

# Modelling customers' intentions to use contactless cards

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# **Modelling customers' intentions to use contactless cards**

## **Abstract**

Since their introduction in the United States in 2002, contactless card payment systems have been widely regarded as the pinnacle of current retail banking technology. However, the potential demand and usage of this innovation has hitherto received little attention from the academic community. Ours is one of the first papers that explores the factors that are likely to govern acceptance and intentions to take-up the technology. The analysis utilizes the methodological framework of the Technology Acceptance Model (Davis, 1989; Davis et al., 1989) and develops a range of empirical representations. Our results lend support to the TAM conceptualization and also indicate that some demographic characteristics imprint upon the intentions of potential users.

**JEL Codes:** E42; M31; G21; O33

**Keywords:** contactless cards; debit cards; RFID; technology acceptance model; retail payments; Polish banking.

# 1. Introduction

This paper explores customer preferences regarding the latest innovation in the field of proximity-type payments, namely contactless cards. Point of Sale (POS) transactions are estimated to generate net costs between 0.49% and 0.65% of GDP (Brits and Winder, 2005; Gresvik and Haare, 2009) and there is considerable debate as to which payment method (cash, debit or credit cards) is most efficient for different transaction values. With such potential financial incentives, it is no surprise that there is considerable demand for research that examines social propensity to utilize different payment technologies. Over the last year, a number of studies employing a range of different methodologies have been undertaken in the Netherlands (Bolt et al., 2009), Germany (von Kalckreuth et al., 2009), Finland (Leinonen, 2008) and the United States (Borzekowski and Kiser, 2008). To date, however, there is a notable lack of data in the rapidly developing markets of Eastern Europe, despite the rapid changes that have occurred across the banking sector in this region over the past two decades.

The process of crowding-out cash by other, electronic, forms of payment has encountered many obstacles relating both to economic reasons and social mores. New technological innovations in the field of payment methods are seen to offer opportunities to surpass these barriers. However, existing systems already enjoy incumbent advantages, including strong network effects and economies of scale (van Hove, 1999; Chakravorti, 2003; Gowrisankaran and Stavins, 2004; Bolt and Humphrey, 2007). New technological entrants to this field need to be accepted by clients and merchants alike, while meeting the substantial costs involved in introducing a new infrastructure of payment terminals (Levitin, 2007). Only a limited number of developments can hope to win widespread acceptance: the contactless card system, with its possibilities of competing effectively with cash for low-value transactions is seen as one such (Eastwood, 2008).

The contactless card is merely the latest iteration of a long line of payment instruments that can be traced back to the metal ‘charga-plate’ systems deployed by large retailers in America before the outbreak of WWII (Phelps, 1947: 147-150). Although they had obvious similarities with contemporary credit cards, they could only be used to purchase items from the issuing retailer (Ritzer, 1995: 33-34). Post WWII, payment cards enjoyed dynamic growth as they became useable across different outlets. Diners Club pioneered a paper-based universal ‘travel and entertainment’ payment card in 1950 (Frazer, 1985: 266) and their success encouraged others – most notably

American Express in 1958. It is generally accepted that the first bank card was that issued by Franklin National Bank of Long Island in 1951 (Ritzer, 1995: 36-7, Mayes and Markantonakis, 2008:116). The 60s and 70s saw the development of a range of payment card organizations and the general acceptance of cards by merchants. At this time, the transactions were not electronic; rather information from the card was recorded on paper by the merchant, who then sought telephone authorization from the issuing bank.

In 1971, technological advances brought about the introduction of the magnetic strip on cards in the United States (Frazer, 1985:267) with the complementary pioneering of Automated Teller Machines (ATMs) by Barclays Bank in 1967 (Batiz-Lazo and Wood, 2002, Batiz-Lazo and Wardley, 2007), further increasing cards functionality and popularity. The next step was the inclusion of a microprocessor on cards, with the first widespread trial from Cartes Bancaire in France in 1992 (Flier et al., 2001). Microprocessors were also used in the launch of e-purses throughout Europe in the 1990s. A milestone was reached in the evolution of the microprocessor-based cards with the adoption in 1999 of a common standard, EMV (standing for Europay, Mastercard and Visa – the principal architects) (Ward, 2006) that offered higher levels of security, longer lifespan, and the possibility of installing additional applications on the card (Ward, 2006). Before EMV, card fraud was increasing rapidly (Mayes and Markantonakis, 2008, Worthington, 2009), primarily due to card skimming – the practice of stealing the data held on a the magnetic strip on a debit or credit card (see Riem, 2001 and Stender and Schosheim, 2007 for a more detailed description) and EMV cards are resistant to such crimes. However, it should be stressed that the United States did not sign up to this otherwise global standard.

The next evolutionary step in the small-value transaction market was the introduction of Radio Frequency Identification (RFID) contactless technology. The first application of this technology for payments was with the Octopus system in 1997 for the Hong Kong's public transport network (Lefebvre, 1999) and RFID smart card ticketing systems have been widely and successfully deployed, particularly in Asia. Contactless payment cards for more general banking purposes can be traced back to the introduction of the Mastercard *PayPass* in Orlando, Florida in 2002 by JP Morgan Chase, Citigroup and MBNA (Capizzi and Ferguson, 2005). Globally, according to Polasik et al. (2009) and Polasik et al. (2011a), there were around 70 million contactless universal payment cards by the end of 2007 (excluding contactless public transportation cards) and that number

quickly grew to over 250 million at the end of 2009. Barclaycard demonstrated the possibility of loading additional services on EMV cards in 2007, when they introduced a card that combined the Oyster card for London public transport (Kountz and Laszlo, 2007, Hancke, 2008) with a debit/credit card and the Visa *payWave* technology. However, despite the ongoing evolution of payment cards, earlier technologies' legacies are slow to disappear. Thus, current contactless cards still also include magnetic strips and microprocessors that work on contact.

The momentous nature of these changes and the considerable excitement within the trade literature has not yet been matched within the academic arena (with the notable exception of Wang's (2008) brief examination of consumer behaviour in Taiwan). Our study is designed to fill part of this void by looking at the intentions of respondents to adopt this technology in the near future. We do this through empirical testing of the Technology Acceptance Model (TAM) of Davis (1989) and Davis et al. (1989) via ordered Logit regressions. To the best of our knowledge, this is both the first work addressing consumer preferences to both existing debit cards and to innovative proximity-type payment methods in Central and Eastern Europe and also one that is based on a large sample. By investigating the plans of potential customers, we believe that the results from this study will be of interest not only to academics, but also to marketers seeking to understand the potential take-up within target markets.

In the remainder of the paper, we first discuss the context and development of the Polish banking system before examining the technical details of contactless card technology in Section 3. We then briefly outline the TAM framework, hypothesize possible relationships in the data and explicate our empirical methodology. Section 5 discusses the data in more detail, including exploration of the summary statistics before we discuss the results. Finally, we analyze the theoretical and practical implications and present our concluding remarks.

## **2. The Polish Banking Context**

Prior to the collapse of the socialist command economy in 1989, Polish banking offered only a limited range of products and services. The development of the banking system was particularly hindered by an outdated telecommunication network, which prevented the implementation of electronic advances and ensured that most transactions remained paper-based. Once the economy

shifted to market conditions in the 1990s, the banks were forced to restructure and change their orientation to customers. Further stimulus was added with the privatization process, which began in 1993 and the relaxation of restrictions on foreign ownership of Polish banks in 1998 (Bohl et al., 2006). Since then, the banking sector has changed radically, as the proportion of foreign ownership has shifted from zero to reach 60.5% in 2006 (National Bank of Poland, 2007). Concurrently, between 1995 and 2008, total assets within the sector increased from 149 billion PLN (61.6 billion USD) to 1042 billion PLN (358.5 billion USD) (National Bank of Poland, 2007, 2009). With the move to widespread foreign investment came international banking expertise and integration with global technological standards (Walker, 1996).

