Payment Systems in the Accession Countries*

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Abstract

In this paper we present a general equilibrium model on payment choice at retail level which allows us to analyze how the accession to the European Union and the influence of European institutions could shape the evolution of consumers' payments in newly acceded countries. The context of the European Union is particularly challenging because of the enlargement process. Building on model results we perform an empirical analysis with real data from countries that participate in the process.

Keywords: cash; payments; European Union enlargement.
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1 Introduction

Following the continuous development of information technology, retail payment systems have been in clear evolution in the last years. Cash is no longer the unique possibility of making a payment and shares relevance with other instruments like cards, direct debits or some other electronic means. Accordingly, managers of financial institutions and other professionals are very interested in knowing how consumers make payments in their daily operations and what changes are taking place. This evolution has also attracted the attention of financial authorities in two respects. First, because one of their responsibilities is to promote efficiency and security in the use of payment instruments and in the payment system as a whole (European Central Bank (ECB), 2010). Second, since these developments affect cash demand and therefore money supply, it could have implications for monetary policy.

The evolution of retail payments differs across countries (Humphrey et al., 1996, Humphrey et al., 2001, Humphrey, 2004, Callado and Utrero, 2004). The literature on payment systems has focused mainly on price and non-price characteristics and incentives as drivers of these differences. However, major differences in payment composition between Western Europe, the US and Japan are not only due to price or cost differences but rather the result of important differences in these countries' technological innovations, geographical size or culture (Humphrey, 2010). These differences for instance, explain the reason why Europe has a well-established nationwide electronic payment system while the US continues to rely importantly on checks. There are some interesting contributions, however, that analyze the effect of technological innovations in banking, in particular, ATM networks in consumer decisions (Snellman and Virén, 2006, Ferrari et al., 2007 and Yang and Ching, 2010). Together with these factors, institutional environment and national regulations shape financial market design (La Porta et al. 1997) and may as well have an influence on payment system development and usage. To the best of our knowledge institutional factors have not been included in the analysis of payment systems.

This paper tries to fill this gap by focusing on institutional characteristics both from a theoretical and empirical point of view. In particular, the paper analyzes the process of European enlargement and how the accession to the European Union (EU) and the influence of European institutions could shape the evolution of consumer payments in newly acceded countries (NAC). The EU context is particularly challenging because of the enlargement process. On May 1st 2004 the EU welcomed 10 more countries as a part of its largest enlargement ever. The accession of the new members increased the EU population by nearly 20% but the EU's total GDP increased just 4% (Hildebrandt, 2002).[1] The NAC accession negotiations required the implementation of the *acquis communautaire*, the set of laws that underpin the common market. As a result, NAC financial systems were expected to be transformed to such an extent that the supervisory and legal framework will reach more or less EU standards. Moreover, EU financial sector has also been experiencing a profound change - deregulation, disintermediation, technological change and single currency - representing, in fact a moving target to the NAC's authorities (Stirbu, 2004).

These countries are also expected to join the European Monetary Union and adopt the single currency Euro, which will also affect the way payments are made, both large value and retail payments. Nowadays, the use of payment instruments in NAC differs

[1] Including Romania and Bulgaria that entered in 2007.

from the uses and customs of EU15 (Callado and Utrero, 2007). In this setting, it is important to remark that security, reliability and efficiency are critical features for new payment solutions to be adopted. Therefore, the priority of NAC is to develop modern, robust and efficient market infrastructures which serve the needs of their economies and facilitate the development of safe and efficient financial markets. As part of the EU, these countries must also participate and work in the adaptation of their payment systems to Single Euro Payment Area (SEPA), see ECB-SEPA (2010). The inherent changes of this process involve an economic effort on the part of the institutions and of the financial firms.

In light of the above discussion, the first objective of the paper is to develop a theoretical model that can describe the effects that the access to a monetary union can have on household payment choice and intermediation costs. We assume that consumers have two ways of acquiring consumption goods, cash and electronic payments, and that technology is crucial for the development of the payment system. Our theoretical model builds on Ireland (1994a) and Hromcová (2008). We use a learning-by-doing setup with proportional intermediation cost. Knowledge improvements lead to more sophisticated payment system and lower intermediation costs for electronic transactions. That makes agents in a more developed economy use more electronic payments than in a less developed one. When the accession takes place, the payment system of the accessing country is gradually improved and the agents' payment choice approaches the one of the consumers in the accepting country, the one with more developed payment system. The second objective of the paper is to estimate the results of the model. For that, we use data on EU payment systems for countries accessing in 2004 and those accepting the NAC. Furthermore, data availability allows us to study the joint effect of institutional environment and banking market structure on payment decisions.

The rest of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 presents the empirical analysis. Finally, section 4 concludes.

2 Theoretical Model

We will consider two economies which differ in the initial level of development. At the beginning they are two separated islands and can have different monetary policies. With the accession moment approaching their monetary policies must converge and at the moment of accession a common monetary policy applies in both islands. After the unification takes place, the accessing country is gradually adopting the payment system technology of the more developed country. They maintain their own structure and other variables unchanged otherwise. Technology level is crucial for the payment system. The higher the technology achieved, the cheaper the non-cash payments. As a measure of technology, we will use the level of capital in the sense of the learning-by-doing model, Barro and Sala-i-Martin (1995). Because the learning-by-doing model can be reduced to an AK model, for simplicity of our theoretical setup, we assume that the production function has the linear form. However, we keep reminding the reader that the level of capital is the measure of achieved knowledge, and higher knowledge leads to higher technological level.

2.1 Accessing country

2.1.1 Household Problem

In the description of the model we follow closely Ireland (1994a) and Hromcová (2008). The behavior of households in both islands is analogous. Both economies consist of a large number of infinitely lived households. All households have identical preferences, production and trade opportunities. Therefore, we present the model for the island which begins with lower level of technology and at the end of the section we generalize the model for the other island.

