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Paths of Influence for Innovations in Financial IS and Technology Ecosystems

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PATHS OF INFLUENCE FOR INNOVATIONS IN FINANCIAL IS AND TECHNOLOGY ECOSYSTEMS

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Abstract

Predicting technological innovations in financial information systems (IS) and technology ecosystems has been challenging for technology forecasters and industry analysts due to their underlying complexity. Technology-based financial innovations over the past four decades, such as programmed trading in the 1980s, risk-adjusted return on capital-based financial risk management systems in the 1990s, high-frequency trading and Internet banking in 2000s, and now mobile payments in the 2010s, have all led to transformations in the financial services industry. What basis can be identified to predict such new innovations? And what areas of financial services will they affect? This study applies the technology ecosystem approach, extended to incorporate stakeholders' strategic actions, to analyse the paths of influence for mobile payment technologies. Our ecosystem model brings together three core elements: emerging technology components, technology-based services, and technology-supported business infrastructure. We will also discuss its applicability to high-frequency trading in the equity markets.

Keywords: Financial services, Paths of influence, Technological innovation, Technology ecosystems.

1 INTRODUCTION

Operations in financial services are characterized by extensive use of *information technology* (IT), which acts as an important driver of product, service and business innovations in the industry (Hatzakis et al. 2010). Over the past four decades, technology-driven innovations have emerged at the level of financial services firms, the services sector more broadly, across business networks involving multiple industries, and at the national level in different countries. Almost all the segments in financial services have been touched and transformed by different kinds of IT, especially its telecommunication capabilities, and the Internet and new forms of digital data exchange. This is true for financial services involving investment banking and capital markets, corporate and institutional banking, private banking and wealth management, and retail banking.

In some important niches in financial services, the impact of technology-based innovations in *financial information systems and technology ecosystems* has been dramatic and transformational (Steiner and Teixeira 1989). Such technology-driven innovations include programmed trading in the 1980s, risk-adjusted return on capital-based financial risk management systems in the 1990s, high-frequency trading (HFT) and Internet banking in the 2000s, and now mobile payments (m-payments) in the 2010s. M-payment innovations have changed how customers make payments, where a mobile device is used to initiate, authorize and confirm an exchange of financial value in return for goods and services (Calamia 2011). Another example is the emergence of HFT technologies in the capital markets since 2005, which has been widely chronicled by government regulators (SEC 2005, U.S. Senate 2009) and industry observers (Aldridge 2013). They have improved market liquidity, price discovery and execution efficiency on the exchanges, while reducing transaction costs and increasing turnover, resulting in the creation of more valuable markets for their participants (Hendershott et al. 2011).

These high-tech innovations are difficult for technology forecasters and industry analysts to predict. This includes when they emerge, what are their evolutionary paths of development, and the extent to which they will have widespread impacts. Though the emergence of new technologies in the high-tech industries and their potential applications in financial services may act as useful forecasting milestones, financial services practitioners and analysts who follow the industry are subject to their own biased views of the industry. This makes it difficult for them to effectively gauge the future impacts of technology innovations, and mount successful technology adoption decision-making processes.

In this study, we will explore the following research questions: (1) How can we forecast the emergence of IT-enabled financial innovations? (2) What kind of patterns will they exhibit? (3) How will the innovations develop over time in the market, given the uncertain responses and likely actions of the various stakeholders? (4) Will they mostly be driven by the emergence of new technologies? Or the assembly of existing services into new combinations? Or new infrastructure capabilities for the financial services? And (5) to what extent will stakeholder actions be able to affect the evolution of technological innovation that is observed?

We will extend and apply the *technology ecosystem and paths of influence* perspective proposed by Adomavicius et al. (2008b) to incorporate stakeholders' strategic actions to treat the issues that senior managers and analysts in financial services firms are facing with future technology forecasting. Due to the underlying complexity of industry operations and uncertain reactions from market participants in the financial IS and technology ecosystem, the drivers of technological change and evolution will be even more difficult to identify than the general IT ecosystems studied by Adomavicius et al. (2008a). Taking advantage of investment and market opportunities in IT is a strategic necessity for successful financial services firms, so understanding the nature of technological change and predicting future technological advances that will influence industry operations are crucial for firm strategy. This is important when senior managers try to make decisions related to new services development, technology investments, large-scale marketing campaigns and technology planning.

