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The economics of mobile payments: Understanding stakeholder issues for an emerging financial technology application

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Abstract

Economic theory provides a unique vantage point from which to examine issues with respect to emerging technologies, where standards and adoption, business process changes and implementation outcomes, information security, investments and business value, and industry impact require care and consideration on the part of senior management strategists and financial services leaders. In this article, we examine a new technology application which is coming into its own around the world, in association with the revolution in wireless connectivity: mobile payments. Although there are likely to be nuances and surprises with this technology application, we caution the reader to recognize that many of the same economic forces will be at work as were with other financial services and related technology applications in the past. We apply a robust evaluative framework that permits identification of the relevant stakeholders and applicable theory in the analysis of consumer, firm, business process, market, industrial and social issues. Our findings are intended to guide senior managers in dealing with the economic aspects of mobile payments, and to help identify some important directions for the research.

Keywords: Business processes; Consumer behavior; Economic analysis; Financial technology; Mobile payments; M-payments; Network externalities; Payment systems; Standards; Technology adoption

1. Introduction

A *mobile payment* or *m-payment* is any payment where a mobile device is used to initiate, authorize and confirm an exchange of financial value in return for goods and services [133,184].[1] An alternative definition for an m-payment is that it is a type of electronic payment transaction procedure in which at least the payer employs mobile communication techniques in conjunction with mobile devices for the initiation, authorization or realization of payment [237]. Mobile devices include mobile phones, PDAs, wireless tablets, and any other devices that can connect to mobile telecommunications networks and make it possible for payments to be made [113,152,238].[2] There have been a number of different technologies proposed in the past. Two technology standards, among others, are helping to achieve device and platform interoperability, resulting in current projections for high growth [2,186]. They are *short message services* (SMS) and *near field communications* (NFC). SMS technology has been leveraged by several companies including PayPal (www.paypal.com) and TextPayMe (www.textpayme.com), but is even more widely recognized as having transformed the social interactions of young people around the world. NFC is used by VIVOtech (www.vivotech.com), which partners with companies such

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[1] These definitions seem to exclude customer-to-customer (C2C) payments, as well as token-based procedures that directly effect payment, such as fairCASH (www.faircash.org) [158].

[2] There are a number of useful papers on the design and technologies associated with m-payment systems. The interested reader should see the following: Karnouskos et al. [136], McKitterick and Dowling [178], Ramfos et al. [205], Vilmos and Karnouskos [239].

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as Phillips, American Express, MasterCard, Visa, Symbian, and Sprint, and MobileLime (www.mobilelime.com), which partners with IBM, Chase, Fujitsu, HSBC, and Verifone, among others. Some others that play this role include Unstructured Supplementary Services Delivery (USSD, www.mobilein.com/ussd.htm) and Java. Even this very brief introductory description of the technology landscape in this area immediately suggests the relevance of economic considerations, including different standards and network externalities [71,218], as well as the nature of the competitors and the competitive environment.[3]

Depending on where an observer looks in the world, the extent of interest and the degree of development and diffusion of m-payments systems and alternative electronic cash systems will dramatically differ (e.g., [3,112,121,132,195]).[4] Many of the European countries, and Korea, Singapore and Japan have already gone far down the path of technological innovation, systems design, implementation, adoption, use and refinements [78,116,128,135,195,202]. The United States is farther behind. Many researchers and business analysts believe that m-payments will flourish in the coming years as the underlying technologies and the market for digital wireless phones mature [48,60,133]. Even today, m-payment technologies already look promising, since they seem to be so well attuned to consumer needs. A recent usability study conducted by Royal Philips Electronics and Visa International [240] on the NFC protocols and contactless payment technology shows that consumers like the convenience and ease of use for transactions and payments with their mobile phones. As a result, the market for m-payments seems to be growing rapidly—indeed, the market is in "takeoff" mode [157]. Celent, a research and consulting firm, projects that worldwide mobile payments would reach US$24 billion in 2006 and more than double to US$55 billion by 2008 [168].

Despite the technological advances and a promising outlook from industry observers, m-payments will face many challenges before their potential for value, convenience and security can be fully realized [37,57,82,129,184,230,250]. Lauri Pesönen, director of mobile payments for the handset manufacturer Nokia Inc., has argued that the concept of mobile payments still has a distance to go to achieve success:

> *"Mobile payments have [ ] great promise which has not so far materialized. There's been a lot of hype ... The promoters of mobile payment services will need to find ways to convince consumers to reach for their phones instead of their plastic—and convince retailers it's worth the equipment investment to accept new forms of payment. The very central question is: What's the business case for merchants? [W]hat is the incentive for consumers to use the mobile phone for paying for something?"* [131]

These and other related questions call for an in-depth analysis of the issues surrounding m-payments, and economic theories and concepts can be drawn on to help provide some possible answers. Furthermore, although m-payments are relatively new and are likely to have their own nuances and peculiarities, other financial technologies—especially electronic payment technologies—have been affected by some of the same economic forces in the past. These include: automated teller machines (ATMs) and shared electronic banking networks; cash, debit and credit card systems; electronic money and stored value applications; and electronic bill payment and presentment (EBPP) systems. Consequently, we can make use of the insights derived from the many available studies of those technologies in the technical, managerial and economic literatures, and apply them to assess and forecast some of the issues that are likely to arise with m-payments. With this point of view in mind, the issues that arise actually end up looking quite familiar to us.

Business processes involving mobility, organizational systems and technologies [56]—and m-payments, in particular—have many different stakeholders [156]. They include consumers, merchants, mobile network operators, mobile device manufacturers, financial services firms, software and technology providers, as well as the government. Consequently, the issues involved are multi-faceted and encompass many different elements of the overall business processes [22,36,68,76,134,173]. In addition, the m-payments industry landscape has been changing at a rapid rate, with the introduction of new technologies, new business models, new applications and the rise and fall of business ventures [66]. In the past several years alone we have witnessed the mass introduction of new technologies such as VoIP (voice over Internet protocol) and NFC, the disintegration of the international m-payment consortium SimPay (a collaborative effort of Vodafone, T-Mobile, Telefonica, and Orange) [77,79], and the launching of PayPal Mobile and other similar startups [94,192,193,217]. In addition, there has been growing interest in bringing m-payments solutions to the point-of-sale and vending machines [53,76,111], as well as to government operations [200]. All of these necessitate a robust analysis framework

[3] SMS applications use a messaging API for the purpose of making payments, an approach which has been criticized as being equivalent to "tuning a piano with garden tools," since it uses a relatively inappropriate and outdated technology for m-payments. In the mobile communications space though, mobile network operators have shown a clear preference for SMS, since charging for content with premium-rated short messages services (PSMS) in many countries avoids regulatory problems that would otherwise prevent an operator from effecting m-payments. With PSMS, the operators can claim to bill for "telecommunications services," and effect relatively complete control of the value chain leading to a revenue model with a 30–70% margin. This sounds good for the operator, but in mature markets it turns out to be a major inhibitor for the adoption of mobile services, other than ringtones, logos and adult content (private communication with Key Pousttchi, December 14, 2006).

[4] For comprehensive background on the range of electronic payment systems development that have occurred around the work in the past twelve years, the interested reader should see the statistics reports prepared by the Bank for International Settlements [13–15]. The reports provide a wealth of background and some interpretive information on the development and growth of various electronic payment solutions around the world.

that not only is capable of revealing key economic theory and managerial issues, but also has intertemporal relevance to capture the industry dynamics over time.

With this brief background in mind, there are several research questions we plan to address in this paper. What are the suitable business models for m-payments? How will m-payments fare in the competition with the existing and more developed payment schemes? Is it reasonable to believe that m-payments will replace cash and credit cards to become a universal payment device? Or will m-payments fill only a particular niche, as micropayments tried to do? What are the gaps between the current technological offerings and the market expectations? We will use a survey of the past theoretical and related financial technology literature, combined with current business press articles that reveal the problems with m-payments technologies and solutions, to support relevant theoretical predictions and managerial findings.

Our discussions will place a special emphasis on consumers and users, and technology producers and vendors, who are at the two ends of the m-payment process. They arguably are the most important stakeholders for the success of m-payments in the marketplace. In the next section, we will identify key economic theories that are relevant to the m-payments industry. In Section 3 we present our evaluative framework and place some of the theories within the framework, while identifying the stakeholders and business and economic issues that arise in this context. The subsequent sections will discuss the business and technology issues in economics terms from the perspectives of consumers, merchants, and mobile payment service providers (i.e., mobile network operators, financial institutions, and specialized intermediaries). We also address the dynamics of the market and the industry, and the potential impacts of m-payments in different parts of the world. We conclude with a synthesis of the key theoretical and managerial findings.

2. Theoretical background

To provide a basis for our analysis throughout this article, we first discuss six areas of economic theory. They are the theories of (i) *consumer choice and demand*, (ii) *network externalities*, (iii) *switching costs*, (iv) *complementary goods*, (v) *information technology value*, and (vi) *adoption and diffusion*. We briefly introduce each theory and illustrate its applications to the phenomena observed in other related industries, including the payment card and electronic payment industries, which offer useful parallel findings that can guide our assessment of the m-payments area.

2.1. The theory of consumer choice and demand

The main role in the *theory of consumer choice and demand* is played by the *consumer*, who is viewed as choosing the best option from a set of feasible options, based on the consumer's preferences. In choosing the best option, typical microeconomics textbooks (e.g., [159]) suggest that the consumer always seeks to maximize her *utility*, the satisfaction or enjoyment she derives from the consumption of a good or service, for a given budget. Some authors emphasize the importance of ease of use, usefulness and usage, as we have seen with the *technology acceptance model* (TAM) [63,64], and related applications for banking technologies [228].