Automated Teller Machine (ATM) technology was first introduced in the UK in 1967 (Bátiz-Lazo and Wood, 2002) but it was not until 23 years later that machines were installed in Poland primarily to cater for the needs of tourists. Similarly, the legal infrastructure for a national system for payment cards was created with the Decree of the President of the National Bank of Poland on 11 December 1992, which detailed the forms and procedures for monetary settlements through banks. This occurred over 20 years after magnetic stripe technology had been introduced in the US (Frazer, 1985: 267). However, initial take-up of payment cards was slow: it was not until the late 1990s that the retail banks started widely issuing debit cards, with credit cards following even later. Over recent years, growth in these instruments has been explosive. According to data from the National Bank of Poland (2010a), the total number of payment cards in use in Poland at the end of 2009 was 33.2 million, of which 22.0 million were debit cards. 24.2% of these cards used EMV technology, with the remainder only utilizing magnetic strips. The increase in the use of ATMs has been equally dramatic – with withdrawals rising from 7.5 billion PLN in 1998 to 245.1 billion in 2009 (National Bank of Poland, 2010b).

**Table 1. Diffusion of Payment Cards and Banking Services in Poland and the EU**

	Poland					EU-27
	2005	2006	2007	2008	2009	2009
<b>Bank Accounts</b> <i>(number of current accounts per 100 inhabitants)</i>	61.95	67.47	75.72	89.60	92.60	126.06
<b>Payment Cards</b> <i>(number of cards with a payment function issued per 100 inhabitants); including:</i>	53.38	62.54	69.51	79.42	87.06	145.07
<b>Debit Cards</b>	40.27	44.43	47.89	53.66	57.62	96.33
<b>Other Cards*</b>	13.11	18.11	21.62	25.76	29.44	48.74
<b>Number of card payments per capita</b> <i>(total for the period)</i>	6.92	9.28	12.11	15.13	18.45	62.98
<b>Number of payment transactions per card</b> <i>(total for the period)</i>	12.97	14.84	17.43	19.05	21.19	43.41
<b>Number of POS terminals located</b> <i>(per million inhabitants)</i>	4,348.00	4,628.00	4,895.84	5,570.84	6,044.04	17,096.90
<b>Value of card payment transactions as a ratio to GDP</b> <i>(total for the period)</i>	3.31%	3.98%	4.67%	5.32%	5.77%	13.85%

Notes: The data has been taken from the Statistical Data Warehouse of the European Central Bank.

\*The category labelled "Other Cards" includes, among others, credit and delayed debit cards, as well as other hybrid forms of payment cards.

Despite this rapid growth in payment cards, Poland remains a country where cash transactions still dominate. In 2005, 98% of payments relating to the running of Polish households were made in cash – which compares to figures of 93% for Spain and Italy, 72% for the UK and 70% for France (National Bank of Poland, 2008). Some of the reasons for the continued widespread use of cash in Poland can be discerned from Table 1, which juxtaposes statistical data for Poland with that of the European Union. A key difference is that Poland still lags well behind the European average in the number of bank accounts per head. And, as regards infrastructure, there are still considerably less retail outlets that possess point-of-sale (POS) terminals where payment cards may be used. Nevertheless, it is clear that Poland is catching up – the period 2005-2009 witnessed a significant growth in all of the considered parameters. POS terminals grew by almost 40%, cards per capita increased by over 60%, while number of card transactions per capita rose by over 250%.

This mirrors the adoption of other financial technologies. PC-banking was introduced in Poland in 1992, some 8 years after it had been established in the US (Grzywacz, 2004). From this late start it swiftly gathered momentum, with over 100,000 installations by 2004 (Polish Bank Association, 2004). Internet banking services arrived in 1998 (Polish Bank Association, 2006), a lag of three years from the US and has continued to develop (Kisiel, 2005: 214-8, Polasik, 2007: 170-3). Recent data indicates some 8.4 million users in 2009 (Polish Bank Association, 2010) reflecting the

widespread investment in transaction security and increased Internet use. Statistics published by Eurostat (2010) reveal that 63% of households had Internet access, a marked increase from the 11% recorded in 2002. What is apparent from the above data is that adoption of financial payment innovations may have been late but once available, enthusiastically received. However, penetration rates are unlikely to reach those of some West European states due to lingering structural differences. There is a relatively high level of unbanked individuals in Poland (Maison, 2010), a cultural element to payment habits (Górka, 2009: 73-80) and an informal economy estimated at about 28% of GDP (Schneider, 2002). For these reasons cash remains an important medium for many transactions.

The development of Internet shopping in Poland since 2004 has been most dramatic of all. Nielsen (2010) places Poland third in the European region (behind Norway and the UK) in terms of online consumers who plan to purchase products or services via the Internet. This again shows that Poles are interested in innovation when it brings tangible advantages and cost benefits. Yet such transactions have a particularly Polish dimension with a significant number of transactions carried out via online auctions and payment made through either cash-on-delivery or bank transfer. Credit/Debit card payments and the use of virtual payment services such as PayPal is low (Polasik and Maciejewski, 2009: 89-93).

The history of contactless technology in Poland begins in December 2007 when Bank Zachodni WBK S.A. issued the pre-paid Maestro *PayPass*. This card not only introduced the contactless system but was also the first form of contactless electronic money in Poland. In 2008, the same bank made further inroads into contactless technology, issuing the MasterCard *PayPass* credit card and the Visa *payWave* debit card so that by the end of 2008 there were 20,000 contactless cards in use. This ran alongside the establishment of 800 contactless terminal outlets, primarily in large metropolitan areas (Polasik et al., 2009: 35-37). In 2009, five further retail banks joined the contactless bandwagon, leading to 321,000 cards being issued by December 2009, of which 197,000 were MasterCard *PayPass* and 124,000 Visa *payWave*. Over the same months, accepting retailers leapt to 6,000, including a national chain of convenience stores, by the end of 2010.

The expansion of contactless cards in Poland also has a specific flavor due to the country's relatively late adoption of EMV card technology. Until 2010, PKO Bank Polski, Poland's largest bank, was reliant upon pre-EMV magnetic stripes for its debit cards. By the end of 2011 it will



have replaced its 6.5 million debit cards in circulation with EMV and at the same time used the opportunity to include Visa *payWave* contactless technology (Datamonitor, 2010). Similarly, Visa is pushing increased use of card payments including both their use for household bills and e-commerce, and simultaneously the development of a wider network of POS terminals across the country, in particular in those small and medium-sized retailers in smaller towns and rural areas that have hitherto been resistant to card acceptance (Visa, 2010b). Visa hopes to double the acceptance network to 400,000 terminals by 2015 and all will be equipped to the latest standards, including RFID (Visa, 2010a, Kiwior, 2010). The RFID component is also finding supplementary benefits: from June 2010, users of contactless cards have been able to use them to purchase tickets on Warsaw's transport system (Woodward, 2010).

At this point in time, Poland along with the UK and Turkey, lead in the adoption of contactless technology in Europe. Given the forthcoming developments, it appears that the Polish market for RFID-enabled cards may become the most developed in Europe and the case will provide an illustrative example from which followers may draw important lessons.

### **3. Contactless cards**

#### **3.1. The Technologies of Contactless Cards**

RFID technology originated in the Second World War, when the British Royal Air Force used transponders to provide identification of individual aircraft on radar systems (Hancke, 2008: 295). In 1948, Harry Stockman published a seminal work which advanced the possibility of *passive* RFID tags (Stockman, 1948). A series of further advances saw the technology being used for protection against theft, keyless door operation and tracking nuclear materials. In the 1980s, RFID was deployed in the automated collection of tolls on motorways, tunnels and bridges. It became even more pervasive in the following decade, as a range of High Street stores used the system for tagging goods. Nowadays, RFID technology can be seen in logistics, public transport, security systems and in the electronic payments market (Rieback et al., 2006; Hancke, 2008: 296; Lee et al., 2008; Roh et al., 2009: 360).

A RFID system comprises three components: a tag, a reader and data-processor. The tag itself incorporates a microprocessor chip and an antenna, which allows it to send information to the

reader. Passive RFID tags use the radio waves from the reader to generate power for the chip to emit its signal (Wu et al., 2006). As was indicated in the paragraph above, the technology can be used in a variety of ways. This is reflected in different technological parameters including the level of power demanded by the chip, the amount of memory, and the radio frequency used. This can range from larger, active, tags with battery power and substantial antennae broadcasting over longer distances to passive tags as small as  $0.05 \times 0.05$  mm that only operate in close proximity to a reader (or indeed an active RFID tag), which triggers their action. Contactless cards are based around passive RFID technology (Hancke, 2008: 296) operating at a frequency of 13.56 MHz (Gebhart et al., 2008; Hancke, 2008: 311), which allows high speed data transmission while limiting range to 10 cm (a substantial security benefit).