We will build a model that brings together three core elements: *technology components*, *technology-based services*, and *technology-supported business infrastructures* for financial services. Based on

these three key building blocks, we identify the roles that a particular technology plays in a financial IS and technology ecosystem and how it has evolved over time in a given context of financial services. We will also consider some accelerators and decelerators of technology changes associated with potential influences, as well as actions from the cluster of stakeholders that are relevant in specific financial services operations contexts. For example, some stakeholders create strategic partnerships to accelerate the adoption of technology innovations, while government regulators may create uncertainty in the marketplace by failing to make a clear ruling on how a technological innovation will be handled. Another possibility is stakeholder alliances that stall or block the adoption and application of an emerging technology will act as a decelerator for technological change.

2 PATHS OF INFLUENCE FOR IT IN FINANCIAL SERVICES

In this section, we will introduce the technology ecosystem and paths of influence model proposed by Adomavicius et al. (2008a). Moreover, we will illustrate how we extend their perspective by considering stakeholder actions in financial IS and technology.

2.1 Technology Ecosystem the Paths of Influence Model

Technology ecosystem. The *technology ecosystem model* considers the supply-side dynamic impacts on technology evolution, while also emphasizing the organic nature of technology developments and changes in the underlying technologies themselves. An *ecosystem* consists of a population of interrelated technologies with specific technology roles and overlapping technology hierarchies. Viewed together, these things represent a complex system of determinants for the evolutionary outcomes that are commonly observed in technology product and services settings. Rapid technology innovation and the uncertain outcomes associated with technology competition contribute to the difficulty of forecasting future technology evolution.

Context of use. Following the concept of a technology ecosystem and considering distinctive characteristics of financial services, we introduce the idea of a *financial IS and technology ecosystem*. It is a set of interdependent financial IS and technologies that work together in the operations and production of a specific financial service. The technologies in different ecosystems also may overlap one another. To define a financial IS and technology ecosystem requires the identification of a relevant set of technologies within a specific *context of use*. For example, if we are interested in analyzing electronic payments solutions to deliver *electronic funds transfer* (EFT) services to customers, then the related EFT technology ecosystem will include technologies such as telecommunications, information and network security, credit cards, electronic banking kiosks, and so on.

Technology roles. We define three major roles that technologies play within a financial IS and technology ecosystem: the *component* role, the *service* role, and the *business infrastructure* role. Table 1 summarizes the definitions, comments and examples for different technology roles. (See Table 1.)

Paths of influence. *Paths of influence* enable us to represent the impacts of technology-based financial innovation across different technology roles in a technology ecosystem (Adomavicius et al. 2008a). Technology innovation that plays any of the technology roles can cascade through the other roles resulting in subsequent innovations. For example, the success of the global adoption of smartphones and mobile applications has helped to drive the development of mobile financial services technologies, including mobile banking, mobile payments, and peer-to-peer money transfers. This represents the introduction of a new business infrastructure technology – from feature phones to smartphones – that will influence the development of other new product and service technologies in the future. We use the letters *C*, *S*, and *I* to represent the present state of technologies in the component role, service role, and business infrastructure role, respectively. An asterisk (*) represents the future state of a technology role. With this notation, we can analyze interdependencies over time and address the complexity of the relationships to identify trends in technology-based financial innovation.

Technology roles	Definitions	Comments	Examples
Component	Technologies that represent most basic building blocks of technological innovation.	Necessary for financial services to be offered and to perform their functions.	Camera in smartphone context in the IT landscape. The Internet, ATMs, credit cards in the EFT context.
Service	Services technologies directly interact with customers; provide access to a spectrum of financial services.	Include a *focal technology* and other related technologies that may directly compete or coexist in financial services.	Focal technology: EBP in online banking. Competing technologies: wire transfers, cardholder-initiated transactions, 3rd-party money transfers, and electronic checks.
Business Infrastructure	Identifies technologies that add value to the functionality or performance of service role of technologies.	Creates a basis for provision of services to customers; extends functionality and provides additional value-added capabilities and services to customers.	Short message services (SMS); email capability for EFT. Electronic communication networks (ECNs) for e-trading. VAR tracking system for financial risk management.

Table 1. Definitions of technology roles.