Households inhabit the following environment: they face continuum of spatially separated markets, which are indexed by $j \in [0, 1]$. All households live in market 0, and the index j indicates the distance from home. In each market j a distinct perishable good is produced and sold in every period. Goods are thus indexed by j, which corresponds to the market of both production and trade. The representative household has the preferences given by

$$\sum_{t=0}^{\infty} \beta^t \int_0^1 u\left[c_t(j)\right] dj \tag{1}$$

where $c_t(j)$ is defined as the consumption at period t of the good produced in market j, $u(\cdot)$ is strictly increasing, strictly concave and twice continuously differentiable, with $\lim_{t\to\infty} u'\left[c_t(j)\right] = \infty$ and β is the discount factor.

The production and trade is like in Lucas and Stokey (1983). Each household is composed of a worker-shopper pair.

Prior to any trading government fixes the level of the gross nominal interest rate R_{t+1} between periods t and $t+1$. We will assume that $R_{t+1} > 1$. Agents enter the period t with certain amount of monetary balances Z_t and the debt B_t, carried over from the previous period, and the capital stock k_t that represents the technology level achieved. A representative worker decides to produce on any of the markets j via the net production function

$$y_t = Ak_t \tag{2}$$

where A is the net productivity of capital.[2]

First, the goods market opens and consumption takes place. Worker stays at the market j during the whole period. Shopper visits various markets to acquire consumption goods carrying all the monetary balances of the household.

Two ways of acquiring consumption goods are allowed: using money or electronic payments. All goods purchased with government issued money will be referred to as cash goods. Goods purchased via electronic payments will be referred to as electronic goods.

Nominal monetary balances Z_t can be used to buy goods in some of the markets

[2] Thanks to the AK technology, we can write the net production function as

$$y_t = \left(A' + 1 - \delta\right) k_t.$$

It corresponds the one defined in the equation (2), where A' is the marginal productivity and δ is the depreciation of capital.

indexed by j. Cash purchases are subject to the liquidity constraint

$$\int_0^1 [1 - \xi_t(j)]\, c_t(j) dj \leq \frac{Z_t}{p_t}, \tag{3}$$

where $\xi_t(j) = 0$ if a good is purchased on market j with cash, or $\xi_t(j) = 1$ if a good is purchased on market j via an electronic payment and p_t is the price level.

As we have said, agents can use an electronic payment to pay for the consumption. The financial intermediary enables electronic payments at a cost $\gamma_t(j)$ that is given for each market j and period t. The part of output that is not consumed is devoted to the investment into capital. After the goods market closes, the monetary holdings of agents are augmented by a lump sum transfer X_t from the government. The amount X_t is endogenously determined in the system according to the given nominal interest rate, so that the money demand is totally satisfied. As the next step the securities market opens. During the securities trading session households choose their currency holdings Z_{t+1}. They also purchase (or issue) one-period nominally denominated pure discount bonds paying B_{t+1} units of money at period $t+1$ while they cost $\frac{B_{t+1}}{R_{t+1}}$ units of money at period t. Bonds are in zero net supply. The budget constraint agents are facing can be written

$$\int_0^1 [c_t(j) + \xi_t(j)\gamma_t(j)]\, dj + k_{t+1} + \frac{Z_{t+1}}{p_t} + \frac{B_{t+1}}{R_{t+1}p_t} \leq Ak_t + \frac{Z_t}{p_t} + \frac{B_t}{p_t} + \frac{X_t}{p_t}. \tag{4}$$

2.1.2 Financial Intermediation

We assume that the intermediation cost must be paid by the buyer, as motivated in Ireland (1994b). To be able to purchase without cash, some resources must be devoted to making the non-cash payment itself available such as checking the identity of the buyer or his ability to pay. When the shopper is far away from home (market zero) the communication becomes more difficult, and therefore we assume that the payment to the intermediary increases with j. The process of learning-by-doing gives a potential for the development of new technologies. It also leads to an increase in income per worker and higher consumption. Higher purchase means that checking the ability of the buyer to pay is more relevant. The development and diffusion of new technologies allows to decrease the processing costs.

The real payment made to the intermediary is characterized by a function that fulfills properties found in some empirical studies, see Hromcová (2008): the intermediation cost is lower in richer countries, the cost of intermediated payment diminishes over time, and the cost elasticity is close to zero (which motivates the proportional intermediation cost).

Intermediation cost function is composed of three parts and is defined as

$$\gamma_t(j) = \gamma^{\text{location}}(j)\ \gamma^{\text{technology}}(k_t)\ \gamma^{\text{consumption}}\left[c_t(j)\right]. \tag{5}$$

The time independent part of the payment, $\gamma^{\text{location}}(j)$ is strictly increasing with the distance from home, strictly convex, twice continuously differentiable, and similarly to

Ireland (1994a) we assume $\gamma^{\text{location}}(0) = 0$ and $\lim_{j\to 1}\gamma^{\text{location}}(j) = \infty$. The time dependent part of the intermediation cost, $\gamma^{\text{technology}}(k_t)$, embodies the effect of new technologies on the cost. It includes the state of the technology frontier as well as the net of electronic infrastructures to perform the electronic payments. This cost decreases as the level of technology develops. The more capital is accumulated, the more knowledge is available, better technologies can be developed and cheaper intermediation services can be offered. The function $\gamma^{\text{technology}}(k_t)$ is strictly decreasing, strictly convex, twice continuously differentiable and $\lim_{t\to\infty}\gamma^{\text{technology}}(k_t) = 0$. The other time dependent part of the intermediation cost, $\gamma^{\text{consumption}}[c_t(j)]$, reflects the proportionality to consumption purchases,

$$\gamma^{\text{consumption}}[c_t(j)] = c_t(j).$$

A special feature of this intermediation cost function is that in the long run it reduces to a fixed intermediation cost. Asymptotically our model becomes the one of Ireland (1994a).

We thus concentrate directly on the effect of new technologies on the intermediation cost. However, the scale economies are also present, because higher stock of knowledge is associated with higher volume of transactions.

2.1.3 Payment choice

Consider a given level of k_t. Taking into account the assumption on the time independent part of the intermediation cost $\gamma^{\text{location}}(\cdot)$, whenever $R_{t+1} > 1$, households will choose cash goods in markets far away from home (market 0) and electronic goods in markets close to home. Therefore, there will exist at each time t a market with cutoff index $s_t \in (0,1)$, such that in all markets with indexes $j < s_t$ consumers will use electronic payments and in all markets with indexes $j \geq s_t$ consumers will use cash to acquire the consumption goods. In the cutoff market consumers are indifferent between using cash or electronic payments. We arbitrarily assume that cash will be used at the cutoff market.

