship between use complexity and the standardization of services. Use complexity increases the need for customized services because of the local nature of the knowledge required and generated. If the use of a product requires significant integration with other systems and the development of organizational skills and processes, the knowledge required to sell the product as well as the knowledge generated from its use tends to be localized. Customers have found consulting and customized services useful to facilitate the transition from one computing platform generation to another. The localized nature of this knowledge and its stickiness, make it difficult to create fully standardized service solutions. Therefore, we propose:

- *Proposition 4. The level of use complexity or localized knowledge required will be positively related to the level of customized as opposed to standardized services offered in a product industry.*

Finally, it is instructive to consider extreme cases where technological uncertainty and complexity are both at high levels. Whereas, for the most part, product and services tend to complement each other, at very high levels of uncertainty and complexity, services can become a substitute to product adoption, at least for awhile.

- *Proposition 5. At very high levels of technological or market uncertainty and complexity, services can act as substitutes for an industry's products.*

Services and Competitive Dynamics

So far, we have only considered the fundamental relationships between the level and type of services and technological uncertainty and complexity. We have not considered the implications of industry life cycle stages on the nature of services – the original premise that drives much of the early thinking about services. Beyond variations in uncertainty and complexity, the competitive dynamics can change and result in changes involving service offerings. Under some competitive conditions, firms may choose to offer services in order to differentiate their products and remain competitive. Therefore, it is also important to consider the different competitive conditions that affect the level and type of services a product company might offer.

What is often called the "onset of maturity" divides the industry lifecycle into two clearly identifiable stages, each with its own specific competitive dynamics. Before the onset of maturity, growth through product innovation is the primary competitive driver. Product design alternatives exist and change rapidly, propelled by a growing number of new entrants who come up with different designs or entirely new technological approaches. The competitive dynamics focus on product innovation and performance while processes tend to be flexible, with high manual content, and rely on general-purpose equipment. After the onset of maturity, there is an increasing role of standardization and economies of scale, and a consequent focus on process improvement.

Under these two different competitive conditions, firms may make different strategic choices that either increase or decrease their service offerings as well as their importance to the business of the firm. The competitive dynamic of product innovation clearly is associated with high technology uncertainty: there is significant product variation within and between technology alternatives as firms experiment to find the best solution. Customized services have helped customers adopt and use unproven technologies, during periods of high levels of technological uncertainty, ranging from new types of propulsion at the turn of the twentieth century to new uses for the internet in the 1990s.

However, this prediction seems to contradict the intuition in the services literature that services increase mainly during the mature industry stage. In addition, not all industries appear to have high levels of services even during periods of significant product innovation. This may depend on the degree of use complexity.

Despite the fact that periods of significant product innovation are typically associated with high technological uncertainty, they can vary in levels of market uncertainty as well as product and use complexity. Even though an industry's product may be going through significant technological changes, the market may be more certain about how it satisfies user needs. For example, the insurance market lowered the uncertainty about the computer by comparing it to and using it like tabulating machines. As a result, lowering the level of market uncertainty can lower the need for customized services. In addition, products vary in terms of product and use complexity. The product and use complexity of a computer, for instance, is much higher than mass-market consumer electronics products, such as a VHS video-cassette recorder or an Apple iPod. We proposed earlier that higher levels of product and, in particular, use complexity generate the need for more customized services. Therefore, we propose:

- *Proposition 6. In competitive environments that exhibit high levels of product innovation,*

the level of customized services will increase with the level of market uncertainty and product's use complexity.

In contrast, the lifecycle literature argues that under conditions of cost competition, firms focus less on product innovation and more on improving efficiency. These changed industry conditions result in a potential new role for services.

In the presence of strong cost pressure, services can help offset the effects of a decline in product revenues and profits. A given product may produce a stream of service revenues long after it is sold, and even after a particular product has been discontinued: general maintenance, repairs, years of recurring maintenance payments and other services for users of mainframe and other enterprise-class computer hardware and software.

The nature of services often makes it possible for firms to create real or perceived differentiation in the market, preventing services from suffering the same cost-reduction pressures that characterize product competition. Services may then become a major source of revenues and profits when product companies have trouble selling their products or if prices decline sharply. Because of these trends, some researchers have focused on helping product firms make a successful transition to a more service-oriented revenue portfolio.
Even during intense cost-based competition services still provide valuable information for producers on what product variations matter to customers. Cost-based competition does not prevent some firms from trying to differentiate their market position.

Moreover, services can directly contribute to profits. In our mainframe computer industry example, most product firms had opened service units by the late 1960s because they "saw an opportunity for profits." Services remain even today a profit-making activity for most computer firms selling to enterprise customers and other large organizations such as governments.

The implication is that services can help prolong the lifecycle of a cost-driven product industry in the late stage by extending its stream of revenues and providing additional sources of profits. Service activities are also generally more labor intensive and costly, with lower profit margins, than mass production of standardized products. Expanding highly customized support services, for example, requires adding new personnel or re-training existing personnel about specific client needs. Cost-based competition may prohibit some firms from building out these services or at least encourage the development of more standardized or even automated service solutions to maintain a lower cost profile. Therefore, we propose

- *Proposition 7. he strength of cost-based competition (commoditization) in a product industry will be positively related to the level of services in that industry*

The Provision of Services in a Product Industry
Thus far, we have only talked about levels and types of services within industry and have not addressed the issue of who actually provides and appropriates the service revenue. This issue is significant because, in many industries, firms other than the producers also provide services. In product industries that also have service offerings, it is important to understand under what conditions the product producer should expect to capture a part or even the majority of the service revenue and profits compared to independent service providers.