The theory of consumer choice can be used to explain the widespread occurrence of *multi-homing* discussed by Rochet and Tirole [208]. This occurs when a consumer carries more than one payment card (e.g., American Express, Visa and MasterCard) or uses a combination of different kinds of payment instruments (i.e., cash, check, credit and debit cards) [238]. Although research has shown that a consumer's choice of payment instrument is significantly correlated with income, age and other demographic characteristics [109,149,180,224], the literature has also frequently assumed that consumers multi-home to maximize their utility. This is because each payment instrument has its own characteristics and offers particular benefits [48,238]. For example, each credit card may offer different benefits such as cash-back bonuses, hotel points, or airline miles, whereas a check might be perceived as allowing consumers to keep control of their budget better [124,153,246].

2.2. Network externalities

The *theory of network externalities* has been used extensively to explain value creation in the network economy. Economides [71], Shapiro and Varian [218], and Liebowitz [171] all offer excellent basic overviews to orient the interested reader to this literature. *Network externalities* exist when the utility derived from the use of a product increases with the number of people using the product [80,137,138]. In other words, a new user that joins an existing *network* or *group of users* will confer additional benefits on the existing users in the network. Authors in this area often distinguish between direct network benefits and indirect network benefits. *Direct network benefits* are those that arise because of how a technology permits the direct communication or interaction with other users. *Indirect network benefits* arise as a ripple effect which encourages producers of a technology with direct network benefits to keep producing goods and services that are compatible within the network. We have seen network externality theory applied in the contexts of interorganizational systems [206], electronic data interchange [242], digital wireless phones [143,144], automated clearing houses in banking [1] electronic banking and ATM networks [98,141,146], and EBPP [4–6], among others. Kauffman and Wang [146], for example, find that banks which shared their ATM networks with each other obtained beneficial impacts for the growth of their individual networks. Thus, the value of a shared electronic banking network to the banks and its cardholders will increase as the network grows.

Financial markets also exhibit network externalities because an increase in the size (or thickness) of an exchange market will increase the expected utility of all participants. The higher participation of traders on both sides of the market reduces the market price variance and thus increases the expected utility of risk-averse traders [71,72]. Similarly, the utility derived from the use of a particular electronic payment instrument depends on how many consumers are using the same instrument [146]. The more consumers that use the same instrument, the more merchants will accept that instrument—and vice versa. This increases the utility of each consumer since the payment instrument becomes more practical [4]. Milne [182] has proposed that some new payment mechanisms may be developed for the purpose of achieving high network effects.

Standards and *compatibility* are key ingredients for network externalities. Shapiro and Varian [218] suggest that standards enhance compatibility, also known as *interoperability*. This will increase network externalities by creating greater value for the users by making the network larger, by essentially combining existing networks. Tirole [236] maintains that one advantage of standardization is that it avoids *excess inertia*, which occurs when users wait to adopt a new technology or to choose among several technologies. Standardization also reduces users' search and coordination costs.

2.3. Switching costs

Switching costs arise when buyers find it expensive to switch to a competitor once they have bought from one supplier, even if the products of the old and new suppliers are functionally identical [24]. For example, when a photographer considers buying a new Canon camera, instead of a Nikon as he has always purchased before, he must think about the investments he has made in Nikon lenses, since the Nikon lenses will not be compatible with the lenses of any Canon cameras. According to Klemperer [154], there are at least three types of switching costs: transaction costs, learning costs, and contractual costs. Closing an account with Wells Fargo Bank and opening a new account with Citibank might cause the consumer to incur *transaction costs*. Migrating from Microsoft's Windows to Apple's MacOS will generate some *learning costs*. Flying on another airline may result in the consumer losing frequent flyer mileage, an example of *contractual costs*.

When switching costs exist, rational consumers usually display brand loyalty if they have to choose between functionally identical products. Switching costs provide consumers with a strong incentive to continue buying from the same firm. Furthermore, switching costs can cause network externalities—just as network externalities can lead to pressure in the market to "lock in" adopters and users. Although in this case there are no direct network externalities, the presence of switching costs and increasing returns together generate an indirect externality: the more consumers that buy a product, the more likely it is to survive and the more attractive it is to the other consumers. However, this could also mean that there is a danger that inferior products may win out in competition with one another if the suppliers play the switching cost game correctly [24,155]. In EBPP, for example, many consumers sign up to pay their recurring bills using credit cards or automatic checking account debits. If the electronic payment is not done centrally through a bill consolidator's site, then changing a credit card or checking account will require a consumer to visit every biller's Web site to update her account information. The time it takes to provide billers with new information contributes to the consumer's switching cost.

2.4. Complementary goods

Two products are *complementary goods* if an increase in demand for one leads to an increase in demand for the other, and vice versa [73]. Examples include DVD players and DVDs, Apple's iPod and iTune songs, cars and gasoline, Nikon's cameras and lenses, ATM machines and bankcards, and many more. Providing complementary goods or services can be important because it has the potential to lock in customers [218]. For example, Sony uses its proprietary memory stick to tie all the devices it manufactures together. A memory stick is an exchangeable flash-memory recording medium that is used in computers, camcorders, digital cameras, PDAs, and MP3 music players. A Sony camcorder buyer uses a memory stick to store snapshots with the camcorder. Since the memory stick can be inserted into a Sony brand PDA, the Sony PDA will have a higher value to the Sony camcorder buyer. Thus the memory stick serves as a complementary good among Sony products. It creates the potential to lock in customers that have purchased any Sony product [175].

In fact, the greater number of complementary goods created for a product, the more people will buy the product [73]. However, for many complex products, the actual complementarities can be achieved only through adherence to specific technical compatibility standards, as suggested by Economides [71]. Complementarities have been shown to work favorably between components in the credit card system also [38,40]. As more consumers carry credit cards, more merchants are encouraged to add credit card readers. This, in turn, increases the number of consumers that have a credit card since they will perceive more value associated with carrying the plastic card [176].

2.5. IT value

Bakos and Kemerer [10] consider three different types of IT value: *normative value* (based on expected values), *realist value* (based on observed outcomes) and *perceived value* (based on subjective user evaluations). Motivated in part

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by Bakos and Kemerer's perspective, Davern and Kauffman [61] analyze the value of decision support systems and distinguish between two types of IT value: *potential value*, which represents the maximum value opportunity available to the investor if the IT is implemented successfully, and *realized value*, which is the measurable value that can be identified after the implementation ensues. How much of the potential value can be realized depends on conversion contingencies (e.g., on the extent to which the IT implementation goes as planned) [243]. Furthermore, often the reason that firms are not able to enjoy the full value of a technology is because they fail to simultaneously invest in the required complementary assets that are needed for realizing the benefits. These include new processes, work routines, organizational knowledge, and responsibility structures, without which the benefits of IT cannot be obtained [234].

Kauffman et al. [141] model the value of an electronic banking network as a combination of firm-specific value and network-generated value, and show that banks participating in shared networks can enjoy more benefits from electronic banking systems than banks with proprietary systems. They also find that although the referents of value may be agreed upon on a market-wide basis, there is considerable variation in individual firms' assessments. Brynjolfsson and Hitt [33] suggest that the value of IT investments should not only be measured by cost savings. Improvements in quality, customer service, and new product development must also be considered.

2.6. Economics of technology adoption and diffusion

Research on the economics of technology adoption and diffusion shows considerable evidence on the positive impact of IT adoption and investment on firm performance, in spite of Nobel Laureate in economics, Robert Solow's 1987 observation that "[y]ou can see the computer age everywhere except in the productivity statistics." Today, the gains come from a number of sources. Stiroh [226] finds an increase in productivity related to IT use in nearly two-thirds of American industries from 1995 to 2000. Similarly, Baily and Lawrence [9] claim that there is clear evidence of productivity acceleration in service industries that purchase IT. In addition, Brynjolfsson and Hitt [34] find that the use of IT has resulted in substantial long-term productivity gains. However, there might be a significant lag between initial adoption and widespread diffusion of a technology within an organization, and the related impacts [18,19,95].

The evidence shows, however, that stakeholders to technology adoption (including consumers, corporate buyers, selling intermediaries and government agencies) do not always reach a consensus about the value of technological innovations. One argument has been that firms and consumers perceive the value and risks associated with network and other technology innovations in heterogeneous terms, based on their unique perspectives, positions and strategies in the marketplace [20,148,211]. Another argument rests on the frictions of information transmission in the marketplace and the difficulties that senior manager in different potential adopter firms and organizations have in coming to a consensus on the business value of a technological innovation [5,6,29,30,169]. Other issues further complicate technology adoption, including market structure [130], firm size effects [227], when to launch a technology product [45], and the period for return on investment [148].

Fudenberg and Tirole [88] maintain that early adopters will benefit disproportionately from the technology than later adopters. This is because there may be first-mover advantages for the early adopters such as the ability to capture scarce inputs [127]. Recent research, however, shows that the impact of IT adoption on firm performance depends on usage [67,105]. For example, unless the IT is properly and frequently used, it will not have a positive impact on the performance of the firm that adopted it. Other research has found that IT is more valuable when it is adopted by firms that implement innovative organizational and managerial practices, including flatter organizational hierarchies and more extensive decentralization [31,114,181].

A firm's technical infrastructure may affect the value of new technology adoption due to the fact that compatibility between the two will influence the costs of adoption. However, Iacovou et al. [125] point out that organizations with significant levels of IT infrastructure are more likely to have access to the technological and managerial resources needed to adopt and make the best use of the new technologies. This is supported by empirical research studies that have shown firms with higher levels of technical competence or more recent infrastructure investments are more likely to adopt new ITs (e.g., [87,248,249]). In addition, in meta-research of eighteen empirical studies conducted between 1981 and 1991, Fichman [81] concludes that individual adoption and independent technologies that impose a small knowledge burden on their adopters obtained the most attention.