Define

$$c_t(j) = \begin{cases} c_t^0(j) & \text{when } \xi_t(j) = 0, \\ c_t^1(j) & \text{when } \xi_t(j) = 1. \end{cases}$$

The functions $c_t^0(j)$ and $c_t^1(j)$ characterize the cash and electronic consumption per market j, respectively. We can then write the utility function, budget and cash-in-advance constraint in a following way

$$\sum_{t=1}^{\infty}\beta^t\left[\int_0^{s_t} u\left[c_t^1(j)\right]dj + \int_{s_t}^1 u\left[c_t^0(j)\right]dj\right], \tag{6}$$

$$\int_0^{s_t}\left[c_t^1(j) + \gamma_t(j)\right]dj + \int_{s_t}^1 c_t^0(j)dj + k_{t+1} + \frac{Z_{t+1}}{p_t} + \frac{B_{t+1}}{R_{t+1}p_t} \leq Ak_t + \frac{Z_t}{p_t} + \frac{B_t}{p_t} + \frac{X_t}{p_t} \tag{7}$$

and

$$\int_{s_t}^1 c_t^0(j)dj \leq \frac{Z_t}{p_t}. \tag{8}$$

2.1.4 Equilibrium

Definition: Given the set of initial conditions k_1, Z_1, B_1, p_1 and the sequence of nominal interest rates $\{R_{t+1}\}_{t=0}^{\infty}$, the equilibrium consists of sequences $\{c_t^0(j),\, c_t^1(j),\, k_{t+1},\, Z_{t+1},\, B_{t+1},\, s_t,\, X_t,\, p_{t+1}\}_{t=1}^{\infty}$ such that

(a) a representative household is maximizing the discounted utility (6) subject to the budget constraint (7) and the cash-in-advance constraint (8), choosing the sequences $\{c_t^0(j),\, c_t^1(j),\, k_{t+1},\, Z_{t+1},\, B_{t+1},\, s_t\}_{t=1}^{\infty}$,

(b) markets for goods, money and bonds clear in every period,

$$\begin{aligned} Ak_t &= \int_{s_t}^{1} c_t^0(j)dj + \int_0^{s_t} c_t^1(j)dj + \int_0^{s_t} \gamma_t(j)dj + k_{t+1}. && (9)\\ Z_{t+1} &= Z_t + X_t, && (10)\\ B_{t+1} &= 0. && (11) \end{aligned}$$

Let λ_t and η_t be the non-negative Lagrange multipliers associated with the budget constrain (7) and the cash-in-advance constraints (8), respectively. The equations that characterize the equilibrium are the above mentioned market clearing conditions (9), (10), (11) and the first order conditions on consumption, capital, nominal balances, nominal bonds and cutoff index, respectively,

$$\begin{aligned} u'\left[c_t^0(j)\right] &= \lambda_t + \eta_t, && (12)\\ u'\left[c_t^1(j)\right] &= \lambda_t, && (13)\\ \lambda_t &= \beta\lambda_{t+1}A, && (14)\\ \frac{\lambda_t}{p_t} &= \beta\frac{\lambda_{t+1}+\eta_{t+1}}{p_{t+1}}, && (15)\\ \frac{\lambda_t}{p_t} &= \beta R_{t+1}\frac{\lambda_{t+1}}{p_{t+1}}, && (16)\\ u\left[c_t^0(s_t)\right] - u\left[c_t^1(s_t)\right] &= -\lambda_t\left[c_t^1(s_t)+\gamma_t(s_t)\right] + (\lambda_t+\eta_t)c_t^0(s_t). && (17) \end{aligned}$$

Using (12), (13), (15) and (16), we can rewrite the first order conditions on both consumptions as follows:

$$\begin{aligned} u'\left[c_t^0(j)\right] &= R_t\lambda_t, && (18)\\ u'\left[c_t^1(j)\right] &= \lambda_t. && (19) \end{aligned}$$

From the first order condition (17) we get the payment to the intermediary to be paid at the cutoff market

$$\gamma_t\left[s(R_t,k_t)\right] = \frac{1}{\lambda_t}\left\{u\left[c_t^1(\lambda_t)\right] - u\left[c_t^0\left(R_t,\lambda_t\right)\right]\right\} + R_t c^0\left(R_t,\lambda_t\right) - c^1\left(\lambda_t\right). \qquad (20)$$

Taking into account the expressions (18), (19), and (5), the equilibrium on the goods market (9) can be rewritten as

$$Ak_t = \int_{s(R_t,k_t)}^{1} c^0\left(R_t,\lambda_t\right)dj + \int_0^{s(R_t,k_t)} c^1\left(\lambda_t\right)dj + \int_0^{s(R_t,k_t)} \gamma_t(j)dj + k_{t+1}. \qquad (21)$$

The current period output is spent between cash consumption, electronic consumption, payment to the intermediary and investment. The real monetary balances, which equal the amount of cash consumption purchased in all markets, are

$$m_t = [1 - s(R_t, k_t)]\, c^0\,(R_t, \lambda_t)\,, \tag{22}$$

where

$$m_t = \frac{Z_t}{p_t}. \tag{23}$$

The consumption via financial intermediaries, which equal the amount of electronic consumption purchased in all markets, is

$$e_t = s(R_t, k_t)\ c^1\,(\lambda_t)\,. \tag{24}$$

Thus the ratio of cash and electronic payments is dependent on the specification of the intermediation function, specification of the utility and the last period monetary policy.