When looking at the current generation of contactless cards, the legacy of earlier systems is readily visible. EMV and magnetic strip technologies are still in widespread use, with a substantial infrastructure supporting their use, and all of these are retained on current European contactless payment cards, as shown in the example in Figure 1. (Of course, the United States, which refused to adopt the EMV standard, retains only two technologies.) RFID is not restricted to cards alone – and where it has been embedded in other devices such as watches, mini-cards, key fobs or even stickers – EMV and magnetic strips are absent (Smart Card Alliance, 2006). This also occurs where the cards are not required to conform to existing infrastructures, such as the London Underground Oyster card or some of the local payment systems in Asia.

**Figure 1. The first contactless payment card issued in Poland: obverse and reverse**



Note: This figure is reproduced with the permission of Bank Zachodni WBK SA.

There are many communication standards in force. However, many of these are a resolutely local or have only limited application (e.g. public transport). The main thrust of development in the area of universal contactless payments has come through the main card organizations American Express, MasterCard and Visa. In 2005, MasterCard International and Visa International entered an agreement to use a common radio communication protocol – ISO 14443 A/B – based on RFID (Rae, 2005), which has since been used also by American Express and partly by the Japan Credit Bureau (JCB). Adoption of a standard both lowered the product costs for the banks and facilitated popularization through the possibility of one terminal accepting a wide range of cards. It is important to stress that RFID only changes the technological interface between card and EFT POS terminal. It does not change the legal form or liabilities associated with different types of card – a credit card remains a credit card whether it operates through magnetic stripe, EMV or RFID, and the same holds for all the other myriad payment cards, be they debit, charge, prepaid or electronic wallet.

In operation, the cards have to be placed close – within a few centimetres – to the terminal reader for around half a second. The terminal will communicate the completion of the transaction by beeping and flashing four LEDs (a procedure defined within the ISO standard). The total time for a transaction will vary according to whether the terminal is offline (unconnected to an authorization server) or online. For online terminals, the transaction time will also be dependent on the type of communication link with the authentication point. Thus, transaction times will be a few seconds for offline terminals, and slightly longer for online. This is much quicker than other card transactions, primarily because there is no requirement for the customer to use a system such as PIN or signature.

The flipside of the absence of customer verification is that it raises fears among potential users of unauthorized transactions taking place without their knowledge or consent. There have been scare stories about the possibility of unscrupulous retailers making additional charges and thieves using portable readers to defraud people in public places. However, there are many reasons why advocates consider contactless cards as both speedy and less at risk than cash. First, there are limits as to how much money can be lost in the event of the card going missing or being stolen. Each transaction is limited to 25 USD in the United States, 20 EUR for most European countries and 15 GBP for the UK (Eastwood, 2008). The limit in Poland has been established at 50 PLN, which is

currently equivalent to about 18 USD. A further feature could be that after several transactions the card has to be verified by a PIN code. Additionally, bank guarantees and card insurance ensures that the costs of multiple withdrawals by thieves would not be borne by the consumer. The maximum distance from which a card can be read is 10 cm (Gebhart et al., 2008) – in practice it may be significantly less – which makes casual thievery difficult. The final, and probably most important, is that the card does not work like an electronic wallet – the holder of the POS terminal has to sign a contract with the acquirer, which removes the anonymity of potential offenders. Clearing is also delayed so that, with the small value of transactions and the application of fraud detection systems (Quah and Sriganeth, 2008), organized theft becomes economically unviable.

### **3.2. The Benefits for Consumers, Retailers and Banks**

There are three distinct groups that could potentially benefit from the widespread introduction of contactless card payment systems: consumers, retailers and banks. For consumers, the card is suited to low-value transactions, potentially obviating the need to carry (and constantly replenish) cash (Olsen, 2008). The system also promises the possibility of allowing users to analyze and control their spending, in a way that would be excessively onerous from re-constructing the multitude of cash transactions. The latest systems are almost instantaneous since, unlike traditional<sup>2</sup> debit cards, there is no need to input a PIN nor to pass the card to a vendor. Keeping the card to yourself has other advantages, such as the lower probability of the card being ‘skimmed’. Ultimately, as the technology becomes accepted, the mechanism may be deployed on a range of other everyday times, such as key fobs, mobile phones and watches. Then, or so the promise goes, we shall be freed from the need to even carry cards.

For goods and service providers, some of the advantages are the same as for consumers. As transactions take place much faster, this leads to less queuing, thereby helping improve customer satisfaction – not only for traditional retailers but for a vast range of businesses including mass-event organizers, transport companies and fast-food chains (Olsen, 2008). Shorter queues also contribute to greater throughput and better staff productivity – Borzekowski and Kiser (2008: 900) estimate that the reduced checkout time due to the use of contactless cards could result in cost savings of \$0.03 per transaction (see also the empirical study by Polasik et al., 2011b). The shift

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<sup>2</sup> A ‘traditional debit card’ is defined here as one that operates with contact technology (magnetic stripe or EMV).

from cash to cashless has a similar, albeit more pronounced effect to the benefit enjoyed by consumers. Retailers will have the significant burden of cash storage, transportation and security reduced (see Garcia-Schwartz et al., 2006: Table 2 for an analysis of these costs). There is a clear question that lies over the development of a sufficiently widespread network of outlets using this technology. As consumer take-up increases, those who fail to offer this technology will undoubtedly be penalized as customers migrate elsewhere. On the flipside, there are costs attached – most notably the purchase of a card reader that can be added to an existing payment terminal.

For banks, or other card issuers, the benefits are more direct. Smaller transactions, hitherto overwhelmingly settled in cash, can now come within the ambit of the banking system with consequent transaction charges (paid by the merchant). Since low-value transactions dominate the volume of cash turnover in the retail trade (see Eastwood, 2008: 78) and cash is ‘the most popular payment vehicle’ (Clark, 2005: 35), this may prove a substantial gain. Indeed, for banks, cash itself carries significant overheads, particularly in ATM maintenance, as well as the cost of labor required to deal with cash withdrawals and retailers’ deposits (Guibourg and Segendorff, 2007: Table 2). The cost of cash is further diminished as consumers move to prepaid contactless cards, which also offer the opportunity to extend banking services to those who currently do not benefit from them. Although this will primarily be a means of drawing younger and younger customers in, there is also the possibility of reaching many seniors. And the marketing opportunities do not end there; the issuance of a new card offers the chance of cross-selling other banking products.

### **3.3. Further Issues**

The idea of the cashless society has excited much interest (see, for example Worthington, 1995; Garcia-Schwartz et al., 2006). Contactless cards finally represent competition for the last bastion of cash: low-value transactions. This is of possible benefit for government for three reasons: it reduces the macro-economic cost of payments; potential elimination of much of the black and grey economy; and it brings more economic transactions under government surveillance. The cost reduction primarily arises from the three aforementioned aspects of payment markets and the lower cost of ‘minting’ electronic money compared to physical specie (Brits and Winder, 2005: 11-12; Quaden, 2005; Gresvik and Haare, 2009). However, the main impetus from governments towards electronification of monetary transactions comes from the drive to combat the black economy and money-laundering (Brits and Winder, 2005: 32-33). The size of the black economy was estimated

at 28% of GDP in Poland, 9% in the US, 13% in the UK and 16% in Germany (Schneider, 2005: 610-611) and governments are understandably keen to bring this within the purview of taxation and regulation.

The electronic payment instruments, unlike cash, are not anonymous, reflecting a conscious intention on the part of the authorities. Governments depict this as part of a necessary crackdown on money-laundering (Buchanan, 2004; Choo, 2009), but at the same time the possibility of extending government invigilation across a greater swathe of society has provoked the possibility of further invasion of personal privacy (Reischmann and Miller, 2007: 14-23). However, in places in Western Europe where electronic transactions are part of everyday life, citizens seem to be dismissive of such concerns. For example, in Holland where card payments are widespread, only 1-2% of people declare that they want to retain anonymity over their payments (Jonker, 2007). In post-communist Eastern Europe, where memories remain of intrusive state surveillance and the informal economy plays a larger part, people attach a greater importance to the issue of anonymity (in Poland, 43%: Polasik and Maciejewski, 2009). However, contactless prepaid cards can remain anonymous (similar to most prepaid cards currently in use) and it is likely that such an option will need to be retained to achieve wide acceptance in that part of the world.