3. A robust framework for analysis

One way to assist our discussion of the economics of m-payments is to formulate an evaluative framework for the exploration of the issues that arise around an emerging disruptive technology, with typical kinds of stakeholders and both private profit incentive-driven and public social welfare-driven considerations related to the economic issues that may arise. This will permit us to consider m-payments as a disruptive technology in the space of electronic payment technology solutions. A *stakeholder* in this research is an agent (e.g., an individual, a firm, an intermediary, a government regulator, a user, a buyer, etc.) that either affects through its own actions or is affected by the actions of others and the relevant technological innovation or related products and services, resulting in changes in some observable or unobservable facet of utility (including profit, social welfare, expenses, losses or gains, etc.).[5]

We propose a robust general framework that identifies how a disruptive technology or innovation is likely to impact the various stakeholders to m-payment-related technological innovations. A *robust framework* provides a basis for effective analysis of some related technological innovations, based on a set of dimensions that maintain their validity over time and across different settings and applications, and that also permit the analyst to assess relevant theories, organizational strategies, industry transformations, technology impacts, and so on, through the framework's lens [145]. A *disruptive technology* is a new technological innovation that creates the basis for new products and services, and infrastructures and applications that eventually displace the technologies, products or services that currently dominate the way firms do business, the nature of their business processes, and the markets in which they operate [46,47]. A disruptive technology may come to dominate an existing market by either filling a niche that the older technology is not able to fill, or by successively moving up-market through business process and firm-level performance improvements until firms that have adopted the disruptive technology begin to replace the market incumbents as market leaders.

We view m-payment technology solutions within the larger electronic payments space as the disruptive technology. Some analysts have predicted that m-payments will *evolve* in exactly the two ways described above [179]. M-payments could initially fill the micropayments niche and other *use cases* [75,196] that previous e-cash solutions were not able to do. In the longer term they may become integrated with debit and credit cards, so that consumers can securely pay for larger transactions from their cell phone or other mobile devices [7,215]. In this way, m-payments will complement debit and credit cards but at the same time have the potential to overtake them with the pervasiveness of cell phones and the improved access to the services, potentially lower operating costs, and so on [36,38]. Furthermore, as teenagers' use of digital wireless phones further expands [167] and they grow up to become a new generation with new spending power, the possibility exists that they could come to rely on their cell phones as *primary* payment instrument, making m-payments the dominant method of payment. We see the same thing already happening among people up to 35 years old, who are highly educated and have a high affinity to technology. Further acceptance will occur as m-payment services and operational procedures are worked out and become more pervasive among merchants.

Our framework recognizes different levels of impact related to the disruptive innovations associated with m-payments. By *levels of impact*, we intend to identify the issues that arise with respect to the disruptive innovation. These may be related to the different stakeholders, relevant theoretical perspectives on why the disruption will matter, and various effects and impacts that may be observed or felt. The latter may be measurable or non-measurable outcomes that lead to: producer, seller and intermediary gains; benefits for users, consumers and customers; and issues for consumer groups, government agencies, regulators and standards bodies (see Fig. 1).

We array the different stakeholders around the north, south, east and west points of the compass in our diagram.[6] At the north side are the producers of the disruptive technologies, which often but not always are technology companies, but may also be product and service providers, and even consulting firms, university and government research labs. A good example of this is global positioning systems (GPS) technologies, which were developed from university, government and military research, and commercialized with the involvement of public sector agencies and private sector firms, and put into different application contexts (e.g., automobile navigation systems, outdoor sports electronics, etc.) with the help of other product design startups, automotive companies, and end user groups. On the south side we have users, consumers and buyers, which in a real sense are at the "opposite end" of the production–consumption spectrum, and act as *value-takers* in the presence of the innovation-creating *value-makers* [145]. Consumers have demonstrated a willingness to pay for GPS applications for automotive route-finding, outdoor sports, boating and navigation, and other uses. During the time that GPS technology and its applications were under development, government regulators and the military were careful to keep the full capabilities of the emerging technology from full public disclosure, but later, in concert with market intermediaries and sellers of GPS applications, the new technology would find its way into the broader marketplace where it is widely embraced today.

We know from other market contexts that technological innovations often require different kinds of subsidies for adoption and diffusion [206] before they are broadly

[5] A contrasting use of the term *stakeholder* in economics is to indicate "[a]ll the parties that have an interest, financial or otherwise, in a company, including shareholders, creditors, bondholders, employees, customers, management, the community and government" (www.economist.com/research/Economics/alphabetic.cfm?letter=S#stakeholders).

[6] For an alternative formulation of a robust framework for analyzing m-payment-specific technology innovations that involve customers, merchants, telecommunications companies, banks and financial services providers, different intermediaries, and other traditional "old economy" players, the interested reader should see Kreyer et al. [161,162]. The authors' framework considers strategic, operational and participant-related aspects of technology solutions that make mobile payments available for four scenarios: *stationary merchants*, typical *online e-commerce*, new *mobile commerce transaction*s scenarios, and *customer-to-customer money transfers*. Another interesting framework has been offered by Gumpp and Pousttchi [102] for the purpose of analyzing *mobility-based value-added* and *information-based value-added* [23,166,199] in mobile business processes that involve the support of mobile technologies.

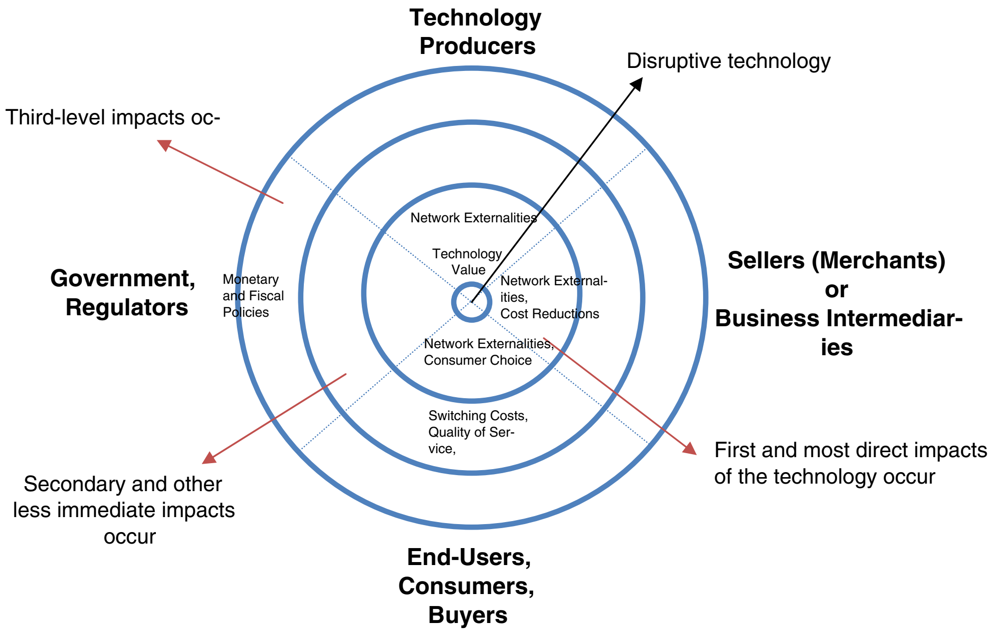

Fig. 1. A robust framework for the analysis of economic issues for disruptive technologies.

enough adopted to make it economical for consumers, corporate buyers and other users to purchase them. Thus, just to the sides of north in the figure we may expect to see producer-side sales intermediaries (east direction) and standards organizations and industry-sponsored government lobbying groups which play the role of "breaking trail" in the marketplace for the smooth adoption and diffusion of the disruptive technology. Ninety degrees to the east we have sellers of the goods and services based on the innovation (e.g., large and small physical retailers, mail-order companies, Internet-based sellers, etc.), which often play the major role of selling to consumers, buyers and users. Directly opposite from the sellers, we see government agencies, regulators and other public sector entities that track sales practices, monitor innovation quality, regulate potential monopoly markets, make laws and stimulate market demand through advantageous taxation and other business policies [204]. Sellers and regulators also appear at "opposite ends" of the spectrum of relationships in our framework, since inappropriate actions from one often lead to impacts on and protests from the latter (e.g., inappropriate tax policy diminishes opportunities to move innovations to market, like Internet services). We should also point out that sometimes regulators' decisions would benefit sellers. In any case, however, the role of regulators is to regulate the market and respond to the actions of the sellers. Sellers also impact the value that producers and consumers can take away from the market, depending on the seller concentration and the structure of market competition. And, of course, regulators impact the market based on the relative incentives they offer for market participation by the producers and sellers, and the terms and conditions for consumers to participate (as has recently been the case with changes in laws prohibiting the electronic movement of funds for poker gambling bets). At the economy level, government agencies may care about the impacts of m-payments on other forms of monetary exchange, the control of the money supply, and consumer risks in the electronic movement of funds and value [8,28,41].

The figure depicts the different levels of impact on the stakeholders using a series of concentric circles. The innermost circle contains issues revealing the most direct impacts related to the innovation or technology—in our case, the technological innovations associated with m-payments. These issues include, for example, network externalities and the value of m-payments transaction-making. They appear to impact all of the stakeholders that we have identified. The next concentric circle just out from the innermost one contains issues that have the first order impacts, including revenue increases and cost reductions for the vendor side, and quality of service and accessibility benefits for consumers. Likewise, the outer concentric circles will contain issues of secondary and other order impacts. Some of the issues that arise may concern certain stakeholders only, while some others may affect all of them, depending on the setting, the disruptive technology, and the nature of the business and social problems. Based on the manner in which we have defined it, our framework is robust and generalizable, and can be applied to a range of interesting technologies, such as VoIP, radio frequency identification (RFID), intelligent agents for Internet search, electronic auctions, information goods, and many other technological innovations.