In order to see the behavior of the cash to electronic payments ratio we set up a parametric example with the CES utility function

$$u(c) = \begin{cases} \ln c & \text{for } \theta = 1, \text{ and} \\ \frac{c^{1-\theta}-1}{1-\theta} & \text{for } \theta \neq 1 \end{cases}$$

where $\theta > 0$ is the inverse of the elasticity of intertemporal substitution, and the following proportional intermediation cost [3]

$$\gamma_t(j) = \frac{j}{1-j}\gamma^{\text{technology}}(k_t)\ c^1\,(\lambda_t)\,. \tag{25}$$

We can then write the cutoff index combining (25) and (20) in the following form

$$s\,(R_t, k_t) = \frac{\phi\,(R_t)}{\gamma^{\text{technology}}(k_t) + \phi\,(R_t)} \tag{26}$$

where

$$\phi\,(R_t) = \begin{cases} \ln R_t & \text{for } \theta = 1, \\ \frac{\theta}{1-\theta}\left(1 - \frac{1}{R_t^{\frac{1-\theta}{\theta}}}\right) & \text{for } \theta \neq 1. \end{cases} \tag{27}$$

The cutoff index describes the proportion of markets in which agents employ services of the intermediary. From (14) we can get the evolution of the marginal utility of consumption, we can see that its growth rate is constant over time. The ratio of cash to electronic consumptions can be expressed as

$$\frac{m_t}{e_t} = \frac{\gamma^{\text{technology}}(k_t)}{\phi(R_t) R_t^{\frac{1}{\theta}}}. \tag{28}$$

[3] The time independent part $\gamma^{\text{location}}(j)$ is taken from Ireland (1994a).

The technology level (the part of the intermediation cost function that depends on the technology) and the monetary policy affect the composition of the payment methods as follows

$$\frac{d\left(\dfrac{m_t}{e_t}\right)}{dk_t} < 0 \text{ and } \frac{d\left(\dfrac{m_t}{e_t}\right)}{dR_t} < 0. \tag{29}$$

2.2 Accepting Country

The specification of the accepting economy is the same as the one of the accessing one described above. When writing the version of the model for the accepting country we use the analogous notation but in capital or blackboard bold letters. In Table 1 we resume the notation for both islands.

[insert table 1 around here]

2.3 Accessing Economy Before and After

Both economies know both initial conditions and when the accession takes place, i.e. T_{access} is given. Both economies can solve their maximization problems using backward induction, see Hromcová (2008). After the accession, the accessing economy is adopting the payment technology of the accepting country. We define k_t^{access} as the level of technology that determines the intermediation cost at each market after accession. Given that the accessing country's payment technology converges to the accepting one, the gap between the payment technologies of both countries will be diminished over time. The evolution of k_t^{access} will reflect the payment technology differences and will be a function of the levels of the payment technologies in both groups of countries

$$k_t^{\text{access}} = \Omega\left(k_{t-1}^{\text{access}}, K_t\right)$$

where $k_t \leq k_t^{\text{access}} < K_t$, $k_{T_{\text{access}}}^{\text{access}} = k_{T_{\text{access}}}$ and $\lim_{t\to\infty} k_t^{\text{access}} = K_t$.[4] The intermediation cost function would be slightly modified and the ratio between the cash and electronic consumptions after the accession, equation (28), depends on the payment technologies of both groups of countries and the common monetary policy

$$\left.\frac{m_t^{\text{access}}}{e_t^{\text{access}}}\right|_{t>T_{\text{access}}} = \frac{\gamma^{\text{technology}}\left[k_t^{\text{access}}\left(K_t\right)\right]}{\phi(R_t)R_t^{\frac{1}{\theta}}}. \tag{30}$$

Equation (30) implies that for given levels of payment technologies and a given monetary policy, any decrease in the real balances will have to be accompanied by an increase in the

[4] An example of a convergence equation could be found in Lucas (2009). The notation k_t^{access} is to account for the payment technology (capital) in the country where the accession actually happened. We save the previously used notation k_t for an economy that does not access and whose payment technology evolves independently of the accepting country's one.

electronic goods. It also implies that the accession, that means higher level of payment technology, $k_t^{\text{access}} > k_t$, induces a drop in the ratio of cash and electronic payments, relationships (29).

3 Empirical analysis

According to equation (30) of the model, the use of alternative means of payments in the accessing countries is a function of cash and the monetary policy (interest rate) in the accessing countries as well as the technology level in accessing and accepting countries. The technology level accounts for the level of technology achieved as well as the set of infrastructures developed to make payments. In order to empirically estimate this relationship, we take logs. Therefore, the equation to estimate is

$$\ln e_{it} = \alpha_0 + \alpha_1 \ln m_{it} + \alpha_2 (R_{it} - 1) + \alpha_3 \ln(K_t - k_{it}) + \varepsilon_{it} \quad (31)$$

where x_{it} represents a variable x in the accessing country i at time t, where $x = e, m, R, K, k$ are electronic operations, cash operations, nominal interest factor, payment technology level in the accepting country (thus no index i) and payment technology level in the accessing countries, respectively. The error term ε_{it} is assumed to be normally distributed with zero mean and variance σ^2, $\varepsilon_{it} \sim N(0, \sigma^2)$. The estimation takes into account the possible existence of non observable heterogeneity.

From the time series analysis point of view some problems may arise in estimating the above equation because most of the data may be non-stationary. If this were the case, that would give rise to co-integration analysis and specification of an error-correction model. Both the augmented Dickey-Fuller and Phillips-Perron individual unit roots tests discard this problem.[5] Furthermore, the short sample period and the panel dimension make us decide to use panel data techniques.

From the econometric point of view, the estimation of the coefficients, α_0, α_1, α_2 and α_3 should take into account the structure of the components of the error term ε_{it}, that is, the specific effects can be treated as fixed or random. If the effects are independent of the explanatory variables they form part of the error term, that in this case will be a compound term. But if the effects are correlated, the estimator by ordinary least squares is not consistent.[6] When there is no correlation, the random effects are used since it is the most efficient alternative (Arellano and Bover, 1990).

3.1 Data

We use pooled cross-country yearly data from the first group of the accessing countries namely: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia and those proposed for a later acceptance, Bulgaria and Romania.[7]

[5] Individual country results are available from the authors upon request.

[6] The Hausman test is used to test whether the effects are fixed or random.

[7] From now on, when we refer to accessing countries we include all of them.