2.2 Paths of Influence and Stakeholders Actions in Financial IS and Technology

Our observations in financial IS and technology setting indicate that the organic nature of technology ecosystem alone is insufficient to tell a full story. Instead, the paths of influence are generated, implemented and affected by networks of interacting organizations and individuals in the ecosystem (Van der Valk et al. 2010), which generates demand-side dynamics of technology evolution. We will now extend the technology ecosystem analysis to include a *stakeholder perspective*. A *stakeholder* in financial services settings is an agent (customer, financial services firm, intermediary, government regulator, seller, user, etc.) that either affects other stakeholders through its own actions, or is affected by the actions of other stakeholders and the relevant technology-based financial innovation or related services. This often results in changes in some observable and unobservable facets of value, including profit, social welfare, expenses, losses or gains, beneficial network effects, goodwill, etc. (Au and Kauffman 2008). For example, the HFT technology ecosystem involves various stakeholders, including investors, issuers, traders, informediaries, brokers, financial intermediaries, market-makers, exchanges, financial IS and technology services providers, and regulators.[1]

Considering stakeholder actions related to technological innovations is critical to mapping out the paths of influence and future patterns of evolution. In view of the influence stakeholders' strategies related to technological change, it will be useful to define the actions of individual or groups of stakeholders. There are four *stakeholder actions*: *push-forward*, *pull-back*, *strategic alliance to speed*, and *collective resistance to stall or block* technology-based financial innovations. (See Table 2.)

3 PATHS OF INFLUENCE FOR MOBILE PAYMENTS

We will next demonstrate the application of the *extended paths of influence* approach with *stakeholder analysis*. This technology ecosystem involves multiple parties, and is an appropriate setting to examine the impact of stakeholder actions and make qualitative predictions about technological innovation.

[1] An *informediary* is a "company whose revenues come from helping consumers both protect and enrich themselves by capturing their own customer information and then selling it to the many companies that are now getting that information for free" (Hagel and Singer 1999a). For a fuller discussion, the interested reader should see Hagel and Singer (1999b).

3.1 The Stakeholders in the Mobile Payments Sector

We offer an overview of the set of stakeholders that characterize the m-payments technology ecosystem involving consumers, merchants, mobile network operators, mobile device manufacturers, financial service firms, software and technology providers and government agencies. To achieve success with m-payments, all these stakeholders need to participate and cooperate in a cross-industry alliance to establish a set of common operational, process and technology standards. Also, understanding the potential impacts of their actions will support strategic decision-making process, and help us to know how a successful m-payments business platform is likely to develop, and how it will fit into our extended paths of influence approach. (See Figure 1.)

We emphasize the need for a joint venture or supra-participant entity that can manage and work with the parties in the mobile payment ecosystem to facilitate an efficient environment and provide oversight, business rules, and standards for the various services vendors. This entity would serve as a third-party intermediary for stakeholders to produce value-creating service transactions for customers, and to facilitate faster and fuller market adoption. Currently, m-payments solutions and application systems vendors work on behalf of all stakeholders and tackle business issues of mutual need. These include such things as determining the relative liabilities of each party, creating process standards and operating rules for handling customer problems, and monitoring and supporting fair value-sharing.

Stakeholder Actions	Definitions and Comments	Examples
Push-forward	A stakeholder plays an active role in adopting a technology innovation or setting up a technology standard to facilitate fast and wide adoption, such as taking on the leadership to form a business network or investing in business infrastructure construction.	In mid-1970s, Philadelphia National Bank (PNB) launched one of the nation's first and largest regional networks of automated teller machines (ATMs): the Money Access Center (MAC) network (Clemons 1990), which pushed the adoption of ATM technology innovations forward.
Pull-back	A stakeholder decides against adopting or making use of a specific technological innovation or setting up a new or competing technology standard. This has the effect of slowing down or even blocking the path of influence for technology evolution.	Citibank declined to join the Cirrus national network of shared ATMs for some years in the U.S. (Quint 1991); U.S. Senate hearings (U.S. Senate 2009) in October 2009 caused the market share of HFT to fall from the 61% of the total in mid-2009 to 51% in late 2009 (Popper 2012).
Strategic alliance to speed	Different stakeholders to leverage one another to perfect their value propositions and business processes, so strategic cooperation often involves *partnerships for perfection* of operational capabilities and *alliances for joint competitive advantage* (Dai and Kauffman 2004).	Cirrus and Plus interbank electronic banking and credit card networks jointly expanded the beneficial effects of ATM and credit card networks. They moved the related technologies from a more limited U.S. national service role to a global business infrastructure role.
Collective resistance to stall or block	Key stakeholders may agree to come together and slow down or block the adoption and evolution of a technology when they consider the potential technological risk and uncertain market responses that may accompany new technology innovations, so the competitive *status quo* in an industry is not undermined.	J.P. Morgan's 1990s effort with CapitaLink Securities Corporation to build CapitaLink Bond Auction Systems to support commercial bank sell-side bond issuance (Quint 1989, 1990) challenged the U.S. Securities Exchange Commission's (SEC) Shelf Registration Rule 415. Later, Merrill Lynch Co. and other investment banks collectively blocked it.