We now turn to a discussion of the issues that arise with the emergence, diffusion and adoption, and growth of m-payment technology solutions in the marketplace, and the stakeholders who are affected. Wherever it is possible, we will further frame our discussion in terms of the six areas of economic theory that we presented in the prior section: consumer choice and demand, network externalities, switching costs, complementary goods, IT value, and technology adoption and diffusion.

4. Analysis of consumer-level issues with economic theory

Economic theory offers different perspectives to treat different levels of impact on consumers with respect to m-payments. A key first-level issue is the extent to which technology adoption and diffusion has been occurring for m-payment technology solutions around the world. Economic theory suggests that the degree of adoption of m-payments will be constrained by the extent of available infrastructure on which to build m-payment systems solutions [115]. According to Mercator Advisory Group (www.mercatorgroup.com), the number of cellular subscribers in the United States surpassed 200 million in 2005 [117]. Furthermore, there are 400 million cellular subscribers in China, 90 million in Japan, and 37.5 million in South Korea [118]. Computer Industry Almanac Inc. (www.c-i-a.com) [51,52], a market research firm, reported that in 2005 the penetration level of cellular subscribers was 93% in Western Europe, 68% in the United States, and only 23% across all of the Asia Pacific region.[7] The latter juxtaposes the high penetration rates of South Korea, Japan, Singapore and Taiwan against the low penetration rates of countries such as North Korea for mixed regional adoption.

4.1. M-payment consumer adoption and penetration: country-level m-payments infrastructure

Although mobile devices are virtually ubiquitous around the world, the penetration of m-payments has been uneven. Some observers have noted that this may be due to the uneven diffusion of mobile telephony and electronic payment cards in different countries around the world.

4.1.1. Global mobile phone adoption

There has been increasing adoption of m-payments in several Asia Pacific countries, less in Europe, and very little in the United States [179]. The number of global cellular subscribers is predicted to be 3.2 billion by 2010, and was near to 2.1 billion as early as 2005 [51], which provides an infrastructure for m-payments (see Table 1, which provides some estimates of global subscribers and penetration rates).

Economic theory also provides a basis for understanding differential rates of consumer adoption of digital wireless phone technologies, as well as the m-payment services solutions that are built on top of them. For example, a number of authors have examined the different bases for adoption of digital wireless phones, and report a range of factors that seem influential. They include:

Table 1
Cellular subscribers and penetration rates by country, 2005

Country	Subscribers (millions)	% Share of world	Country	Subscribers (millions)	% Share of world
China	398	19.3	Italy	59	2.9
United States	202	9.9	United Kingdom	58	2.8
Russia	115	5.6	France	47	2.3
Japan	95	4.6	Mexico	46	2.1
Brazil	86	4.1	Turkey	40	1.9
India	79	3.8	Spain	39	1.9
Germany	73	3.5	South Korea	38	1.8

Notes: Data are from Computer Industry Almanac [51]. Total global cellular subscribers in 2005 were 2.065 billion. These estimates are different than those discussed in the Mercata Advisory Group reports by Holland and Broad [117,118]. The reader should exercise caution in interpreting the percentages, since it is not clear that the different reporting services are capturing true cellular subscriptions, or if they are capturing people who own more than one mobile phone and SIM card, and where vending machines are equipped with GSM modules to permit m-payments to be made.

- gross national product (GNP) per capita, social homogeneity, the size of the installed base of the technology, and the degree of international experience with the technology [65];
- cosmopolitanism, population mobility, and the role of women in society [93];
- entry regulation, number of standards, operator competition and availability [100,101];
- network externalities and installed base [103];
- access costs, education, English proficiency [151];
- culture, time lag from technology and production introduction [231];
- and consumer willingness-to-pay, urbanization, and access to product information [232].

Another critical factor is the extent of the existing banking and electronic payment infrastructure [115].[8] Recently, Kauffman and Techatassanasoontorn [143,144] have examined the inertial effects and influence of fixed phone line infrastructure, analog and digital telephony service prices, competition among analog and digital operators, and government wireless phone standards and operator licensing policies. They note that more standards tend to slow down consumer adoption, most likely due to the uncertainty of service continuity or the number of competing plans and providers.

[7] We caution the reader with respect to the interpretation of the different regional penetration rates, since the different reporting services are not always careful to differentiate between the *SIM card penetration rate* and the *mobile phone ownership penetration rate*.

[8] An example is GXchange in the Philippines, a mobile phone-based payment capability for people in rural areas to send and receive payments using text messages in support of microfinance in the country [43].

Table 2
Cards issued in 13 selected countries, 2004

Country	# Cards w/a cash function (million)	# Cards w/a cash function per population	# Cards w/e-money functions (million)	# Cards w/e-money functions per population	# Cards w/credit functions (million)	# Card w/credit functions per population
Belgium	15,727	1.51	8979	0.86	NA	NA
Canada	NA	NA	NA	NA	56,536	1.77
France	49,112	0.79	1160	0.02	NA	NA
Germany	115,623	1.40	63,912	0.77	NA	NA
Hong Kong	NA	NA	NA	NA	NA	NA
Italy	32,736	0.56	1432	0.02	27,020	0.46
Japan	445,170	3.49	NA	NA	NA	NA
Netherlands	28,300	1.74	18,000	1.10	NA	NA
Singapore	6200	1.46	10,673	2.52	3933	0.93
Sweden	5262	0.59	NA	NA	2754	0.31
Switzerland	9410	1.26	3983	0.53	3391	0.45
UK	165,915	2.77	69,888	1.17	69,888	1.17
US	928,000	3.16	≈0	≈0	1,246,300	4.24

Notes: 2004 data for this table were adapted from data collected by the Bank for International Settlements (BIS) [16]. The number of cards is stated in millions, as noted. NA = data not available, since national bodies do not always collect similar data to report to the BIS. The lag time of two years for reporting this kind of data is typical for international organizations and government bodies. Fiscal years for reporting also may vary by country, and may not match calendar years. The data set includes information on *cash cards with no additional functionality*, and other categories of *cards with greater functionality*. They include *cards with electronic money functionality*, *cards with debit and delayed debit functions*, *cards with payment functions*, and *credit cards*.

4.1.2. Country-level installed base for electronic payments

The extent of e-payments infrastructure in different countries is also likely to have some bearing on how much diffusion and adoption of m-payments we are likely to see around the world. Table 2 shows the comparative extent of penetration of various kinds of cash cards in a set of countries selected by the Bank for International Settlements (BIS) [16] (see Table 2).

The table shows that the greatest installed base of cash cards occurs in the US, Japan, United Kingdom, Germany, and France, in that order. However, cash cards with e-money functionality have close to no installed base throughout North America, and are most prevalent in the UK, Germany, Netherlands, Singapore and Belgium, respectively. We further note that cash cards per 1,000,000 in population is greatest in Japan and the US, and then the UK, Belgium and the Netherlands. In contrast, Singapore, the UK, and the Netherlands have the greatest installed base of cards with e-money functionality per capita. Interestingly, underscoring the differences in card-related business processes and patterns of use, we see that the greatest number of credit cards occur in the US, the UK and Canada. Based on the BIS data, it appears that only the US has a larger installed base of credit cards than cash cards (though missing data prevent us from knowing if this is true for Canada as well). In addition, only Singapore has more cards with e-money functionality than cash cards and credit cards combined, indicating the advanced nature of electronic payments there, in comparison to other countries. Europe is more debit card-focused.

4.1.3. Economics and consumer evaluation of m-payment systems solutions

Economic theory also enlightens our understanding of how people evaluate different alternative means to make their purchases—a secondary issue—largely on the basis of utility or disutility for a given transactional mode [40,238]. In a recent survey conducted by Visa USA with 800 American consumers, more than 50% of respondents between ages 18 and 44 said they worried about not having enough change to make a small purchase, and would prefer to have m-payment options so they did not have to carry cash [32]. Clearly, this is an issue of consumer choice and utility. The survey also reveals that consumers are twice more likely to carry their mobile phones than cash, and that this number jumps to four times in the 18–34-year old age group. A similar market survey was conducted with mobile phone users at Waterloo Station in London in 2004 by Qpass (www.qpass.com), an m-commerce software vendor. The survey revealed that 78% of the respondents would use a mobile phone to pay for parking, 56% a newspaper or magazine, and 53% for public transport [203].

4.1.4. The value of m-payments

These facts suggest that many consumers actually see the *potential value* of m-payments; however, they may not yet find the *realized value* significant enough [61] to warrant expressing demand or signing up for m-payment services. The disparity between potential value and realized value as seen by consumer stakeholders can be attributed to several factors [164], including the lack of a specific business model, cost issues, consumer apathy, security, accessibility (i.e., a combination of convenience, speed, and ease of use), and the lack of unified standards [35,143]. Kreyer et al. [162,163] discuss the importance of having standardized m-payment procedures for favorable consumer acceptance of m-payments. Dahlberg et al. [58,59] consider such issues as ease of use, usefulness, trust and important human factors, as other drivers of consumer acceptance of m-payments. Karnouskos [133], Pousttchi [194,195] and

Pousttchi and Schurig [197] have offered well-developed perspectives on how to make m-payments successful based on their observation of the German and European experiences in the past several years with implementation and adoption of m-payment services. Pousttchi [194] notes, for example, that consumers and users need to count on m-payments business processes being designed in a way that fosters consumer confidence and ease of participation. Furthermore, in a study conducted on a sample of consumers in the United States, Dewan and Chen [68] report that although consumers acknowledged the potential benefits of m-payments, they expressed great concerns about security and privacy. Furletti and Smith [89] report on the range of legal protections that electronic payment systems users can rely upon in the United States. This article's evaluation suggests to us that it will take some time for the equivalent level of details with respect to legal practices around m-payments to gel, another secondary or higher issue that suggests the range of possible impacts of the technology.