We can consider two dimensions of services provision: the level of "product-specificity" and the level of "industry-specificity." We define the level of "product-specificity" of services as the percentage of total industry services that are exclusively related to the industry's products. Maintenance and repair, for instance, are services that in almost all cases are exclusively related to the given industry's physical product – a high level of product specificity. Similarly, we define the level of "industry-specificity" of services as the percentage of total industry services provided by firms in the product segment of the industry.

The degree of product specificity and industry specificity in services is likely influenced by the location of product-related knowledge. The locus of knowledge, in turn, seems related to the level of product or use complexity, and possibly technological or market uncertainty as well. Industry evolution also may affect the location of product-related knowledge in the value chain.

- *Proposition 8. Product producers are likely to provide a larger share of product-specific services when there are high levels of technological or market uncertainty as well as use complexity.*

We also can anticipate how the provision of services might spread beyond the product producers. As markets evolve and grow, technological and market uncertainty is likely to fall, resulting in greater clarity among users with regard to how to use a new product. Complementors should emerge enticed by the growing installed base of industry products,

especially if these can serve as "platforms" for other firms to offer related products and services that make the platform product more valuable. This network or positive feedback effect may increase as the market grows because specialization is possible and the industry may "de-verticalize," encouraging entrepreneurs to create independent services firms.

Another potential factor is product modularity – the extent to which a product can be decomposed into several subsystems that may be designed independently but work together as a whole through well-defined interfaces. Modularity can result in simpler designs and reduce the importance of product-specific knowledge possessed by the product firms, which could then encourage the creation of more independent service providers. By having a well-defined core and interfaces, the way a modular product interacts with other products should be clearer than in the case of an integral design. Modularity makes it less crucial for a third-party firm to know how exactly the product works because much of the product knowledge is "built into" the product's modular design. This in turn means that the product firms may have less of an advantage in the provision of services if their product simply becomes a "core module" with well-defined interfaces that link to complementors. With modular designs, buyers can even do their own installation and customization, or hire independent service providers.

- *Proposition 9. Product producers are likely to provide a smaller share of product-specific services in the presence of industry-wide product platforms and higher degrees of product modularity.*

Summary

In conclusion, this paper has provided the building blocks for a theory that can explain the role and characteristics of services in product industries. Services embody the product and use-related knowledge that transfers between the producer and customer in activities associated with selling, financing, implementing, customizing, using, maintaining, and repairing products. By relating services to both industry-level dynamics and levels of complexity and uncertainty at the product and use level, we move away from the common belief that services only increase as an industry matures. These relationships should help delineate when we would expect to see higher or lower levels of services as an industry, a technology, and patterns of customer usage evolve.

References

Abernathy, W.J., Clark, K., & Kantrow A. 1983. *Industrial renaissance: Producing a competitive future for America*. Basic Books: New York.

Abernathy, W.J. & Utterback, J.M. 1978. Patterns of innovation in industry. *Technology Review*, 80:40-47.

Anderson, E. W., Fornell C., & Rust, R.T. 1997. Customer satisfaction, productivity, and profitability: Differences between goods and services. *Marketing Science*, 16:129-145.

Anderson, P., & Tushman, M. 1990. Technological discontinuities and dominant designs: A cyclical model of technological change. *Administrative Science Quarterly* 35: 604-633.

Austin, R. & Nolan R. 2000. IBM Corporation Turnaround. Harvard Business School Case #9-600-098.

Baldwin, C., & Clark K. 2000. *Design rules*. MIT Press: Cambridge, MA.

Chase, R.B., & Aquilano, N.J. 1977. *Production and operations management: A lifecycle approach*. Irwin: Homewood, Ill.

Fisher, F., Mckie, R., & Mancke, R.B. 1983. *IBM and the U.S. data Processing industry: An economic history*. Praeger: New York.

Gawer, A. & Cusumano, M.A. 2002. *Platform leadership: How Intel, Microsoft, and Cisco drive industry innovation*. Harvard Business School Press: Boston, MA.

Gort, M., & Klepper, S. 1982. "Time paths in the diffusion of product innovations." *The Economic Journal,* 92:630-653.

Henderson, R. & Clark, K.B. 1990. Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms, *Administrative Science Quarterly*, 35: 9-30.

Leonard-Barton, D., 1985. "Implementation as mutual adoption of technology and organization". *Research Policy*, 17: 251-267.

Leonard-Barton, D., & Sinha, D. 1993. "Developer-User interaction and user satisfaction in internal technology transfer. *Academy of Management Journal*, 36(5): 1125-1139.

Oliva, R., & Kallenberg, R. 2003. Managing the transition from products to services. *International Journal of Service Industry Management*, 14:160-172.

Sanchez R., & Mahoney, J.T. 1996. Modularity, flexibility, and knowledge management in product and organization Design. *Strategic Management Journal*, 17: 63–76.

Stigler, G. 1951. The division of labor is limited by the extent of the market. J*ournal of Political Economy*, 59 (3): 185-193.

Tripsas, M. 2008. "Customer Preference Discontinuities: A Trigger for Radical Technological Change." *Forthcoming in Managerial and Decision Economics*.

Ulrich, K. T., & Eppinger, S.D. 2004. *Product Design and Development*. New York: McGraw-Hill.

Utterback, J., 1994. *Mastering the Dynamics of Innovation*. Harvard Business School Press: Boston.

Utterback, J., & Suarez, F.F. 1993. Technology, competition and industry structure. *Research Policy*, 22, 1–21.

Wise R. & Baumgartner, P. 1999. Go downstream: The new imperative in manufacturing. *Harvard Business Review*, 77:133-141.

Yates, J. 1993. Co-evolution of information processing technology and use: Interaction between the life insurance and tabulating industries. *Business History Review*, 67: 1-51.

Yates, J. 2005. *Structuring the Information Age: Life Insurance and Technology in the 20th Century*. Baltimore: John Hopkins University Press.

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