Table 2. A classification of possible stakeholder actions.

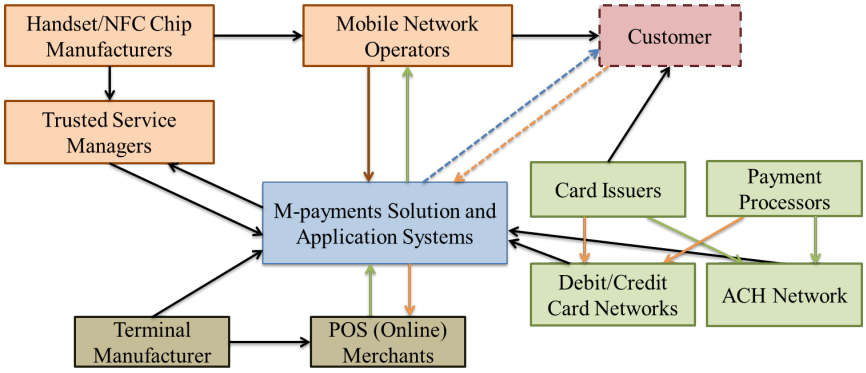

Figure 1. Stakeholders in the mobile payments technology sector.

3.2 The M-Payments Technology Ecosystem

We follow the four steps offered by Adomavicius et al. (2008a) to identify the technologies that play different roles in m-payments technology ecosystem: Step 1, identification of focal technology and context; Step 2, identification of competing technologies; Step 3, identification of component technologies; and Step 4, identification of business infrastructure technologies. Figure 2 provides a first-level analysis to understand the relationships and potential interactions among the technologies playing the three different roles – components, products and services, and business infrastructures, as a basis for interpreting how the market has developed and how it will evolve further. (See Figure 2.)

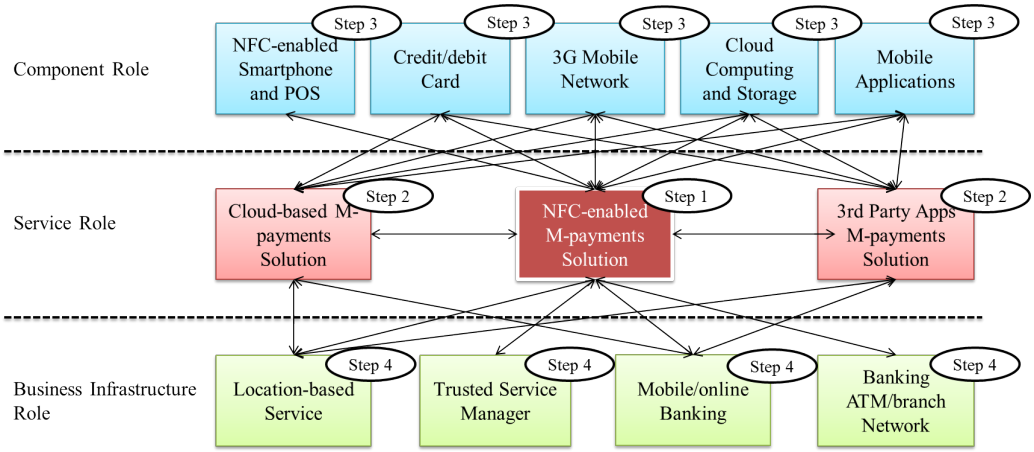

Figure 2. The m-payments technology ecosystem: components, services, infrastructures.

NFC-enabled m-payments solutions represent the focal technology for m-payments. Other related technologies play a role too. Although the illustration of the structure of the m-payments technology ecosystem is limited to a specific point in time, it is relatively complete in its coverage.

3.3 Data Collection

There are significant uncertainties due to technological risks and the changing consumer and financial services marketplace associated with investment and adoption decision-making for current m-payment technologies. So it is important for senior managers to understand the nature of technology evolution, the patterns of technological change, and what kind of innovations are likely to emerge to support their decision-making processes. M-payments technologies have existed since the late 1990s, and there have been many technological changes that occurred in this ecosystem during the past two decades. The recent launches of various m-payment technology solutions have generated great interest among industry practitioners in what is likely to be the future state of the m-payments market. M-payment

technologies span multiple sectors, including banking, payments, telecoms and retailing. This contributes complexity in the m-payments technology ecosystem. Many industry participants view m-payments as "the next revolution in payments," and large potential benefits are associated with their adoption for the industry stakeholders that get the technology innovations right (Etherington 2013).