Contactless cards are probably not the end of the story. Advocates of the technology suggest that the idea of the card itself may become obsolete as further developments of the RFID technology, such as Near Field Communication (NFC), become subsumed within other handheld devices – most notably mobile phones<sup>3</sup>. Currently, however, this technology is still inchoate outside Japan, where it has already been implemented on a large scale (Bradford and Hayashi, 2007). This integration of mobile telephony and NFC technology appears to be the most likely line of development of proximity-type retail payments in the future (Eastwood, 2008).

#### **4. Theoretical and Empirical Models**

Our study uses the Technology Acceptance Model developed by Davis (Davis, 1989; Davis et al. 1989) that explicates the diffusion of innovations. The model is perhaps the most widely cited

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<sup>3</sup> There are possible many models of mobile payments; see: Van Bossuyt and van Hove (2007).

framework for examining technological adoption and has been widely tested across a range of innovations (Al-Gahtani, 2001; Mathieson, 1991; Pikkarainen et al., 2004). It has been of particular interest to scholars examining developments in banking, including mobile payments (Gu et al., 2009; Shin, 2009; Schierz et al., 2010), Internet banking (Pikkarainen et al., 2004; Gerrard et al., 2006), mobile credit card usage (Amin, 2007) and online trading (Lee, 2009). In essence, the model provides a framework that connects Perceived Usefulness and Perceived Ease of Use of a product to Behavioral Intention to Use and, ultimately, Actual Use, as shown in Figure 2. However, as Agarwal and Prasad (1999) argue, for survey-based research it is more appropriate to consider intentions, rather than usage, as they are contemporaneous with beliefs as to usefulness and ease of use. Also, at this stage, the take up of this technology is low, so the task of modeling actual usage becomes impractical. Consumer intentions are important in determining marketing strategy, particularly in targeting groups that might be seen as potential early adopters and identifying others that may be resistant to innovation. Further, it has been well established in prior literature that socio-demographic variables are important in determining intentions towards technological adoption (see, for example, Venkatesh et al. (2000), Morris and Venkatesh (2000), Stavins (2001), Im et al. (2003)).

In the light of the foregoing discussion, we arrive at three testable hypotheses:

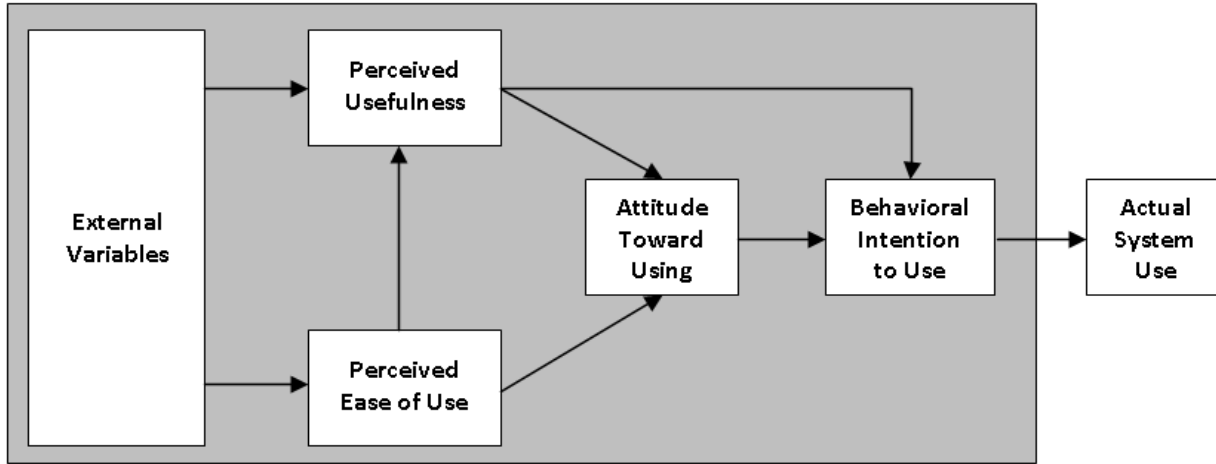
Hypothesis 1: Perceived Usefulness determines Behavioral Intention to Use contactless cards.

Hypothesis 2: Perceived Ease of Use affects Behavioral Intention to Use contactless cards.

Hypothesis 3: Demographic characteristics differentiate respondents' Behavioral Intention to Use traditional debit and contactless cards.

The variables used to explore the linkages are detailed in the following section.

**Figure 2. The Technology Acceptance Model (adapted from Davis et al. 1989)**



Our dependent variable in this study is *Behavioural\_Intention\_to\_Use*, measured on a Likert scale, ranging from 1 (denoting ‘highly unlikely to use’) to 5 (the opposite end of the intentional spectrum). Because the variable is both ordinal and discrete, simple OLS is inappropriate in this context and thus we use the ordered logit model (described in great detail in Borooah, 2002). However, for the sake of completeness, we did carry out an OLS estimation and found that the main conclusions are unchanged. In our study, we consider a latent variable *LV* which is a linear combination of our independent variables and an error term:

$$\begin{aligned}
 LV_i = & \beta_1 \text{Perceived\_Ease\_of\_Use}_i + \beta_2 \text{Perceived\_Usefulness}_i + \\
 & \sum_{j=1}^6 \beta_{2+j} \text{Demographic\_Variable}_i^j + \varepsilon_i = Z_i + \varepsilon_i
 \end{aligned}
 \tag{1}$$

where *i* is an index for the respondent, the first two variables are TAM constructs further defined in Table 3 below and the last six variables measure the demographic characteristics of the respondent. In some of the specifications of latent regressions selected  $\beta$ s can be restricted to zero. The equation does not include an intercept term, as it later becomes absorbed into the thresholds (Borooah, 2002: 10). We are assuming that the latent error  $\varepsilon_i$  is logistically distributed. As we show below, respondents are categorized into five levels of intention, based upon the value of the latent variable *LV*:



$$Behavioral\_Intention\_to\_Use_i = \begin{cases} 1 & \text{if } LV_i \leq \gamma_1 \\ 2 & \text{if } \gamma_1 < LV_i \leq \gamma_2 \\ & \vdots \\ 5 & \text{if } \gamma_4 < LV_i \end{cases} \quad [2]$$

where  $\gamma$ s are threshold values estimated jointly with  $\beta$ s. From this, it follows that the probabilities of observing a given value of *Behavioural\_Intention\_to\_Use<sub>i</sub>* are:

$$Pr(Behavioral\_Intention\_to\_Use_i = 1) = 1/[1 + \exp(Z_i - \gamma_1)] \quad [3]$$

$$Pr(Behavioral\_Intention\_to\_Use = 2) = 1/[1 + \exp(Z_i - \gamma_2)] - 1/[1 + \exp(Z_i - \gamma_1)] \quad [4]$$

⋮

$$Pr(Behavioral\_Intention\_to\_Use_i = 5) = 1 - 1/[1 + \exp(Z_i - \gamma_4)] \quad [5]$$

We have  $N$  respondents in our sample and each is considered a single draw from a multinomial distribution with the possibility of one of five outcomes. Thus, the sample can be subdivided based on these outcomes so for  $N_1$  individuals *Behavioural\_Intention\_to\_Use* is 1 (highly unlikely), whereas  $N_5$  respondents declare that their use of a given technology in the future is 5 (highly likely). Given this notation, the likelihood function can be expressed as follows:

$$L = [Pr(Behavioral\_Intention\_to\_Use_i = 1)]^{N_1} \times \dots \times [Pr(Behavioral\_Intention\_to\_Use_i = 5)]^{N_5} \quad [6]$$