Data on EU-15 is also available.[8] In order to have pre-accessing and post-accessing periods we take the period between 1996-2009.[9] We use data on cash and cards to account for cash and non-cash operations respectively. To allow for comparisons, these variables are expressed in euros and scaled by the population. To proxy for the technology level achieved in the payment systems, we use data on Automatic Teller Machines (ATM) and Electronic Fund Transfers at Point of Sale (EFT-POS) network.

The model suggests that the institutional environment influences payment decisions. Accordingly, we introduce two alternative variables to capture the effect of accessing the EU. First, the candidate variable identifies the moment when the country is considered prepared to become a member and individual negotiations with Brussels start. Second, the accessing variable captures the moment when the candidate is finally admitted. On one side, a positive effect can be expected since candidate countries have followed European Central Bank recommendations for the modernization of the banking system in order to have success in the negotiations. On the other hand, a negative effect could arise if the costs derived from those reforms and investments made by the institutions were transferred to consumers. If this were the case, clients would be reluctant to use new means of payments different from cash.

We also include some control variables in the estimation. We introduce two alternative variables to proxy for economic development (GDP per worker and consumption per capita). Previous empirical papers (Humphrey, 2004, among others) find a positive relationship between economic development, electronic means of payments and national banking structure. There is a strand of literature that analyzes the incentives of banking firms to introduce and develop ATM and EFT-POS networks. This is an interesting question since ATM and EFT-POS replace some of the desk services provided by banking institutions through commercial branches. However, the maintenance of the networks is paid by banking institutions and therefore, banks may have incentives to induce consumer not to use ATM (for example applying fees) to prevent developing a large ATM network (Ferrari et al., 2007). Ishii (2008) suggests that the development of ATM and EFT-POS networks is also related to market structure. Therefore, banking structure may be affecting payment choice decisions as well. To proxy for banking structure the number of banking institutions and branches are used. In particular, we introduce the distance to the EU banking market structure. We expect that the shorter the distance to the EU banking structure, the closer the pattern of the means of payment use to the EU counterpart. Further, per capita income is introduced to control for development and economic stability. Table 2 collects the definitions of the main variables and presents some descriptive statistics.

[insert table 2 around here]

The two columns present the mean and the standard deviation for all accessing countries and for accepting countries (EU-15), respectively. Some interesting differences are

[8]EU-15 are Germany, France, Belgium, Netherlands, Luxemburg, Italy, Great Britain, Ireland, Denmark, Greece, Portugal, Spain, Austria, Finland and Sweden (in membership order).

[9]In the estimation we take into account when the countries become members and therefore, from that moment in time, they are included in the accepting group.

evidenced between both sets of countries. First, the per capita currency in circulation is much higher in the accepting countries than in the accessing ones. This preliminary positive relationship is in line with previous evidence such as Drehmann et al. (2002), among others. Similarly, consumption per capita is much lower in the latter. Observing the other means of payment, accepting countries present higher level of card operations. They also have higher level of EFT-POS networks. Card use and ATM networks per capita in both groups of countries exhibit an increasing trend and we can conclude that the accessing countries are heading towards the accepting ones, see Figure 1. Table 3 presents the correlation matrix of the main variables.

[insert figure 1 around here]
[insert table 3 around here]

3.2 Results

Table 4 presents the results for card use. Hausman test is presented at the end of the table. As it can be observed that in all runs the test rejects the uncorrelation of the effects and consequently, the fixed effect estimator is used.

[insert table 4 around here]

Looking at the variables of interest, cash presents a negative and significant coefficient as expected from the results of the model. This result is consistent throughout the different specifications. Therefore, the more cash in circulation, the less number of card operations. This result confirms as well the substitution effect of cards observed in previous empirical studies (Humphrey, 2004, for the U.S., Carbó Valverde et al., 2003, for Spain). The ATM network variable does not affect significantly card use. However, EFT-POS network variable presents a negative and significant coefficient in all runs. Therefore, the more distance to the European EFT-POS network (the longer the road to achieve the European technology payment system standards), the lower use of cards. This evidence confirms the result of the theoretical model that the use of alternative means of payment not only depends on a country's own technological development but on the accepting countries technology level as well. Nominal interest rate, that accounts for the monetary policy, presents a positive and significant coefficient. Hence, an increase in the interest rate implies an increase in the card use, since the opportunity cost of cash is increasing. This result is coherent with the previous evidence on the demand for cash and highlights the negative relationship between cash and interest rates (Humphrey, 2004 and Snellman and Virén, 2006, among others). Both, per worker GDP and per capita consumption, have a positive and significant coefficient, meaning that more developed countries present higher card use, confirming previous results on international comparisons (Callado and Utrero, 2004 and 2007). Looking at the variables that account for the institutional environment, the candidate variable presents a positive and significant coefficient both when it is introduced alone and when it is introduced together with the accession dummy. Yet, accessing variable is not significant, except for the columns 11 and 12. The general message of these coefficients is that the prospects of entering the EU have a positive effect on the card use. This may indicate that the expectation of accessing to the EU is considered a positive shock for the reliability of the economic and the payment systems and that consumers have already started to change their payment choices when the accession takes place, therefore, accessing does not have a significant independent impact. Finally, we introduce two control variables about the market structure: branches and number of institutions. Neither branches nor the number of banks are significant. This result suggests that technology is what really matters in payment decisions.

3.3 Robustness analysis

Here we present additional evidence to check the robustness of the results. First, we check if the conclusions reported are sensitive to the accepting group composition. EU membership has changed in the last decade. However, it is the monetary union and the single currency participation that has presented more changes. Afterwards, we decide to use the membership to the monetary union instead of the EU membership as the accepting group. As in the previous analysis, we take into account the individual membership changes. Results are presented in Table 5. We can see that results are very similar to those presented when considering EU-15 as the accepting group. Cash in circulation, technology measures, economic development variables, interest rate, accessing variable and the number of banks present the same conclusions as above. Namely, cash and technology level affect negatively and significantly the card operations, while economic development and interest rate show a positive relationship. Accessing variable and the number of banking institutions continue to be insignificant for card operations. The main differences come from the candidate variable and branch structure. Candidate variable presents milder results, being significant only in some runs. This could be somehow expected, since being a candidate may happen many years before actually entering the monetary union. Branch structure coefficient, however, is positive and significant. Therefore, banking market structure is more important for card operations when considering monetary union.