We collected data between 1997 and 2013 from news in multiple sectors, industry announcements, government reports and surveys, and publicly available historical documents related to m-payments technologies. We used Internet search tools and interviews with industry practitioners. We coded announcements for approximately 20 related technologies in the m-payment technology ecosystem for the component, service, and business infrastructure roles. We offer a qualitative explanation of technology trends in the m-payments technology ecosystem by using information on the timing of related technology news releases. For example, since the first two SMS payments-enabled Coca Cola vending machines were installed in Helsinki, Finland in 1997, people have been aware of the capabilities of mobile devices to initiate, authorize and confirm the exchange of financial value in return for goods and services supplied. In 2001, the introduction of 3G mobile networks supported the connectivity and capability for data transmission among mobile phones, which pushed forward m-payment technology innovations in the early 2000s. After 2006, the release of new generations of smartphones and the rise of 4G mobile networks have begun to drive the market demand for more advanced m-payments services, transforming stakeholders' prospects for new revenues and profits in the m-payments business. Table 3 shows the timeline of m-payments technologies. (See Table 3.)

Year	Event
1997	Vending machines with SMS payments introduced in Finland
	Mobile phone-based banking services also rolled out in Finland
2001	Widespread adoption of online banking began to occur
	Commercial 3G networks launched in Japan
2002	eBay's acquisition of PayPal occurred
2004	NFC Forum founded, and MobileLime began to offer an NFC-based m-payments service
2005	NTT DoCoMo launched DCMX m-payments services in Japan
2006	Mobile WiMAX standard for 4G network commercialized in Korea
	First commercial cloud computing service offered by Amazon Web Services (AWS)
2007	Apple introduced the original iPhone
2008	HTC introduced the first smartphone using Android
2009	Long Term Evolution (LTE) 4G standard first released in Europe
2010	Square application to read credit cards launched on iOS and Android smartphones
	Widespread adoption of mobile banking began to occur
2011	Google Wallet, an NFC-enabled m-payments solution, launched in the U.S.
2012	PayPal partnered with 15 retailers for in-store cloud-based payments
	Apple awarded a patent for its iWallet technology innovation
	Isis brought NFC mobile payments to Austin and Salt Lake City in the U.S.
2013	Mobile apps enabling money transfer, NFC m-payments and card readers became pervasive
	AT&T, Vantiv partner for m-payments acceptance, and NFC platforms began rolling out

Table 3. A time line of m-payments technology developments.

4 WORK-IN-PROGRESS AND DISCUSSION

Our current work involves coding events for m-payments to represent different patterns of change based on the technology roles and paths of influence. We will adopt a *state transition diagram* to visualize the patterns over time in the ecosystem, as in Adomavicious et al. (2008a). We also will lay out a number of propositions that are intended to characterize how the evolution of m-payments technology might be affected by a firm's strategic interactions. They also recognize the roles of stakeholder and industry ecosystem structure as key forces that influence the pace of m-payments innovation. The extension of the technology ecosystem perspective to incorporate stakeholder actions enables us to fore-

cast technology innovations for some sectors of financial services, and to assist senior managers in understanding the nature of technology changes and the evolutionary patterns that underlie them. The distinctive characteristics of financial services make our approach more broadly applicable to financial IS and technology ecosystems that have multiple stakeholders whose actions may influence the paths of technological innovations. This perspective permits us to forecast the future state of the interrelated technologies at the industry level, and also to analyze the impact of industry structure and different stakeholders' interactions on the pace of technological innovation at the firm level.

Our approach is applicable in other financial IS and technology ecosystems settings. Characterizing the interplay among different technology roles may not be sufficient to explain the observed technology evolution though. Instead, analyzing stakeholders' actions will be more critical in forecasting how technological innovations emerge. An example has been occurring in financial technologies for the capital markets. They have been transformed by technological innovation but they also are highly regulated by the United States Securities Exchange Commission. The actions of regulators have been influential in determining the evolutionary patterns of HFT technologies over time. Such actions as the new SEC regulations on Alternative Trading Systems in 1998 and on the National Market System in 2005 were critical turning points to push the adoption of electronic trading technologies and venues forward. On the other hand, the pull-back actions because of the concerns arising around technological risks, such as the order production glitches of Knight Capital (Mehta 2012) and problems with Facebook's initial public offering at NASDAQ in 2012, affected how technological innovations have been permitted to play out in the market. As a result, stakeholder actions within the ecosystem need to be identified to provide a fuller picture of the developments.

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