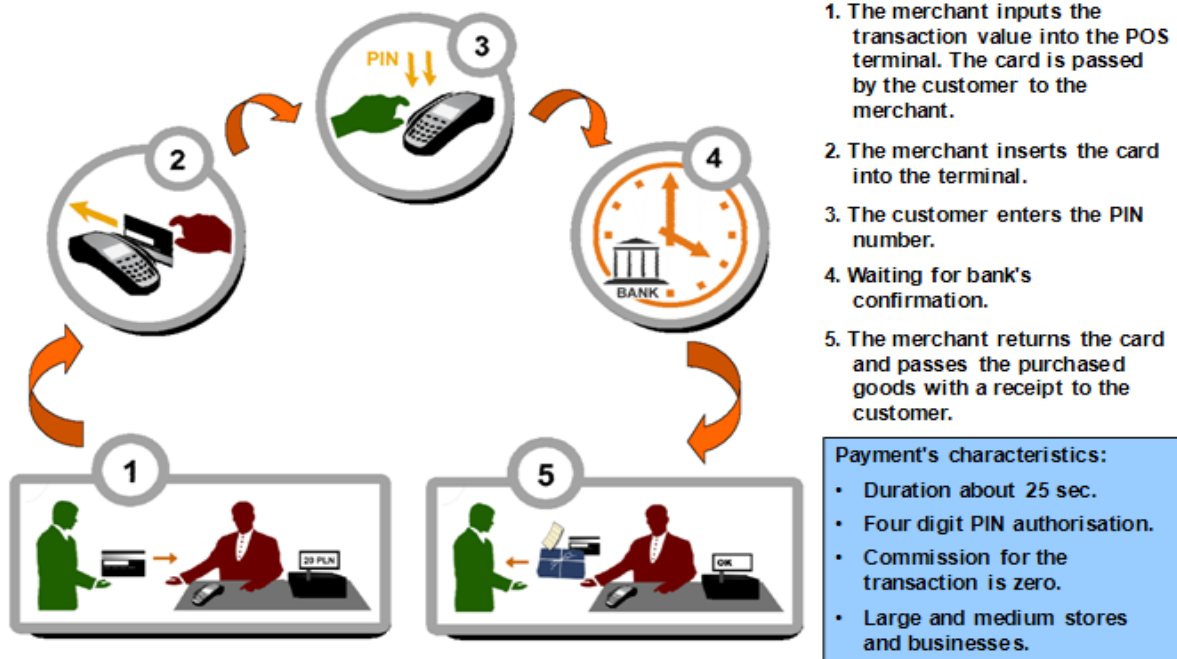
where  $N = \sum_{i=1}^5 N_i$ . The values of  $\beta$ s and  $\gamma$ s are estimated by maximizing the log of the likelihood function above.

## 5. Data

The data for this study emerged from a collaborative effort between the researchers and the National Bank of Poland. The idea for the study and the questionnaire design was developed by the former, while the Bank paid for the collection of data by independent consultants from Millward Brown SMG/KRC. The data was a random representative sample of 1010 Polish respondents aged between 15 and 75, although useable data for this particular study was restricted by people who

did not offer responses to the questions of interest to us<sup>4</sup>. 174 canvassers carried out interviews at respondents' homes across Poland and followed Computer Aided Personal Interview (CAPI) protocols. As part of this process, interviewees were shown diagrams relating to payment processes on a laptop screen. Figures 3 and 4 are examples used to illustrate the differences between different card technologies.

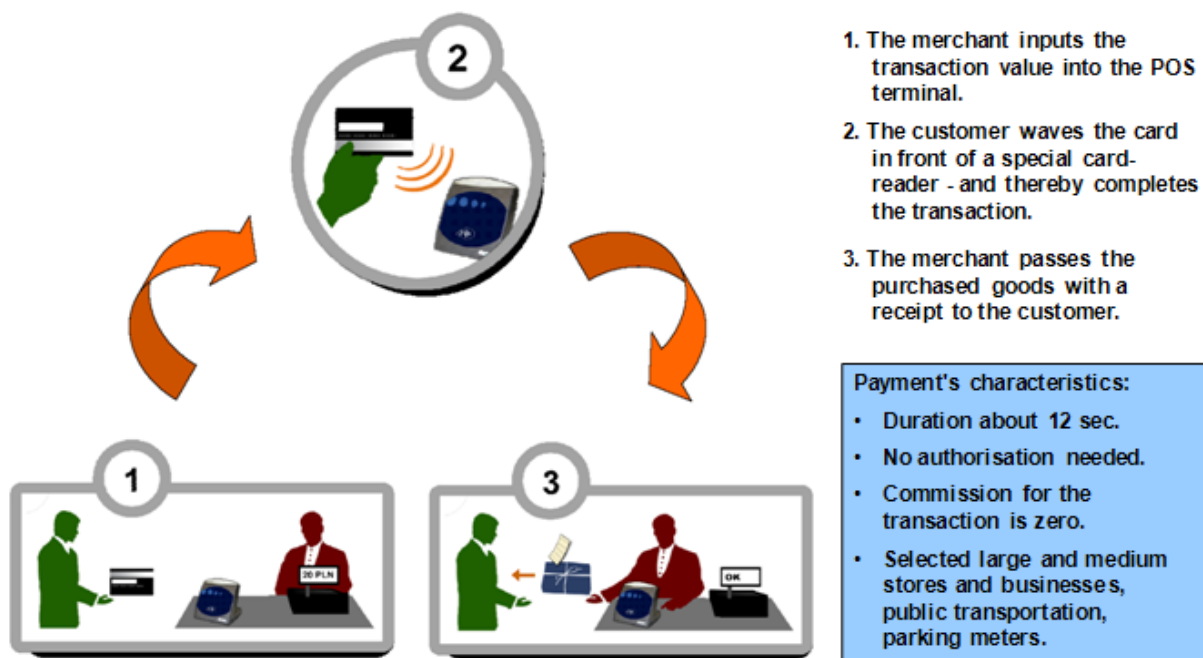
**Figure 3. Debit Card in Contact Technology: Stages of the Payment Process**



Note: Respondents were shown this diagram in interviews to illustrate how the technology works.

<sup>4</sup> This resulted in a sample of 694 for traditional debit card analysis and 581 for contactless. The summary statistics reported later in this section indicate that these sub-samples are still representative.

**Figure 4. Contactless Card: Stages of the Payment Process**



Note: Respondents were shown this diagram in interviews to illustrate how the technology works.

The interviewees were sampled from the PESEL (a personal identification number) database compiled by the Ministry of the Interior and Administration. Systematic sampling was used to draw particular respondents within pre-specified strata. The stratification took into account urbanization, voivodeships (the 16 Polish administrative regions), gender and age. The first phase of the sample selection procedure arranged geographical representation through the localization criterion and degree of urbanization. Within these selected localities, the respondents were then stratified with respect to age and gender. When the study was carried out, non-responders were primarily replaced based on address. By the end of the process, the sample did not diverge from the overall population on the above criteria.

Table 2 details the definitions of variables used in this study. The first three, *Behavioral\_Intention\_to\_Use*, *Perceived\_Ease\_of\_Use* and *Perceived\_Usefulness* are the central pillars on which the TAM framework rests. The remaining variables are demographic. As questions as to *Perceived\_Ease\_of\_Use* and *Perceived\_Usefulness* were not directly asked (nor would be

particularly helpful, had they been so) we use constructs to arrive at these variables by aggregating a number of different questionnaire items, as shown in Panel A of Table 3. The responses for each of the questions regarding transaction speed, cost attractiveness, effortless use and convenience of conducting transactions were generated by asking interviewees their level of agreement to a statement about the abovementioned features. Following established procedures for generating a 5-point Likert scale (see Likert, 1932) respondents were asked if they strongly disagree, disagree, neither agree nor disagree, agree or strongly agree with the statement and these responses were given values of 1 to 5 respectively. *Perceived\_Ease\_of\_Use* averages the scores for effortless use and convenience, while *Perceived\_Usefulness* takes the mean of speed and cost.

We test these constructs for reliability using Cronbach's alpha (see Cronbach, 1951) and confirmatory factor analysis<sup>5</sup>. Panel A of Table 3 shows that the estimated values of the Cronbach's alpha coefficients substantially exceed the lower threshold of 0.6 showing that the internal consistency of the constructs can be deemed acceptable (Churchill, 1979; Hair et al., 1998). Panel B reports on the confirmatory factor analysis where we assume the existence of two correlated common factors: the components of *Perceived\_Usefulness* load on one factor and those that make up *Perceived\_Ease\_of\_Use* load on the second. The Chi-square test does not reject the null hypothesis that the structure is valid and the values of Root Mean Square of Approximation (RMSEA) are within the acceptable range. Overall these tests indicate that the model is an adequate reflection of the underlying data (Long, 1994).

We further probe for the discriminant validity of *Perceived\_Usefulness* and *Perceived\_Ease\_of\_Use*, following the prescriptions of Fornell and Larcker (1981). We calculated the square root of average variance extracted (AVE) for the two constructs and compared them to the correlation between them. The results confirm that discriminant validity seems to be satisfactory in the cases of both debit and contactless cards.<sup>6</sup>

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<sup>5</sup> Readers interested in learning more about confirmatory factor analysis are directed towards Lewis-Beck's (1994) edited collection.