An additional issue in this context is the simultaneous relationship between cash and ATM (Snellman and Virén, 2006). To control for this potential bias, we use Generalized Method of Moments (GMM) estimation. Although the above mentioned simultaneity between cash and ATM can also be controlled by using a simultaneous equation estimator (e.g., maximum likelihood and two- or three-stage least squares) our choice is based on consistency concerns. In other words, the above mentioned estimators are more efficient than GMM, but they are not consistent since they do not eliminate unobservable heterogeneity. In contrast, GMM estimation implies less efficiency, but it is consistent because it eliminates unobservable heterogeneity. Traditionally GMM uses first-difference transformation. However, this technique has a weakness. It magnifies gaps in unbalanced panels (Roodman, 2006). Arellano and Bover (1995) propose a second transformation 'orthogonal deviations' that minimizes data loss and since lagged observations do not enter the formula, they are valid as instruments.[10] Since we have a small sample, we

[10] In the estimation, lagged values of cash, interest rate, GDP and banking structure are introduced in

decide to use this transformation in order to preserve sample size. Further, to avoid overfitting, we collapse the instrument matrix.[11] Table 6 collects the results. Focusing first on the diagnostic tests, Hansen's J-statistics for all specifications are too small to reject the null hypothesis that the instruments are valid. Further, AR(1) and AR(2) test statistics for first and second order serial correlation in the first-differenced residuals indicate, as required, that while we can sometimes have evidence of first order autocorrelation, we always accept the null hypothesis of no second order autocorrelation. Looking at the variables of interest, as it can be seen, results are very similar to those presented in Table 4. The banking variable, that accounts for the distance between the own banking structure and the accepting one is significant in all runs, suggesting that banking structure does have a word to say in payment decisions.

4 Conclusions

We present a general equilibrium model on payment choice at retail level which allows us to analyze the evolution of consumer payments in the context of the European enlargement process.

The theoretical model predicts a drop in the usage of cash after the accessing country adopts the financial system of the accepting one. It also shows that the card use will depend on the cash in circulation, monetary policy and the level of technology.

Results from the econometric analysis confirm these conclusions. Both capital level in the accepting and accessing countries affect payment decisions. It also confirms the importance of developing the necessary structures for increasing card use in the new member countries as well as achieving a certain economic development. Monetary policy is also shown to affect payment decisions as expected. Of the two institutional variables introduced it is shown that being a candidate to enter the European Union affects significantly consumer's behavior, however, the entering date is not significant. Results are robust to different estimation techniques and maintain when we consider the decision to enter into a more restrictive and demanding group, European Monetary Union.

GMM-style, while ATM and EFT-POS receive the standard treatment for endogenous variables. Further, time dummies are included as IV-style instruments.

[11] We have chosen not to run two-step GMM due to well-known finite sample problems associated with the standard errors of two-step estimates. Indeed, two-step estimates of the model (not reported) suggest significant downward bias in the standard errors, even after using the Windmeijer (2005) correction.

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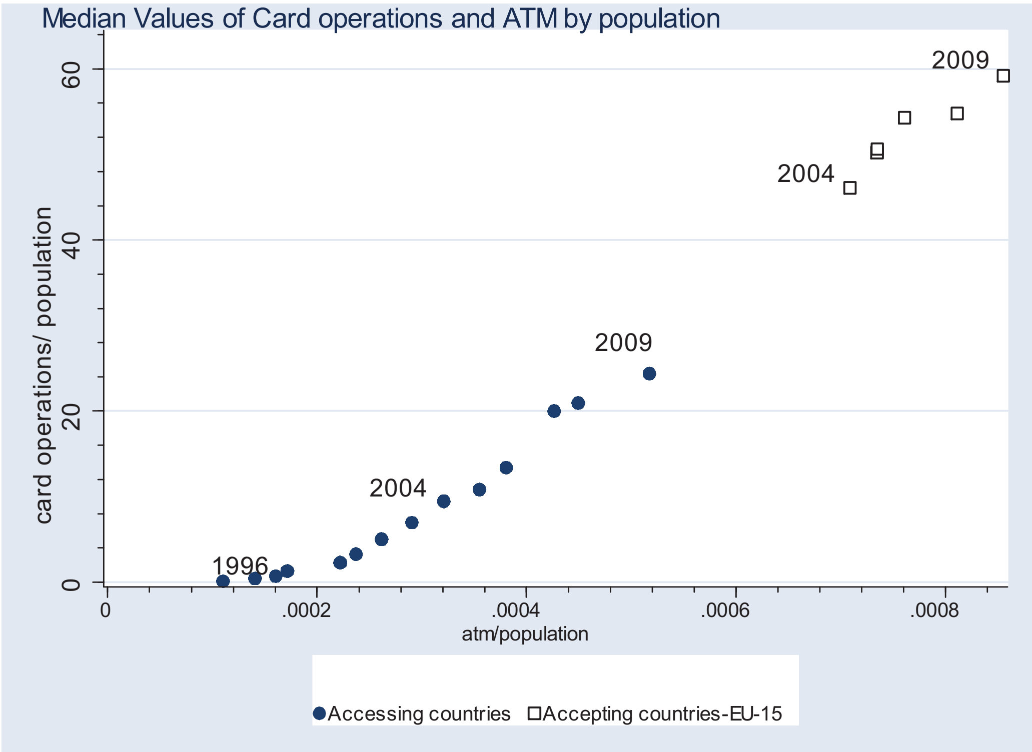

Figure 1: Transformation of the payment system in the accepting and accessing countries over the analyzed period.

Table 1: Resume of the notation for the accessing and the accepting countries.

Variable	ACCEPTING COUNTRY	ACCESSING COUNTRY
payment technology	K_t	k_t
total cash consumption	M_t	m_t
total non-cash consumption	E_t	e_t
cutoff market index	S_t	s_t
parameter related to the monetary policy[12]	$\Phi(\mathbb{R}_t)$	$\phi(R_t)$
marginal utility of wealth	Λ_t	λ_t
net marginal productivity of capital	$\mathbb{A}$	A

[12]In fact, whenever the two groups of countries share the same monetary policy $\Phi(R_t) = \phi(R_t)$.