Consumer willingness to support the replacement of prior electronic payment systems with new ones is another key issue, as Khodawandi et al. [150] report based on a 2002 survey in Europe. The authors revealed that out of 4432 respondents, about one-third said that they would adopt m-payments to replace other payment instruments. Out of the total, one-sixth also said that they would use m-payments for micropayment transactions. The factors they cited as reasons for adoptions include ease-of-use, short processing time, ubiquitous availability, and the emotional added value of the technology [23]. The survey also discovered that some of the respondents said they would not adopt m-payments for the following reasons: perceived lack of security, preference for other payment instruments, unfamiliarity with m-payments, lack of transaction tracking ability in m-payments, complexity, general subjective rejection, and fears of unauthorized transactions. Respondents also reported a high willingness to use m-payments in the mobile commerce environment, and successively fewer at vending machines, attended counters, in e-commerce, and for P2P payments. A follow-up study by Eisenmann et al. [74] involving 6,343 respondents showed that interest was mounting to the point of a majority of respondents indicating their willingness to use m-payments for vending machine, m-commerce, e-commerce and P2P payments.

Another useful and arguably more accurate estimate has been made by the German National M-Payment Roundtable, which suggests that 49.6% of the German population was willing to accept m-payments in 2004 [183]. Still, the fact that two-thirds of the respondents in the Khodawandi et al. [150] study and about one-third in the Eisenmann et al. [74] study failed to see the benefits of m-payments is worth considering further. Consumers' apathy may relate to the fact that they have many options when it comes to payment methods, and because many consumers simply are used to, and therefore prefer certain payment forms. For example, Japan is known as a cash society and the vast majority of purchases are still economically done with cash—in spite of the popularity of wireless phone and hand-held devices. This can be attributed to the low crime rate in Japan, which makes people feel safe to carry a wallet full of cash [116], and express their willingness-to-pay in cash. On the other hand, consumers in the US rely more on checks and credit cards, where physical safety may be a concern. In any case, switching to a different payment method would require consumers to change their habits—something that not too many will be willing to do, as economic theory predicts, without the right incentives and subsidies [206]. Financial services providers also often build in switching costs [38,154,155], which makes a decision to switch on the part of a consumer more difficult. An example is CapitalOne's "No Hassle Miles" credit cards, which permit credit card purchase dollar amounts to be translated into airline miles that are redeemable for free airline tickets by credit cardholders. Giving up the card means foregoing the contingent benefits of past participation.

4.1.5. The role of network externalities in consumer valuation of m-payments

Network externalities potentially can add to lock-in incentives, based on the primary findings in the network externalities literature we have already discussed (e.g., [71,147]). The more merchants that accept an m-payment, the more consumers are willing to use it [5,6]. However, depending on where consumers are located in the world, today there may be too many competing m-payments standards. It is not impossible for consumers who subscribe to just one standard to enjoy a "pay everywhere" guarantee (as they nearly have with debit and credit cards now). We expect consumers to become frustrated when their m-payments providers' services have limited acceptance. The option of subscribing to many different m-payment providers' services will be unattractive for most consumers, who are more likely to multi-home across the different payment instruments (i.e., checks, cash, debit and credit cards) to maximize utility and enjoy the best combination of benefits from the different instruments. Economic theory argues that additional substitutable resources are freely disposable by consumers and firms that do not wish to use them. Moreover, adding an m-payment instrument to the mix also should not be an issue, assuming the addition preserves or increases the consumers' utility. Still, some have asked whether m-payments have the potential to substitute for, or eventually cause the death of credit cards [36]—an issue that may apply to debit cards as well.

4.2. Consumers and business process design issues involving m-payments

Economic theory also has much insight to offer for the analysis of what is likely to happen with business process designs that have digital payment transactions involving consumers, merchants, issuers, and acquirers. The *consumer* is the party who makes the payment, the *merchant* is the

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party accepting the payment, the *issuer* is the party that provides a credit line or a direct link to a checking or savings account, and the *acquirer* is the party that interacts with the merchant [216]. In a credit card system, the information about the consumer or the cardholder is kept in the card's magnetic strip. When a transaction is initiated, the merchant sends the information in the card to the acquirer which will in turn send it to the issuer for verification. Once approved and the transaction is completed between the consumer and the merchant, the funds are transferred from the issuer to the acquirer to the merchant, and the issuer will bill the consumer. The transaction procedure is similar in m-payments, although the consumer information and transaction credentials are kept in mobile devices [133,160,162]. Furthermore, the transmission of payment details will involve a mobile network operator and use standards like Wireless Application Protocol (WAP), among others. The transport of payment details can also be done via SMS, Bluetooth, infrared, RFID or contactless chip in the case of proximity payments, among other means [184].

Karnouskos [133] categorizes mobile payment procedures based on several different criteria. The types of m-payments based on location are *remote transactions* and *local transactions*. The types of m-payments based on value include *micropayments* under $2, *minipayments* between $2 and $20, and *macropayments* of more than $20. There are also *postpaid*, *prepaid*, and *pay-now* types of payments based on the charging method that is employed by the issuer [201]. Two additional categories, online *m-payments* and *offline m-payments*, are based on how the exchange of *tokens* representing monetary value is validated. Some other distinctions made by Karnouskos [133] and Ondrus and Pigneur [190] include *single-chip phones* and *dual-chip phones* that include a *subscriber identification module* (SIM) and a *wireless identification modul*e (WIM), and *single-slot* and *dual-slot phones* that also can read smart cards. These are descriptors for the number of chips and slots on the mobile phones that can be used for m-payments. M-payment systems can also be *e-coin based* and *account-based.* Finally, Ondrus and Pigneur [190] also distinguish among a number of other m-payment technology solutions. They include: wireless wallets (which usually indicates some sort of mobile phone with an embedded smart card reader and slot) [235], infrared financial messaging (IrFM)-based solutions (Infrared Data Association or IrDA, www.irda.org), RFID-based m-payments systems, "top-up" card and m-payment systems (for additions of money to an m-payment account) (e.g., Virgin Mobile USA, www.virginmobileusa.com), and prepaid mobile cash cards, among others.[9]

[9] The vernacular meaning of a *wireless wallet* is simply a mobile phone, which provides connectivity for a user to access various kinds of payment services. Early use of this term was associated with a Bluetooth-ready mobile phone, a product prototype that Ericksson dubbed the "Wireless Wallet" upon its 1999 introduction. IrFM is somewhat problematic, since not all mobile device manufacturers make it available now.

Kreyer et al. [162] offered a set of payment scenarios where the m-payment transactions (e.g., in mobile commerce, e-commerce, stationary merchants, and consumer-to-consumer exchanges) each may require a different set of procedures. Ondrus and Pigneur [190] present results from their analysis of market preferences for m-payment solutions. Their analysis shows that consumers tend to prefer magnetic and contactless cards, merchants prefer contactless cards, and providers and issuers prefer magnetic cards and smartcards. Hence, the market in general appears to prefer cards to mobile phones. An economic theory-based interpretation of this would emphasize the role of prior installed base (similar to video cassettes vs. CDs, or UNIX vs. Microsoft Windows), as well as the operative switching costs that are involved (similar to PC-compatibles vs. Apple computers) [218]. These give rise to transaction costs through new account setups and learning costs with the new service solution, as well as contractual costs if connectivity is lost by the consumer to other service providers [154,155]. Card-based technologies are already proven, have significant installed bases throughout the world, and have very mature business process designs set up around them. In addition, they have become cheaper to operate because they have been around longer and reached critical mass, so that their components have fallen in price.

4.3. Mobile phone e-money functionality in support of mobile business processes

Current electronic payment systems solutions cover both innovations that provide similar kinds of functionality to m-payments, but do not necessarily involve the same thing as using a mobile phone. The Bank for International Settlements [16] study calls this *e-money functionality*, which includes a blend of "swipable" cards and also "contactless" cards that may be based on RFID or other technologies. Let's consider several examples of solutions with e-money functionality as well as those that support truer m-payments business processes.

4.3.1. Octopus cards, e-money functionality and beyond

A good example beyond the typical electronic bank account access cash cards and credit cards is the use of contactless smart cards known in Hong Kong as "Octopus Cards" (八達通卡有限公司 at www.octopuscards.com). These have e-money functionality, as suggested by the BIS study, and have been used successfully by the general public in passenger transportation system since 1997 [42]. However, these cards still do not approach the functionality that mobile phones can offer. As a result, over time, we expect that mobile phones (and similar devices such as integrated mobile phone and PDAs) will become consumers' preferred choice for m-payments. From the point of view of functionality, mobile phones offer many features that contactless and smart cards do not have, including telecommunications capabilities and screen interfaces that

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can be used to support many different applications involving m-payments integrated with business processes [198]. Mallat et al. [174] report on the use of mobile phones in Helsinki, Finland, where 55% of tram tickets and 10% of public transportation tickets by Helsinki City Transport originate with mobile phone-based orders. Obviously, the potential exists to bring contactless cards and mobile phones into the payment arena for public transportation services.

4.3.2. PayPal mobile and MobileLime's m-payments processes

Although there have been many different proposed and implemented m-payment procedures (e.g., [133,202]), the ones that will dominate the market will be secure, easy-to-use, and cost-effective. These are the typical utility concerns for electronic banking systems that economic analysis would predict are important [109,110]. Although there are other competing technology solutions available, SMS is employed by PayPal Mobile (www.paypal.com/us/cgi-bin/webscr?cmd=xpt/cps/mobile/MobileOverview-outside) and TextPayMe (www.textpayme.com/us/secure/index.tpm), among others as discussed by Mobile Payments World (www.mobilepaymentsworld.com/). NFC is used in combination with mobile phones to permit "phone swiping as a means of payment," developed by MobileLime (www.mobilelime.com), which currently is piloting it in several cities, including Boston, Chicago, Dallas and Washington, DC [223].