<sup>6</sup> Detailed results of this test can be obtained from the authors on request.

**Table 2. Variable Definitions**

<b>Variable Name</b>	<b>Definition</b>	<b>References</b>
<i>Behavioural_Intention_to_Use</i>	<i>Behavioural_Intention_to_Use</i> gauges respondent's self-declared likelihood of using a particular payment method within the next 6 months. It is measured on a five-point scale: 1 (highly unlikely to use); 2 (unlikely to use); 3 (neither unlikely nor likely to use); 4 (likely to use); and 5 (highly likely to use).	Davis (1989), Davis <i>et al.</i> (1989), Gu <i>et al.</i> (2009), Muller-Seitz <i>et al.</i> (2009), Kim <i>et al.</i> (2010).
<i>Perceived_Ease_of_Use</i>	<i>Perceived_Ease_of_Use</i> is a construct averaging two questionnaire items, namely 'effortlessness of use' and 'convenience of conducting transactions'. Each item was measured on a five-point Likert scale expressing agreement with a statement as to whether the contactless cards possess these particular characteristics. The scale was as follows: 1 (strongly disagree); 2 (disagree); 3 (neither agree nor disagree); 4 (agree); 5 (strongly agree).	Davis (1989), Davis <i>et al.</i> (1989), Amin (2007), Shin (2009), Crotty (2009).
<i>Perceived_Usefulness</i>	<i>Perceived_Usefulness</i> is a construct which averages the two following items: 'transaction speed' and 'cost attractiveness', each of which was measured in the same way as 'effortlessness of use' and 'convenience of conducting transactions'.	Davis (1989), Davis <i>et al.</i> (1989), Jonker (2007), Klee (2008), Schuh and Stavins (2010).
<i>Area_of_Residence</i>	<i>Area_of_Residence</i> denotes the natural logarithm of the population of the city/town/village in which the respondent resides (in thousands of people).	Gan <i>et al.</i> (2006), Klee (2008).
<i>Gender</i>	<i>Gender</i> takes a value of one if the respondent is a male and zero otherwise.	Carow and Staten (1999), Borzekowski and Kiser (2008), Shin (2009).
<i>Education</i>	<i>Education</i> measures the number of years in formal education. It has been derived from the highest educational attainment.	Carow and Staten (1999), Klee (2008), Borzekowski and Kiser (2008), von Kalckreuth <i>et al.</i> (2009).
<i>Single</i>	<i>Single</i> takes the value of one for anyone who is not married and zero otherwise.	Borzekowski and Kiser (2008), Gu <i>et al.</i> (2009), Schuh and Stavins (2010).
<i>Income</i>	<i>Income</i> records the household income (in thousands of PLN) divided by the number of household members.	Borzekowski and Kiser (2008), Schuh and Stavins (2010).
<i>Senior</i>	<i>Senior</i> takes the value of one for respondents above 65 years of age and zero otherwise.	Carow and Staten (1999), Schuh and Stavins (2010), Kim <i>et al.</i> (2010).

**Table 3. Appropriateness of Empirical Measures**

<b>Panel A: Reliability Analysis</b>			
<i>Construct</i>	<i>Item</i>	<i>Cronbach's Alpha</i>	
		<i>Traditional Debit Cards</i>	<i>Contactless Cards</i>
<i>Perceived_Usefulness</i>	Transaction speed	0.8180	0.8723
	Cost attractiveness		
<i>Perceived_Ease_of_Use</i>	Effortlessness of use	0.8913	0.9094
	Convenience of conducting transactions		
<b>Panel B: Confirmatory Factor Analysis</b>			
<i>Payment Method</i>	<i>Chi-square</i>	<i>p-value</i>	<i>RMSEA</i>
Traditional Debit Cards	1.8774	0.1706	0.0356
Contactless Cards	0.4243	0.5148	0.0000

Notes: The questionnaire items were measured on a five-point Likert scale, where the lowest assessment of a particular characteristic was recorded as one and the most positive responses recorded as five. Panel A of the table reports Cronbach's alphas for the constructs used in our empirical specifications. Panel B shows results of confirmatory factor analysis, which assumes an existence of two correlated common factors. Items 'transaction speed' and 'cost attractiveness' are assumed to load only on one factor, while 'effortlessness of use' and 'convenience of conducting transactions' load only on the second remaining factor. The Chi-square statistics and its corresponding p-value is for the null hypothesis that this presupposed model is an acceptable fit for the observed data. RMSEA stands for Root Mean Square Error of Approximation.

Summary statistics for our dataset are presented in Table 4. There are two sub-samples of different sizes, which is a by-product of removing entries with incomplete responses. Examination of the two panels reveals that both are representative of the population as a whole, and the characteristics of an average respondent similar, with the exception of the TAM variables. Here it is apparent that interviewees, on average, indicated that they were more likely to use contact rather than contactless technology in the future, as they saw it as both easier to use and more useful. An average respondent was equally likely to be male or female and had over 12 years of formal education. The figure for Single initially appears high, but this variable differentiated solely on marital status, thus including cohabitating couples. The average size of the locality in which respondents lived was around  $\exp(3.6) \approx 36.6$  thousand people, and the mean household income per head was just over 1,000 PLN. Finally, our table shows that roughly one in seventeen was over the age of 65. The median figures allow us to generate a profile of a representative respondent and her/his preferences.

**Table 4. Summary Statistics**

<b>Panel A: Traditional Debit Cards (N=694)</b>					
<b>Variables</b>	<b>Mean</b>	<b>Median</b>	<b>Standard Deviation</b>	<b>t-statistic</b>	<b>p-value</b>
<i>Perceived_Ease_of_Use</i>	3.6780	4.0000	0.9299	7.0394	0.0000
<i>Perceived_Usefulness</i>	3.6174	4.0000	0.9106	6.8939	0.0000
<i>Area_of_Residence</i>	3.6133	2.9444	1.8738	3.6375	0.0003
<i>Gender</i>	0.4971	0.0000	0.5004	2.3238	0.0205
<i>Education</i>	12.4546	12.5000	2.4505	5.0969	0.0000
<i>Single</i>	0.4669	0.0000	0.4993	-0.4282	0.6687
<i>Income</i>	1.0295	0.7000	1.1110	2.9759	0.0031
<i>Senior</i>	0.0591	0.0000	0.2359	-4.2422	0.0000
<i>Behavioral_Intention_to_Use</i>	2.6916	2.0000	1.4584	-	-
<b>Panel B: Contactless Card (N=581)</b>					
<b>Variables</b>	<b>Mean</b>	<b>Median</b>	<b>Standard Deviation</b>	<b>t-statistic</b>	<b>p-value</b>
<i>Perceived_Ease_of_Use</i>	3.5336	3.5000	1.0365	3.9026	0.0001
<i>Perceived_Usefulness</i>	3.4905	3.5000	1.0122	4.6027	0.0000
<i>Area_of_Residence</i>	3.5757	2.9444	1.8657	2.0449	0.0423
<i>Gender</i>	0.5043	1.0000	0.5004	0.5293	0.5973
<i>Education</i>	12.3313	12.5000	2.4350	1.6922	0.0926
<i>Single</i>	0.4819	0.0000	0.5001	2.9284	0.0039
<i>Income</i>	1.0183	0.7000	1.0926	0.9602	0.0423
<i>Senior</i>	0.0602	0.0000	0.2381	-2.1219	0.0348
<i>Behavioral_Intention_to_Use</i>	2.1394	2.0000	1.2288	-	-

Notes: The sample sizes are N=694 for Panel A and N=581 for Panel B. The difference arises from the number of usable responses across the relevant questions. Each sample is divided according to the positive or negative expressions of *Behavioral\_Intention\_to\_Use* as measured on a 5-point Likert scale. Within positive, we include respondents who declare that they are likely or highly likely to use a given technology, whereas negatives incorporate those expressing unlikely and highly unlikely intentions. Under the null hypothesis that the averages of a given variable are equal within these two groups, the t- statistic follows a Student's t distribution. The degrees of freedom have been calculated using the Welch-Satterthwaite equation (Welch 1947, Satterthwaite 1946). The p-value is the probability of observing a more extreme t-statistic than the one that is reported in the table, assuming validity of the null hypothesis.