Table 2: Definitions of the variables and means.

Variable	ACCESSING COUNTRIES	ACCEPTING COUNTRIES
pccurrency	657.1531	1249.556
(per capita currency in circulation)	(704.4418)	(286.4857)
pccardop	13.9415	52.5298
(*per capita card operations)*	(20.2578)	(4.5398)
pceftpos	0.0063	0.01169
(per capita point of sale terminals)	(0.0068)	(0.0041)
Pcatm	0.0003	0.0006
(*per capita atm terminals)*	(0.0002)	(0.0001)
Pwgdp	18543.76	56978.71
(*per worker gdp)*	(10389.13)	(2571.081)
pcconsumption	6790.014	19263.086
(*per capita consumption)*	(3887.674)	(621.600)
Irate	9.1054	3.0125
(*money market interest rate)*	(14.8071)	(0.5011)
Nbanks	55.58084	21.7142
(*number of banking institutions)*	(133.7555)	(4.1957)
Nbranch	570.2096	571.6429
(*number of bank branches)*	(329.0762)	(35.7869)

Note: standard deviation in brackets.
Source: ECB and Eurostat.

Table 3: Correlations between variables.

	Pccurency	Pwgdp	Pcconsumption	irate	pcatm	pcpos	nbranch	nbanks
Pccurency	1							
Pwgdp	0.6486*	1						
Pcconsumption	0.5811*	0.9723*	1					
Irate	-0.2560*	-0.3798*	-0.3597*	1				
Pcatm	-0.1796*	-0.5947*	-0.6489*	0.2950*	1			
Pcpos	-0.5555*	-0.6957*	-0.7434*	0.1313	0.6392*	1		
Nbranch	-0.0899	-0.5352*	-0.6047*	0.1673*	0.3157*	0.4167*	1	
Nbanks	-0.2412*	-0.5811*	-0.6093*	0.1269	0.3266*	0.4714*	0.8150*	1

* significant at 1%.

Table 4: Card Use.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Cash	-0.0430***	-0.0426***	-0.0389***	-0.0356**	-0.0189	-0.0216	-0.0386**	-0.0401**	-0.0446***	-0.0442***	-0.0516***	-0.0493***
	[0.0121]	[0.0131]	[0.0134]	[0.0144]	[0.0133]	[0.0149]	[0.0150]	[0.0167]	[0.0131]	[0.0143]	[0.0147]	[0.0160]
Atm network	5.7819	6.4657	11.9746	12.1951	9.5508	10.9127	19.9149**	21.0499**	6.1054	6.7381	14.2990	14.4525
	[8.7151]	[9.0181]	[9.7309]	[10.0751]	[9.5721]	[9.8676]	[10.0650]	[10.3924]	[8.7976]	[9.0920]	[9.7097]	[10.0626]
Pos network	-2.1274***	-2.1214***	-1.5789***	-1.6238***	-1.7804***	-1.7374***	-1.2129***	-1.1801***	-2.1088***	-2.1031***	-1.5085***	-1.5338***
	[0.2193]	[0.2306]	[0.2360]	[0.2558]	[0.2389]	[0.2497]	[0.2351]	[0.2533]	[0.2273]	[0.2393]	[0.2365]	[0.2581]
Interest rate	0.2539***	0.2540***	0.3441***	0.3383***	0.1917***	0.1960***	0.3078***	0.3115***	0.2509***	0.2513***	0.3250***	0.3225***
	[0.0643]	[0.0650]	[0.0734]	[0.0746]	[0.0701]	[0.0707]	[0.0767]	[0.0779]	[0.0652]	[0.0658]	[0.0734]	[0.0744]
Gdp p worker	0.0375***	0.0375***			0.0391***	0.0401***			0.0369***	0.0370***		
	[0.0041]	[0.0045]			[0.0049]	[0.0052]			[0.0045]	[0.0048]		
Consumption			0.0417***	0.0405***			0.0447***	0.0452***			0.0390***	0.0384***
			[0.0056]	[0.0059]			[0.0057]	[0.0060]			[0.0057]	[0.0059]
Candidate	0.0123***	0.0122***	0.0091***	0.0093***					0.0123***	0.0123***	0.0097***	0.0098***
	[0.0023]	[0.0023]	[0.0025]	[0.0025]					[0.0023]	[0.0023]	[0.0025]	[0.0025]
Accessing					-0.0005	-0.0005	0.0039	0.0040	0.0009	0.0008	0.0052*	0.0050*
					[0.0029]	[0.0029]	[0.0028]	[0.0028]	[0.0027]	[0.0027]	[0.0027]	[0.0027]
Branches		0.0024		0.0060		0.0002		0.0011		0.0021		0.0035
		[0.0084]		[0.0089]		[0.0092]		[0.0093]		[0.0085]		[0.0088]
Banks		0.0041		0.0016		0.0095		0.0070		0.0040		0.0014
		[0.0133]		[0.0141]		[0.0145]		[0.0146]		[0.0134]		[0.0139]
Constant	5.1170***	5.0680***	4.4597***	4.4314***	5.3615***	5.2764***	4.6836***	4.6072***	5.1550***	5.1060***	4.7045***	4.6735***
	[0.4526]	[0.4771]	[0.5105]	[0.5378]	[0.5096]	[0.5383]	[0.5455]	[0.5746]	[0.4687]	[0.4951]	[0.5206]	[0.5487]
Observations	167	167	167	167	167	167	167	167	167	167	167	167
R-squared	0.71	0.71	0.67	0.67	0.65	0.65	0.64	0.64	0.71	0.71	0.68	0.68
Hausman Test	27.91***	22.33***	24.23***	19.89***	33.84***	25.43***	27.26***	19.98***	30.40***	28.91***	35.24***	49.17***