With PayPal Mobile, a consumer who would like to make a payment sends a text request to PayPal. The text request will include the amount of funds the consumer wants to transfer and the phone number or e-mail address of the recipient. Upon receiving the customer's text request, a PayPal computer will call the customer and request him to enter his PIN to confirm. Next, PayPal immediately will notify the recipient of the incoming payment. MobileLime's NFC-based service, on the other hand, provides its customers with the ability to pay for purchases by just clicking a special icon on the menu screen, choosing the payment method they want to use (e.g., credit card, bank account, or prepaid) and waving their phone over a contactless reader that is integrated with the merchant's point-of-sale system at checkout. For added security, the users can choose to use a PIN to complete a transaction. At least for the near future, PayPal Mobile seems to be ahead of its competitors due to the fact that PayPal already has over 100 million customers [126]. However, NFC-based phones may eventually attract a larger customer base if they are marketed well.

5. Firm and market-level analysis of m-payment issues

We now turn to a discussion of other key stakeholders that our framework emphasizes, including firms in the north and east quadrants, representing mobile network operators, technology vendors, financial services institutions and specialized intermediaries.

5.1. M-payment innovators and service providers

Firms that create mobile payment systems solutions, and firms that sell or act as intermediaries to their sale (e.g., PayPal, www.paypal.com; Peppercoin, www.peppercoin.com; and PayBox, www.paybox.com) have the potential to reap great benefits from the growth of m-payments [120]. So far, however, these firms have not been able to realize the potential benefits, as has been predicted by economic theory, which suggests that compatibility [218], value appropriation [61], market acceptance issues [5], and the strength of leading players will be critical [44]. As a result, firms that are eager to start offering mobile payment services must deal with the ever-changing infrastructure requirements and the fragmentation of standards, networks, and devices that have been suggested as being a roadblock to market consensus [6]. As a result, firms that are looking into investing around a particular set of standards must also consider what will be the future technological infrastructure, if they want to reach customers in different markets worldwide. Kauffman and Li [140] have called this a problem *of standards drift*, and Economides [71] and Au and Kauffman [5] have further pointed out that uncertainty generally slows down technology adoption and diffusion in the marketplace, making entrepreneurs and solution providers vulnerable to failure—and adding complications that may cause some business adopters (e.g., financial services firms especially in the electronic payments case) to be stranded [218].

Banks and credit card companies have been particularly reluctant to commit to investing in a single solution due to integration and security issues, but others have argued in favor of a single solution advantage, especially when systems help to integrate multi-channel operations [212]. Major financial institutions are working towards integrating their mobile services into existing multi-channel delivery environments, but choosing a single set of mobile standards that will work consistently in every market served by the financial institutions is nearly impossible. Furthermore, the issues of security and privacy remain a significant concern among the major players [135,170]. Consequently, most of the investments in m-payments have been made by mobile network operators, who are more like selling intermediaries in our evaluative framework than like the original innovators and producers of the m-payment technology systems solutions, since these operators see the opportunity to capitalize from their customer base.

For the mobile network operators themselves, however, the task of making successful technology investments has been far from easy—something that economic theory straightforwardly predicts due to difficulties with technology adoption. Despite the awareness of the importance of concerted efforts, many such endeavors have not produced the desired results. Tirole [236] and Kauffman and Techatassanasoontorn [143], who have recognized the importance of inertial adoption in the presence of multiple standards, offered predictive logic for the difficulty associated with technology adoption, even when the innovations behind the new technologies are substantial. For example, in the electronic payments arena, Hunt [123] has suggested both adoption externalities and usage externalities as critical determinants of payments network success. Small networks rarely have sufficient adoption externalities to offer, and rarely are profitable. Instead, larger network launches are required to manage consumer and merchant expectations to the point where they are collectively willing to adopt [139]. In this context, Au and Kauffman [6] have pointed to the difficulties associated with *multi-partite adoption*, where firms of different kinds and roles must collectively adopt systems related to new business processes, in order for any value whatsoever to materialize—a reason why we often see firm alliances and consortia as means to coordinate investments [172].

In spite of the predictions of theory, it still is critical to understand the limitations of these points of view, and to examine the possibility of other compelling explanations. A case in point is Simpay, a joint venture of several European mobile phone companies (including T-Mobile International, Vodafone Group, Orange, and Telefónica Moviles). Simpay was created in 2003 to facilitate commerce using mobile phones for payments of different sizes, but later ended up focusing on payments of less than €10.[10] It was intended from the start to be a relatively ‘‘large’’ implementation effort [219]. One of its aims was to provide a *single platform* to process the routing, clearing, and settlement of m-payments. The joint venture was to have its payment system operational in as many as twenty countries by 2004. The project was riddled with delays, however, and SimPay ultimately collapsed in 2005 after T-Mobile decided to pull out [212]. Simpay's difficulties underscore the challenges of bringing business rivals together to promote a service or standard that could potentially benefit all parties [229]. The fact that Simpay consisted of *only* mobile phone companies also demonstrates the need for cross-industry involvement for m-payment systems collaboration [230]. In addition, this example points out how the path-dependent behavior of just one player in a multi-firm technology project can shift the expectations of the other players. This may bring on greater uncertainty about the viability of a standard. This, in turn, may further motivate under-investment and even defection on the part of firms which initially thought the innovation would be viable in the market. The unfulfilled advantage of Simpay was that it would have made it easier for m-payment consumers to use the services in different countries. Without R&D and technology investment alliances like Simpay, m-payment services will be mainly regional, due to the lack of global standards. This will likely dissuade potential users of m-payments to use them when they travel in the different countries of Europe.

Mobile network operators in some other countries like Japan have been comfortable with focusing more to develop a strong local market, even though they may have global aspirations. Among these, NTT DoCoMo Inc., the largest mobile network operator in Japan, stands out [119]. NTT DoCoMo, with about 51 million subscribers as of late 2005, recently launched an m-payment service, DCMX, which is available on cell phones equipped with Sony Corp.'s Felica contactless IC chip [12] (see Fig. 2).

NTT DoCoMo will earn commissions from shops and restaurants for payments through DCMX. Unlike a typical credit card, subscribers as young as twelve years old, with consent from their parents, are eligible for the DCMX minicard. To promote the new contactless technology, NTT DoCoMo invested ¥98 billion in Sumitomo Mitsui Card Co. in April 2005. Sumitomo Mitsui began offering a contactless service in December 2005. NTT DoCoMo also invested ¥1 billion in UC Card Co., a Mizuho Bank affiliate. About 25,000 shops and restaurants already accept payments by this new method of payment, and NTT DoCoMo has set a goal of 100,000 retail outlets by the end of 2006 and is focusing on the sectors where credit cards are least used [191]. These efforts reflect the large-scale rollouts that Hunt [123] was suggesting, as a basis for generating large adoption externalities, and reducing the heterogeneous risks that individual firms would perceive in developing services around NTT DoCoMo's increasingly standard mobile phone system solutions [20].

NTT DoCoMo's initiative to aggressively team up with some of the financial services institutions and their success so far again show how important cross-industry partnerships in making m-payments a success, similar to what we have previously seen in electronic bill payment and presentment in the United States (e.g., [4,139]). The Japanese mobile phone services providers understands that potential value of m-payments cannot be realized without the correct execution. As it turns out though, the model implemented by NTT DoCoMo is not the only one that promises suc-

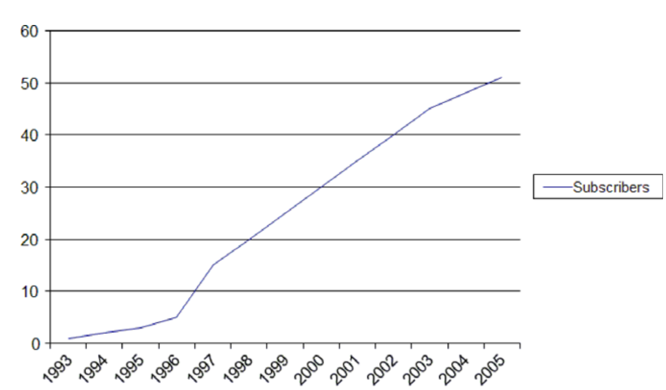

Fig. 2. M-payments infrastructure: subscribers to NTT DoCoMo's mobile phone services, 2005. *Note:* Data adapted from an NTT DoCoMo press release, November 10, 2005 [187].

[10] Personal communication with Key Pousttchi, December 14, 2006.

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cess. In South Korea, for example, mobile network operators have enjoyed some success with their m-payment services. Some examples include: Moneta of SKTelecomm (www.sktelecom.com), which is operated with participation from Korea Exchange Bank Credit Service (www.yescard.co.kr), Woori Card (www.wooricard.com) and SK Corp.(www.skcorp.co.kr) (SK Telecom 2002); K-merce (www.ktf.com); and ZOOP from Harex InfoTech Inc. (www.mzoop.com). These compete with the more traditional payment instruments offered by financial services firms [189], and are similar in their success as Octopus Cards of Hong Kong has been in overcoming competition from e-cash systems offered by credit card companies, such as Mastercard Mondex [49] and Visa Cash [42].