Each of the samples was divided in two depending upon the value of the variable *Behavioral\_Intention\_to\_Use*. The first group paired responses of 1 and 2, the second included those who replied that that they were likely or very likely to use a given technology, while the undecided were eliminated from the testing. The t-tests for unequal sample sizes and variances are given in the table and the degrees of freedom have been calculated using the Welch-Satterthwaite equation (Welch, 1947; Satterthwaite, 1946). The corresponding p-values are reported in the last column. The t-statistics give us a first glimpse of what we might expect from a more elaborate empirical model and they are illuminating. Among all of the variables, only *Gender* is insignificant for contactless cards, and marital status for traditional debit cards.

## 6. Empirical Results

The first point of note arising from the inspection of our Table 5 is that it adds to the body of work that affirms the efficacy of the TAM framework (see, for instance Al-Gahtani, 2001; Mathieson, 1991; Pikkarainen et al., 2004 and Schierz et al., 2010). Both *Perceived\_Ease\_of\_Use* and *Perceived\_Usefulness* are significant in all of the considered models, a finding consistent with the results of Amin (2007) for mobile credit cards and Muller-Seitz et al. (2009) for RFID technology in customer checkout and complaint handling. Accordingly, the data provides support to our first two hypotheses detailed in section IV. It needs to be mentioned at this stage that these two variables are highly correlated, as predicted by the theoretical model in Figure 2. To avoid the issue of multicollinearity in model (5), where the two constructs are bundled together, we have performed an orthogonalization procedure<sup>7</sup>.

As for the demographic variables, it is education that appears to exert the strongest influence across the two technologies. In this, our study suggests that the importance of formal schooling, as described by Carow and Staten (1999) for debit and credit cards is carried across to contactless payments. This is perhaps largely to be expected, as exploratory studies (such as Parasuraman's (2000) influential paper on the Technology Readiness Index) suggest that one of the key drivers towards the acceptance of new technology is the level of discomfort that users initially experience. Since many of the measures of discomfort appear to score consumers inability to understand new technology and its implications, we should expect, in general, those with a higher level of education to be more comfortable. Also, research suggests that more educated workers are more likely to come into contact with a variety of new technologies through their employment (see, for example, Bartel and Lichtenberg, 1987).

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<sup>7</sup> The variable *Perceived\_Usefulness* has been regressed against *Perceived\_Ease\_of\_Use* using the ordinary least squares (OLS) method. The collected residuals from this regression have been subsequently used as an explanatory variable in model (5).



**Table 5. Modeling the Behavioral Intention to Use: Ordered Logit Estimates**

<b>Panel A: Determinants of Behavioral Intention to Use – Traditional Debit Cards</b>					
	(1)	(2)	(3)	(4)	(5)
<i>Perceived_Ease_of_Use</i>	0.6287*** (0.0804)		0.5463*** (0.0836)		0.5530*** (0.0838)
<i>Perceived_Usefulness</i>		0.6165*** (0.0816)		0.5726*** (0.0859)	0.3473** (0.1568)
<i>Area_of_Residence</i>			0.1703*** (0.0382)	0.1802*** (0.0384)	0.1778*** (0.0384)
<i>Gender</i>			0.2956** (0.1395)	0.3191** (0.1394)	0.3057** (0.1397)
<i>Education</i>			0.1230*** (0.0290)	0.1335*** (0.0289)	0.1278*** (0.0291)
<i>Single</i>			-0.2287 (0.1425)	-0.2267 (0.1423)	-0.2338 (0.1425)
<i>Income</i>			0.1056* (0.0623)	0.0967 (0.0625)	0.0985 (0.0625)
<i>Senior</i>			-1.1568*** (0.3486)	-1.1383*** (0.3504)	-1.1177*** (0.3506)
$\gamma_1$	1.4057*** (0.2989)	1.3267*** (0.2985)	3.2819*** (0.4701)	3.5112*** (0.4886)	3.3850*** (0.4748)
$\gamma_2$	2.3842*** (0.3060)	2.3010*** (0.3052)	4.3384*** (0.4807)	4.5707*** (0.4996)	4.4462*** (0.4856)
$\gamma_3$	2.8554*** (0.3109)	2.7712*** (0.3102)	4.8395*** (0.4865)	5.0740*** (0.5057)	4.9502*** (0.4916)
$\gamma_4$	4.2117*** (0.3319)	4.1236*** (0.3309)	6.2644*** (0.5083)	6.5008*** (0.5275)	6.3815*** (0.5137)
LR statistic	64.6742	60.1512	133.0175	134.9750	137.9212
Prob(LR statistic)	0.0000	0.0000	0.0000	0.0000	0.0000
Percentage of Outcomes Predicted Correctly	32.4207	32.8530	35.7349	35.5908	36.3112
<b>Panel B: Determinants of Behavioral Intention to Use – Contactless Cards</b>					
	(1)	(2)	(3)	(4)	(5)
<i>Perceived_Ease_of_Use</i>	0.2268*** (0.0745)		0.1388* (0.0789)		0.1527* (0.0794)
<i>Perceived_Usefulness</i>		0.3321*** (0.0781)		0.2576*** (0.0827)	0.4931*** (0.1587)
<i>Area_of_Residence</i>			0.0420 (0.0415)	0.0369 (0.0415)	0.0396 (0.0416)
<i>Gender</i>			-0.0716 (0.1540)	-0.0969 (0.1546)	-0.1099 (0.1548)
<i>Education</i>			0.0897*** (0.0321)	0.0858*** (0.0321)	0.0868*** (0.0321)
<i>Single</i>			0.4016** (0.1572)	0.3993** (0.1573)	0.4161*** (0.1576)
<i>Income</i>			0.0531 (0.0687)	0.0480 (0.0689)	0.0457 (0.0692)
<i>Senior</i>			-0.6094* (0.3647)	-0.4746 (0.3665)	-0.5155 (0.3688)
$\gamma_1$	0.4436 (0.2745)	0.7990*** (0.2842)	1.5612*** (0.4919)	1.8909*** (0.4973)	1.5527*** (0.4933)
$\gamma_2$	1.5659*** (0.2803)	1.9347*** (0.2924)	2.7229*** (0.5006)	3.0626*** (0.5074)	2.7313*** (0.5020)
$\gamma_3$	2.2771*** (0.2886)	2.6530*** (0.3018)	3.4506*** (0.5082)	3.7961*** (0.5157)	3.4676*** (0.5097)
$\gamma_4$	3.8445*** (0.3365)	4.2280*** (0.3490)	5.0345*** (0.5410)	5.3867*** (0.5486)	5.0587*** (0.5423)
LR statistic	9.3867	18.5130	32.8342	39.5499	42.6118
Prob(LR statistic)	0.0022	0.0000	0.0000	0.0000	0.0000
Percentage of Outcomes Predicted Correctly	41.3081	41.3081	41.1360	42.8571	41.8244

Notes: Due to high correlation between *Perceived\_Ease\_of\_Use* and *Perceived\_Usefulness*, these variables were orthogonized in model (5) in order to avoid multicollinearity. The  $\gamma$  thresholds have been estimated jointly with the regression coefficients. The standard errors are reported in parentheses. \*, \*\*, \*\*\* denote statistical significance at 10%, 5% and 1%, respectively.

Carow and Staten (1999), Borzekowski and Kiser (2008: 895, 899) and Hoffman et al. (2009) argue that the age of respondents negatively impacts upon the propensity to use plastic. Our results concur, with the additional finding that this is more strongly emphasized where the technology is already in widespread use. Several potentially different rationalizations can be offered for the observed ‘digital generation gap’. For example, this disjuncture can be discussed both in connection to risk aversion (see Halek and Eisenhauer, 2001) and individual learning behavior (see Jamieson and Rogers, 2000). Gender and residential differences are significant for user intentions for traditional debit cards but not for contactless. Gender difference may be explicable through disparate employment rates for men and women in Poland, with employees consequently more likely to possess both a bank account and a debit card. In 2010, employment rates for males stood at 58% and 43.5% for females (Central Statistical Office, 2010) and this disparity seems to account for statistically significant coefficients on *Gender* reported in Panel A of Table 5. However, the insignificance of the same variable in Panel B perhaps suggests that both genders are equally appraised of the potential benefits of the new technology. Similarly, the likely explanation for the differences in significance of the *Area\_of\_Residence* variable may lie with the currently relatively poor infrastructure supporting plastic transactions in rural areas. This, of course, does not preclude respondents from seeing the advantages inherent in contactless cards.