***, **, and * significant at 1, 5 and 10% respectively.

Table 5: Card Use. Euro entrance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Cash	-0.0247**	-0.0177	-0.0360***	-0.0269**	-0.0202*	-0.0122	-0.0433***	-0.0326**	-0.0286**	-0.0203	-0.0481***	-0.0369**
	[0.0116]	[0.0124]	[0.0122]	[0.0126]	[0.0120]	[0.0129]	[0.0129]	[0.0136]	[0.0128]	[0.0138]	[0.0135]	[0.0142]
Atm network	-3.6244	-3.2991	13.3462	12.7229	-0.0422	-0.3097	18.1214**	16.4379*	-2.6991	-2.7874	15.6495*	14.3786
	[8.2425]	[8.4781]	[8.8680]	[8.9667]	[8.2912]	[8.4966]	[8.6454]	[8.7837]	[8.3570]	[8.5838]	[8.8458]	[8.9957]
Pos network	-3.0658***	-3.2061***	-2.6336***	-2.8984***	-3.0926***	-3.2486***	-2.5944***	-2.8521***	-3.0210***	-3.1753***	-2.5550***	-2.8128***
	[0.2974]	[0.3185]	[0.2892]	[0.3117]	[0.3041]	[0.3260]	[0.2876]	[0.3134]	[0.3044]	[0.3272]	[0.2887]	[0.3155]
Interest rate	0.1168*	0.1011	0.2527***	0.2214***	0.0838	0.0727	0.2212***	0.1996***	0.1121*	0.0986	0.2358***	0.2122***
	[0.0660]	[0.0666]	[0.0691]	[0.0692]	[0.0651]	[0.0655]	[0.0680]	[0.0681]	[0.0664]	[0.0671]	[0.0689]	[0.0692]
Gdp p worker	0.0428***	0.0396***			0.0429***	0.0400***			0.0415***	0.0389***		
	[0.0041]	[0.0045]			[0.0045]	[0.0047]			[0.0045]	[0.0047]		
Consumption			0.0526***	0.0484***			0.0512***	0.0478***			0.0497***	0.0467***
			[0.0050]	[0.0051]			[0.0050]	[0.0051]			[0.0051]	[0.0052]
Candidate	0.0036*	0.0033	0.0019	0.0016					0.0039*	0.0035	0.0027	0.0022
	[0.0021]	[0.0021]	[0.0021]	[0.0021]					[0.0022]	[0.0022]	[0.0021]	[0.0021]
Accessing					0.0009	0.0002	0.0044*	0.0032	0.0018	0.0011	0.0050**	0.0037
					[0.0026]	[0.0026]	[0.0024]	[0.0024]	[0.0026]	[0.0026]	[0.0024]	[0.0025]
Branches		0.0164*		0.0222**		0.0174*		0.0202**		0.0157		0.0192**
		[0.0095]		[0.0091]		[0.0096]		[0.0092]		[0.0096]		[0.0093]
Banks		-0.0018		-0.0050		-0.0015		-0.0048		-0.0020		-0.0052
		[0.0124]		[0.0122]		[0.0126]		[0.0121]		[0.0125]		[0.0121]
Constant	5.9009***	5.8831***	4.9905***	5.0527***	6.0954***	6.0269***	5.2719***	5.2614***	5.9729***	5.9306***	5.2173***	5.2236***
	[0.4602]	[0.4822]	[0.4767]	[0.4923]	[0.4705]	[0.4951]	[0.4836]	[0.5021]	[0.4718]	[0.4958]	[0.4845]	[0.5032]
Observations	167	167	167	167	167	167	167	167	167	167	167	167
R-squared	0.72	0.73	0.72	0.74	0.71	0.72	0.73	0.74	0.72	0.73	0.73	0.74
Hausman Test	48.77***	37.87***	43.40***	32.01***	48.86***	35.80***	41.39***	26.17***	43.38***	38.24***	50.98***	62.52***

***, **, and * significant at 1, 5 and 10% respectively.

Table 6: GMM estimation.

	(1)	(2)	(3)	(4)	(5)	(6)
Cash	-0.0570***	-0.0583***	-0.0428***	-0.0475***	-0.0521***	-0.0409***
	[0.0185]	[0.0199]	[0.0112]	[0.0108]	[0.0195]	[0.0113]
Atm network	-0.3990	2.4906	-2.7006	2.934933	-2.4850	-3.7097
	[17.7769]	[16.9875]	[16.6788]	[15.3769]	[17.9219]	[16.9551]
Pos network	-1.9341***	-1.6451***	-1.6311**	-1.4171***	-1.9115**	-1.6794**
	[0.7363]	[0.6133]	[0.6868]	[0.5275]	[0.7396]	[0.6705]
Interest rate	0.3039*	0.1133	0.3256***	0.1942***	0.2702*	0.2821***
	[0.1771]	[0.1448]	[0.0914]	[0.0733]	[0.1706]	[0.0894]
Gdp p worker	0.0425***	0.0442***			0.0373***	
	[0.0111]	[0.0153]			[0.0122]	
Consumption			0.0416***	0.0445***		0.0365***
			[0.0071]	[0.0099]		[0.0074]
Candidate	0.0130***		0.0103**		0.0129***	0.0103**
	[0.0041]		[0.0041]		[0.0041]	[0.0040]
Accessing		0.0026		0.0028	0.0028	0.0036***
		[0.0044]		[0.0023]	[0.0024]	[0.0012]
Branches	0.0151	0.0117	0.0202*	0.0177	0.0146	0.0194*
	[0.0113]	[0.0105]	[0.0116]	[0.0114]	[0.0106]	[0.0110]
Banks	0.0303***	0.0341**	0.0201***	0.0228***	0.0253**	0.0160***
	[0.0101]	[0.0135]	[0.0058]	[0.0059]	[0.0106]	[0.0053]
Constant	4.5071***	5. 8245***	4.3353***	5.2565***	4.7924***	4.7002***
	[1.2820]	[1.0591]	[0.6800]	[0.5420]	[1.2577]	[0.6707]
Observations	167	167	167	167	167	167
AR(1)	-0.91	-1.98**	0.45	-1.68*	-1.25	-0.49
AR(2)	0.12	0.90	0.75	-0.19	-0.17	0.19
Hansen Test	6.04	3.10	1.86	2.90	3.39	1.75

***, **, and * significant at 1, 5 and 10% respectively.