The success of the mobile network operators in those countries leads to the question of whether financial services firms should let the mobile network operators take the initiative in the m-payments arena. Economic theory tells us that interorganizational investments in IT are never easy, due to the difficulties of identifying how to apportion the emerging benefits [11,104] and to share the financial and operational risks [50,142]—the so-called problem of *incomplete contracts* [106]. Moreover, as in the case of e-billing, financial services firms carry the advantage of having the trust of the consumers due to deeper and longer-term relationships [5]. This gives them the ability to wait a little longer before fully committing to competitive entry. However, with m-payments the banks' competitors (i.e., the mobile network operators) are likely to have increasingly good relationships with their consumers or subscribers, so the financial services institutions cannot wait for too long either.

Thus, in any model for m-payment system services launch and market entry, the key is to establish network externalities by attracting as many consumers and merchants as soon as possible to use the services, similar to what we have seen with the adoption economics of group-buying networks [69] and ATM networks [123]. Network externalities will create the connectivity and convenience that consumers expect and the efficiency that the merchants desire. And, with the right blend of incentives and rewards—comparable to the ones offered by the credit card companies—it should be possible to encourage consumers to eventually use m-payments as their main payment instrument.

5.2. The dynamics of the market for m-payments

The dynamics of the market for m-payments are different than those for other electronic payment systems. This is because m-payments involve new players, such as mobile network operators, which have their customer bases and may be strong enough in their own right to force financial services intermediaries no other choice but to split their market shares and profits. This problem is often referred to as digital convergence [247], which means that changing technologies make it possible to deliver a product or service by a different means than in the past, resulting in the destabilization of the related industry structures. Some examples where technology led to digital convergence and the transformation of industry structures include digital phones vs. land lines, electronic mail vs. postal mail, and digital cameras vs. film cameras. Mobile network operators, by the same token, provide the infrastructure for m-commerce, metering of downloaded digital goods, measurement of elapsed time for data sessions, billing mobile phone subscribers for content or service charges, and settling payments periodically with merchants [201]. No traditional intermediaries, outside of transforming telecommunications firms, are naturally able to do that—and especially not the financial services firms at this time; however, we may modify our views with research in process by Pousttchi and his colleagues.[11]

Since the mobile network operators understand the behavior and profile of their subscribers well, they also can promote and deliver the right services—including m-payment services—to their subscribers. Further, since m-payments can piggyback on the mobile network operators' existing network infrastructure, they also may be in a better position to offer lower commission charges to merchants than are possible through the credit card firms. However, despite all of these advantages, mobile network operators still may not wish to start diversifying into the area of financial services. This is not their core competency—indeed, it is an area that has taken the banks decades to master—and so the mobile phone operators risk unleashing the power of some of the largest financial services firms. The latter may wish to reintermediate in the market for m-payments, just as we have seen with the market for e-billing services [139].

Consequently, there seems to be a general understanding throughout the industry that banks and mobile network operators should work together to provide m-payment services, just as economic theory and other theories of strategic competencies, such as the *resource-based view of the firm* [17,245], would argue. Some of the major industry groups established by the leading mobile network operators and the major players in the financial sector serve as evidence. The cooperation of mobile network operators and banks, facilitated by the technology producers, should work well to address the issues related to information security, product development, users' requirements, resource and expertise sharing, and so on.

A key issue in the development of cooperation among different parties—beyond the bargaining issues discussed by Bakos and Nault [11]—will be how revenue should be split in practice. The air travel, hospitality and rental car industries have mastered the financial value chain in their sectors, and have complex and effective operational means to apportion revenues that are received by any participating stakeholder (e.g., travel agencies, airlines, digital reser-

[11] Personal communication with Key Pousttchi on December 14, 2006.

vation-making intermediaries, etc.). These are known as *interchange fees* in financial services, especially in the credit card market [21,39,40] and the ATM banking services market [90,91,207,209,214]. Significant competitive and social welfare issues exist, especially when sellers and intermediaries pass on surcharges to consumers [97,177] and interchange fees and surcharges are observed worldwide [244]. Baxter [21] maintains that interchange fees are necessary to balance the demand of consumers and merchants for credit card services and the costs among issuers and acquirers. However, reaching agreement on a revenue model that is attractive to all parties is always a challenge, since many parties may be involved, each party will expect to profit from its transactions, but not all service coalition members are equal contributors to the value that is created [11].

Although m-payment instruments are offered mainly as an alternative to or substitute for credit cards, it is interesting to note that the credit card companies have responded by offering their own versions of m-payments, as a defense against being *disintermediated* [44] by mobile phone services providers. For example, Visa, Discover, Mastercard and American Express all have come up with credit card-based m-payment services that utilize *proximity technology* solutions, such as NFC [62], and collaborate with mobile network operators on their m-payment initiatives. In Asia Pacific, Visa International works together with NTT DoCoMo, KDDI (www.kddi.com) and SK Telecom on proximity payments, although Visa considers this more of an effort to defend itself against signature-based credit card fraud. In Europe, however, credit card companies have been largely absent from the pan-European mobile payment schemes. A contrasting initiative was PayBox (www.paybox.net), which began operating in 2001. With PayBox, instead of providing a payment card, a consumer gives her mobile phone number to a participating merchant. After transaction initiation by the merchant, the consumer received an interactive voice response (IVR) call with a request to punch in a PIN to confirm the transaction. Afterwards, the merchant was notified that a successful transaction was made, and the customer received an SMS message confirming the payment. The money was then debited from the consumer's bank account. PayBox claimed to have 750,000 users in Germany, Austria, Spain, Sweden and England in early 2002, and had planned to expand to the US and Asia. But later in the year, Deutsche Bank, as the major shareholder pulled out of PayBox, and shut down its operations [84]—an obviously *path-dependent outcome*. The Austrian part of PayBox survived because it was bought by the mobile network operator, Mobilkom Austria. More recently, the third largest mobile network operator in Austria bought one-sixth of Paybox's shares.[12] PayBox continues to operate now within Europe again [55]. Still another initiative is Crandy (www.crandy.com), a cell phone-based payment system offered by the NCS Mobile Payment Bank GmbH, Europe's first independent mobile bank.

Other examples of various kinds of electronic payments service providers that once offered services similar to PayBox include eBay's BillPoint (closed in April 2003 when it acquired PayPal [54], Citibank's C2It which also shut down) [83,225], Yahoo's PayDirect (closed in the face of competition with PayPal in November 2004) [165], FastPay (www.fastpay.com) offered by National Westminster Bank (which took over PayBox's customers in the UK, but was later shut down in July 2005) (Finextra.com 2005), and PayPal Mobile (which is now owned by eBay Inc.). These failures demonstrate the nature of the competitive market forces that have wreaked havoc since March 2000 [147], and the over-capacity in the infrastructure for e-payments.

Today, banks and other financial services firms are offering SMS-based services that require online pre-registration, as a means to deal with the economic costs of information security and fraud-based losses. These services allow users to send or receive money from credit card or checking accounts via their mobile phones using SMS. Many of the new m-payment providers also have targeted the micropayment segment of the market, hoping that their payment systems can replace cash, as well as fill a market that the credit card companies are not interested in. Their ventures into this marketplace follow the well known comments of pundits who believe that micropayments cannot succeed [86,185,188], and still others who have held that micropayments will improve the efficiency of market exchange in a world where the marginal costs—and likely competitive price—of Internet-delivered electronic information will be near to zero [45]. Such context are out there today on the Internet though: 99-cent songs, brief independent videos, pay-by-hit search, and so on, suggesting that an efficient means of micropayments will bring new transaction-making to the Internet that was not possible before for cost reasons [120]. But this will still represent a big challenge because the margins on small-value payments are very low and adequate economies of scale are hard to achieve due to the fact that the markets still are very fragmented. Indeed, Rosenberg [210] has written that this entire marketplace may be hard for large corporations to monetize, just as we have seen in the area of micro-finance in the developing world. He points out that this is not really the main issue though; instead, the issue is to provide economic access for market exchange at *all* levels of the market. In addition, many smaller merchants are unaccustomed to paying any fees whatsoever for payment services, since credit card transactions fees are costly, and they typically have only been able to accept cash. And with the ready availability of ATM access, the merchants' customers probably will not be caught short of cash too often. Those merchants who willingly pay the transaction fees may do so because credit card use induces consumer demand to shift upward—not because of intrinsic technology or business process value—just as we see drivers more frequently filling

[12] Personal communication with Key Pousttchi, December 14, 2006.

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up their cars' gas tanks when they pay with a credit card [108].

6. M-payments and the future industry and economy impacts

Economic theory and thinking also offers insights for making predictions about m-payments, and the future industry and economy impacts that are likely to occur. What bases are there for changes to occur? What explanations will support such changes? Where will the main impacts be focused in the future? In this section of the article, we will further explore how economic theory can help to arrive at some possible answers.

6.1. Credit cards, m-payments substitution and regulatory issues

The simplest economic predictions relate to exogenous technological change-induced transformation in the economy's use of money, especially the *substitution* of one technology for another in the presence of cost pressure. We expect the changes to arise at the epicenter of our framework's emphasis—with the emergence of new technologies, and the corresponding changes in costs and operating performance expectations that the different stakeholders to the transactions exchange process experience. For example, we expect merchants to look to the potential operational benefits of m-payments over paper money, checks and credit cards when the comparative risks, clearing and settlement costs can be replaced with cheaper operating costs [96,108].

Today the credit card system dominates retail payments, despite being costly, prone to fraud, unsuitable for micropayments and person-to-person (P2P) payments, and not anonymous [213]. Many observers with a knowledge of the economics of payment systems would argue that credit cards represent an inferior system—except, of course, that it has been repeatedly shown to work "well enough," as we have seen with paper checks, check float and check processing in the Unites States. There is a large payments and check processing systems literature (e.g., via the working papers and published papers of the economic research departments of the Atlanta, Chicago, Kansas City, New York and Philadelphia Federal Reserve Banks), and it offers many useful perspectives on performance, costs, efficiency, business and social impacts, and support for economic growth that can help us to interpret whether m-payments have the potential to play a new role in the electronic payments landscape in the US, and what reasons there are (if any) to replace the existing system.