One of the more interesting results is that for *Single*, where it is positively influential, and significant, for contactless cards. By contrast, for traditional debit it is negatively so and close to being significant at the 10% level. In view of our results, singles can be viewed as technological early-adopters, according to the terminology of Rogers (1962). Initially when a new product is launched, ‘early adopters’ are quick to engage, before being followed by the majority. But the newness of the product is part of the appeal for these technological pioneers – once it is so diffuse as to become part of everyday life, their interest wanes. The impact of income is, in general, positive but not statistically robust. Overall, then, these results lend some support to our third hypothesis that demographic characteristics differentiate consumers’ intentions.

## 7. Theoretical and Practical Implications

One of the more interesting theoretical conclusions is that the TAM model (Davis, 1989; Davis et al., 1989) continues to remain relevant across an ever-changing terrain of innovation. It is a mark of the solidity of the original construction that it endures the test of time. In addition, the two constructs used in this study, *Perceived\_Ease\_of\_Use* and *Perceived\_Usefulness* appear to capture well the key theoretical components of the model. However, such psychological categories are unlikely to fully account for the entirety of human intention to adopt new technologies and future research may usefully deploy additional control variables. Similarly, as the technology becomes more widespread, later studies may endeavor to model actual usage as opposed to intentions.

Our results show that intention to use payment technologies differs across payment systems. Part of this comes from the ready visibility of traditional debit cards and the relative niche marketing of contactless technology to potential consumers. Many will be uncertain about the possible benefits of this new form of payment – hitherto advertising has concentrated on the ease of use of the new cards and perceived usefulness has so far only received little coverage in marketing communications. The benefits to the consumer, such as shorter queuing, the removal of the necessity of carrying cash and the possibilities of paying for public transportation and services at mass events have not been emphasized enough. We suggest that future marketing efforts focus on this area.

The study shows that there is a marked difference between the drivers for intentions between contact-based versus contactless technologies. This has important repercussions for the future marketing and promotion of the latter. Since the demographics of the target groups differ, marketers will need to seek alternative strategies to those in place for existing debit cards. At this stage of diffusion of contactless cards we might suggest that we are still on the lower foothills of the S-curve of adoption (Kuznets, 1930). In particular, it appears that the likely early adopters (Rogers, 1962) are likely to be well-educated singles. As Hooley and Saunders (1993) note, their ‘lifestage’ demographic segmentation identifies these consumers as having few financial burdens, recreation-oriented with a focus on entertainments outside the home. Successful marketing communication strategies are likely to be ones that emphasize these themes.

Rogers' (1962) model of the diffusion of technology has further relevance to the findings of this study. As the level of adoption moves through the stages of 'early majority' and 'late majority', the target group will also change. As our research indirectly shows, the willingness to accept traditional debit and contactless cards differs across demographics. With growing maturity of the innovation, marketing effort will also need to evolve to take account of the shifting audience and broaden its appeal beyond the initial group of early adopters. Our results for debit card intentions perhaps suggest that once a technology becomes ubiquitous and an integral part of everyday life, then they appear mundane to those most interested in newer technologies.

What is also evident from our estimates is that consumers who perceive a technology as being easy to use are likely to be more positively inclined towards it. This has important ramifications for the design of banking products and services, particularly in these turbulent times. Many scholars have identified the complexity of financial innovations as one of the root causes of the recent financial crisis (see, for example, Crotty, 2009, Issing, 2009, Mackenzie, 2011). It appears probable that consumers will be increasingly wary of financial developments that they do not fully understand.

Within the literature on payment innovations, there is consensus on the importance of network size, whether labeled as the "network externality" (Katz and Shapiro, 1985), the "network effect" (Liebowitz and Margolis, 1994), or "positive size externality" (Economides, 1993). As payment systems are typical examples of two-sided markets (Rochet and Tirole, 2003), the existence of a critical mass of both customers and retailers is thus one of the factors promoting further adoption of innovations. Within Poland, as we have seen in Section II, the number of cards in circulation has risen dramatically over recent times and continues to increase. As the market becomes flooded with cards there is increasing pressure from consumers, driving retailers to invest in new contactless readers, costing between \$100 and \$150 each (Wolfe, 2010). Consequently, Datamonitor (2010) has predicted a sharp rise in the number of terminals. With both consumers and merchants holding the necessary tools, the endemic 'chicken-and-egg' problem may be solved and this suggests that the tipping point might be close. Should the Polish experiment prove successful, it will serve as a model for other countries. However, it does appear that for consumers to shift from mere possession of cards to their actual use, there must be a strong marketing campaign (Wolfe, 2010).

Such a campaign may be well received by consumers. Recent research by Barclays Bank (2010) has shown that consumers are increasingly impatient with queues. Their study suggest that two fifths of people will refuse to queue for more than two minutes, while two thirds will abandon purchases rather than face an extended wait. Our empirical model included transaction speed as one of the components of *Perceived\_Usefulness*, which proved to significantly affect *Behavioural\_Intention\_To\_Use*. It needs to be noted that in Europe, contactless cards are being issued to customers at a similar cost to traditional debit cards. In the light of our results, this is likely to aid proliferation of this technology.

Other research has shown that contactless technology has been widely used in a range of business contexts and has become generally accepted by consumers in applications such as public transportation networks. It is also clear that mobile phone suppliers and operators are gearing up for a further push on Near Field Communication (a shorter range subset of RFID technology) (see Fischer, 2009, for example). This opens up both opportunities and threats for banks interested in developing contactless cards. Opportunities, in that there will be even greater impetus for merchants to install appropriate readers but also threats arising from competition out of unexpected quarters. For example, Google is tying its mobile phone operating system to its Google Checkout service – widespread adoption of this system would bypass the fees collected from merchants for processing transactions (Ray, 2011).

## **8. Conclusions**

This paper has endeavored to set out the terrain of current academic research into consumers' dispositions towards contactless payment cards. By detailing the historical development of payment technologies and the possibilities that are promised by recent innovations, we demonstrate that contactless cards have the potential to play a major role in the low-value transaction market in the future. The cards offer a number of possible benefits to consumers, merchants, banks and governments which are considered here. The history of the evolution of the technological specifications has been outlined together with a summary of how commentators see their future development. This is considered in both a general global context and more specifically within that of the Polish banking sector. Existing data on the state of contactless technology identified Poland as one of the European pioneers in bringing this product to the consumer. Considering the issue

from this perspective, there will be much for potential participants in other markets to learn from this example.

Our study draws upon a large, representative sample of Polish respondents, assembled with the assistance of the National Bank of Poland and interviewed by professional canvassers using Computer Aided Personal Interview (CAPI) protocols. Using this dataset we were able to both test the theoretical predictions of the Technology Acceptance Model (TAM) and evaluate the intentions of different demographic sections of Polish society. Our empirical implementation rests upon the ordered Logit approach appropriate for modeling ordinal and discrete dependent variables. We are able to conclude that the TAM framework provides an accurate depiction of reality and that education level and marital status are strong predictors of the behavioral intention to use contactless cards. It appears that time spent in formal learning correlates with facility towards newer technologies and that singles are more likely to be early adopters.

There are some caveats that should be borne in mind. Every country has its own unique culture and traditions. Poland, a country that emerged from communist rule, still has an unusually high dependence on cash transactions compared to Western Europe and North America. The more limited use of debit and credit cards also suggests that there might be greater novelty in the dispersion of contactless cards. It therefore seems that for greater surety as to the generalisability of our findings, similar studies could be recreated across a diverse range of countries. Similarly, a broader range of explanatory variables may deepen our understanding of the factors influencing intentions and adoption. In addition, we should like to point out that Davis's TAM model is not the only theoretical framework that is potentially capable of explaining the behavior of future users. We would encourage other researchers to explore other theories and models.

However, despite these qualifications, we believe that this study confirms that, given the right impetus, contactless payment cards certainly have the potential to eat away at the current dominance of cash in low-value transactions. The market definitely appears to be primed for that push. Since Visa, MasterCard and American Express have effectively established the standard for the technology, the risks of entry and costs of investment for banks are limited. In addition, this enables both banks and acquirers to gain the necessary experience and to build the infrastructure, which is likely to be used in the next few years with the development of NFC mobile payments.

Finally, in developing and emerging economies, these cards in their pre-paid form are likely to bring financial services to the unbanked.

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