M-payments-based electronic cash is broadly expected to reduce the use of central bank notes and coins, as well as credit and debit cards, and give rise to a changed set of costs and benefits in transaction-making [92]. However, a widespread use of electronic cash also will raise many questions for monetary and fiscal policymakers, since it will affect central banks in such areas as monetary policy, banking and payment system supervision, and the stability of the financial system [25,27,28,70,99,163,241]. For example, there are questions of whether non-bank institutions should be allowed to issue electronic cash, and whether traditional regulations such as reserve requirements and capital regulations should be extended to electronic cash issuers. Another concern is whether banks will be required to issue electronic cash with the same reserves as those required for checking and savings accounts.

6.2. Cost efficiency and m-payments in smaller businesses

But a key question will remain: what does it cost to make a payment [122]? Goodhart and Krueger [96] maintain that the informal small business and individual economy will preserve the demand for physical cash, in spite of the technological innovations that create pressure on money in economic exchange. However, Spencer [223] argues that this will not prevent the adoption of electronic cash, in some form, by the formal business-to-consumer, business-to-business and government sectors of the economy. The reason why banknotes and coins remain in use in the legitimate economy is largely because notational transactions are costly to process due to the involvement of financial intermediaries, as we saw from our discussion of small companies and credit card transaction costs earlier. This constitutes the main difference in transaction-making value between electronic cash and physical cash, since the security and privacy issues remain difficult in both domains. Nevertheless, as the transaction costs decrease, electronic cash in the form of m-payments, following the diffusion of mobile phones, will become more widespread. This may challenge government monetary policy and undermine the historical control of central banks over their national money supply due to the fact that electronic cash will circulate outside the central banking system on unmonitored computer networks, and thus electronic cash will become untraceable and hard to measure.

M-payments, based on the rapid adoption and diffusion of mobile phones, have the potential to achieve wide penetration. As their usage level increases, the impacts of m-payments on the economy will become more significant and noticeable. And although m-payments can be based on credit card accounts (e.g., PayPal Mobile), in the future we expect to see more and more of m-payment systems that are based on electronic cash (or digital currency) due to the operations cost disadvantage of credit cards.

6.3. M-payment disadvantages and the "legal tender" issue

M-payments are not without their disadvantages, as government regulators and banking system oversight professionals would argue. M-payments have the potential to facilitate illegal activities, such as money laundering, fraud and tax evasion [233]. This is because they provide a high level of privacy and allow users to remain anonymous [26]. Although many attributes of electronic cash are similar to those associated with physical cash, electronic data

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are easier to conceal and smuggle across borders than just about any other form of physical goods. As a result, electronic cash may be used to defeat programs instituted by some governments that require banks to detect, hold, and report international funds transfers to help confiscate funds from certain groups or individuals. In many countries, this has already come to be recognized as a "homeland security" issue.

Although electronic cash allows parties to make contracts and to freely engage in economic exchange, is not *legal tender* in the sense that it lacks the status of a medium of exchange that has been authorized, adopted, or backed by the government. Electronic cash will only be backed by the issuer's promise to pay. So if it is issued by a non-financial institution, the applicable regulations may be different and insufficient to protect the parties that adopt it, leading to the well known problem of underinvestment [11] again. This situation will most likely change in the future though. For example, the Singapore government has already announced that it will make electronic cash and mobile money legal tender by the year 2008 [128]. This means that all merchants and service providers would be legally required to accept payments exchanged electronically using mobile phones, handheld computers, etc. Nevertheless, the Singaporean government believes that the move will help the economy by cutting the high cost of handling cash.

7. Challenges and directions for m-payments

We next present a summary of challenges and directions of m-payments, and discuss the state of m-payments in the United States, Europe, and Asia. We also address the question of whether m-payments will become a universal payment device, replacing cash and credit cards, from the economic perspective.

7.1. M-payments in the United States, Europe and Asia

The various surveys that we have reviewed suggest that many consumers recognize the potential value of m-payments. However, there is a gap between potential and realized value as seen by most consumers, particularly in the United States. Consumers in a number of European and Asian countries seem much more willing to adopt and use this means of payment, although the same potential and realized value gap still exists, albeit to a lesser degree. This disparity appears to be caused by a number of factors, which include the lack of a sound business model and unified standards that have prevented m-payment service and technology providers from offering universal services to meet consumers' expectations, as well as issues related to security and privacy. In addition, the theory of consumer choice and demand suggests that consumers tend to choose to use a combination of payment instruments that maximize their utility. Consequently, m-payments must offer *higher* realized value to effectively compete with the other payment alternatives. This is likely to occur as mobile phones diffuse more widely and checks and cash become less preferred instruments of payment.

Network externalities, as we have stressed, will play a big role in creating value in m-payments systems. The more merchants there are who accept m-payments, the more consumers will be willing to use them. This can only happen, however, if there is a cohesive set of technology standards that every merchant and consumer can rely upon. Without integrated and universal standards, the m-payment industry and the markets in the US and elsewhere will remain relatively fragmented and localized, forcing merchants as well as consumers to accept several different m-payment systems and preventing providers from reaching the critical mass needed to survive or deliver the best services to consumers. To achieve the objective of having common standards, however, m-payment technology and service providers from different industries must join forces. The collapse of Simpay, an alliance of major European mobile network operators, offers a good lesson on the need for cross-industry collaboration; to date, however, there are few initiatives to match Simpay in the US, where the market is much more fragmented among mobile network operators in comparison with Europe, Japan and South Korea.

For consumers and merchants alike, switching costs will continue to be a major factor to consider, due to the lack of organization of services in the marketplace. Although most m-payment service providers do not (yet) charge consumers for using their services, this may change in the future once providers understand their cost structures and the market better—and recognize the importance of subsidizing adoption. More importantly, consumers' switching costs may come in the form of lost opportunities to enjoy the incentives that other payment alternatives offer (e.g., reward points or airline frequent flyer mileage bonuses offered by the credit card companies). Conversely, merchants that are used to accepting cash only will now have to consider giving up some of their revenues (albeit a relatively small portion) to the providers as m-payment service fees, for the m-payment services providers will surely not offer free payment services for very long.

The idea of positioning m-payments as an alternative to cash for micropayment transactions is quite interesting—in spite of the arguments of the naysayers. Moreover, European observers (e.g., [150]) believe that m-payments are most likely to address the needs that consumers have in the range of lower macro-payments up to €50, though there exists a solid basis for acceptance at all different amounts. In this case, m-payments have the potential to serve as a complementary payment instrument to checks and credit cards, replacing cash. In this scenario, we expect that consumers frequently will carry their debit cards, credit cards (or checks) and m-payment devices (e.g., mobile phones) wherever they go. Any payments that are not appropriate to be made by credit cards or checks will be taken care of by m-payments, and vice versa. Consequently, a full "complementary goods" effect will be generated. However,

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unless there is a critical mass within a reasonable amount of time, this kind of business model will not work because the margins on micropayments are too low. Furthermore, achieving the critical mass in fragmented markets will prove to be very difficult.

This prompts us to recommend that m-payments should be positioned to compete with the other payment schemes on all fronts. Only this alternative will attract sufficient attention of all the stakeholders, including and especially the major banks. The involvement of major banks will prove to be key to building greater momentum for m-payments and ensuring their success in the marketplace. This is because they have decades of experience in the payment business and have earned the trust of their consumer/customers. Nevertheless, as we have discussed, banks cannot work alone and must be a part of an effective cross-industry alliance aimed to establish a set of common standards.

7.2. Towards universality in m-payments

The question that remains to be answered now is: Will m-payments replace cash and credit cards to become a *universal payment device*? There is much evidence, in our view, to suggest that they will, although it will take some time. Whether we consider Europe, Asia or North America, the young generation (especially our children and other teenagers) will constitute the main m-payment adopters as they grow up to become the next generation of a workforce with expanding spending power. Even the credit card companies realize the great potential of m-payments and would like to have a head start before the competition gets too much more intense. This is evidenced by their active participation in many m-payment initiatives (e.g., Visa with the NFC-based system). Furthermore, although m-payments can be based on credit card accounts, in the future we expect to see more electronic cash-based m-payments.

M-payments based on electronic cash will present a set of challenges, however. The use of central bank notes will diminish, and monetary policies and their management will need to be altered. We expect that central banks will have less control over their national money supplies because electronic forms of money are notoriously hard to measure, control and trace. Without the proper safeguards, security and regulation, digital forms of money will facilitate money laundering, fraud, tax evasion and other illicit activities in the economy. Finally, because electronic cash is not considered to be legal tender, we expect that the complexity of the issues related to the guarantee of clearing and settlement of m-payments will create some frictions on the speed with which adoption and diffusion occur.

Overall, the m-payment industry has a bright future throughout the world, but there will be many challenges ahead before a widespread adoption occurs. Economic analysis offers the potential to understand a variety of m-payment-related phenomena on the basis of electronic payment initiatives of the past, as well as on the basis of other technologies that give rise to similar issues for their key stakeholders.

8. Conclusion

Economic theory offers useful ways to understand and interpret past developments, and predict what is likely to happen in the area of mobile payments in the coming years. In our survey of the applicability of economic perspectives on m-payments, we have leveraged a framework that emphasizes the roles of m-payment innovation producers and m-payment services consumers, as well as selling and network intermediaries, and government regulators and standards groups, which are relevant to a variety of issue areas. To further frame this discussion, we have used consumer choice and demand, network externalities, switching cost, IT value, complementary goods, and technology adoption and diffusion theory as a means to analyze the issues from the different stakeholders' points of view.

9. Uncited references

[85,107,220–222].

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