Macroeconomic effects of the increase of electronic retail payments – A general equilibrium approach using Hungarian data*

Tamás Ilyés – Lóránt Varga

In our study, we assess the possible impacts on the performance of the Hungarian economy if various proportions of retail cash payments were substituted with debit card payments. We conducted our analysis in the framework of a general equilibrium model, which also takes into account the costs of payment transactions in a detailed manner. The results indicate that substitution of cash payments with debit card transactions has a favourable impact on the performance and competitiveness of the economy, increases real income, real consumption, the level of GDP and the tax income of the state as well. The favourable effects increase exponentially with the degree of substitution, but are also manifest even in the case of a low level substitution, which is attainable in just a few years. According to our calculations, the favourable macroeconomic impact derives, to a smaller extent, from the transfer of resources released in the field of payment services to other sectors. A more significant impact derives from the fact that, on the one hand, substitution also improves the efficiency of resources already available in the real economy, and, on the other hand, the characteristics of the pricing of debit card services typically causes a smaller deadweight loss than the level we could register concerning the more complex cross-pricing of cash payment services. Based on our findings, on the whole we can formulate the conclusion that by supporting and accelerating the constant efficiency improvement of retail payments, economic policy is able to improve the performance and competitiveness of the entire economy, both directly and indirectly.

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1. Introduction

In the economic literature, it is a commonly held opinion that a higher ratio of electronic payment transactions indicates a more developed, more efficient payment system, i.e. contributes to the development of the economy and the increase in competitiveness. Two types of methodology are commonly used for assessing this matter. The first group contains the econometric analyses performed on cross-sectional macroeconomic data, which explore the relationship between the level of development of the payment systems of the countries and their level of general economic development. The other approach is from a micro aspect; it is based on the survey and aggregation of the individual costs, which makes the social cost of the methods of payment quantifiable. As a result, the amount of savings available through the replacement of methods of payment incurring higher social cost with methods incurring lower costs can be determined. Social cost is a concept based on net settlement, which screens out the flows of charges between actors of the payment supply chain and only takes into account the sum of own, private costs.

Research taking the cross-sectional, econometric approach demonstrates with compelling results that a more developed, more efficient system of retail payments has a positive impact on the performance of the economy. *Hasan et al.* (*2012*) assessed the correlation between the choice of payment method by residents and economic development in 27 European countries for the period between 1995 and 2009. In their panel model, they explained the logarithm of the per capita by macroeconomic variables and variables that measure the penetration of electronic means of payment (number of payment cards, bank transfer orders, direct debits, checks, use of cash). Their findings indicate that the penetration of electronic means of payment has a significantly favourable impact on GDP growth. The most powerful effect can be seen in relation to the use of payment cards. *Hasan et al*. (*2009*) used data in the panel of EU member states to analyse the relationship between the level of development of the system of retail payments and the profitability of the banking sector. Following this method, *Hasan et al.* (*2013*) presented a general analysis of the correlation of retail payments and the performance of the real economy. Based on panel data, they demonstrated that the ratio of electronic payments positively correlates with per capita GDP in the EU. According to their calculations, a 1.2% increase in card coverage increases the level of GDP by 0.07%. The most comprehensive international results on this topic are presented by *Zandi et al*. (*2013*) in an analysis of the panel data of 57 developed and emerging countries between 2008 and 2012. Their results show a very strong relationship between the penetration of purchases by bank cards and economic growth practically in each country under consideration. According to their calculations, in developed countries the increasing use of electronic payments in the period under review raised the GDP of these countries by 0.3%, and in the emerging countries this value is even higher, i.e. 0.8%. The aggregate average annual GDP growth rate of the 57

countries under consideration was 1.8% between 2008 and 2012, which would have been only 1.6% without a rise in the use of electronic payments. Therefore, the increasing penetration of electronic payments registered in recent years raised the global growth rate of GDP by almost 0.2 percentage points annually on average.

In the area of retail payments, the assessment of social costs started as early as the 2000s. The study of *Humphrey et al*. (*2003*) demonstrated that in the United States the decrease in the ratio of cash-based means of payment resulted in a significant saving of resources, estimated at 0.5% of GDP. This study also demonstrated that the high penetration of electronic means of payment in 12 European countries led to a significant decrease of banking costs (USD 32 billion, 0.38% of GDP).

This research was followed by several similar social cost surveys, typically performed on the basis of a harmonised methodology in Europe, which were collected and compared in the study of *Schmiedel et al.* (*2012*). It is the main conclusion of that study that in North European countries, where the ratio of electronic payments is higher, the social cost of retail payments constitutes a lower part of the gross domestic product than in countries which use cash and paper-based payments more intensively. It can also be observed based on the data that in countries characterised by a higher ratio of cash use, cash payment transactions typically incur lower unit costs than in countries which use electronic means of payment more intensively, as these methods of payment do have a cost advantage. This can be explained by pointing out that, to a significant degree, retail payments incur fixed costs – typically related to the installation and maintenance of the necessary infrastructure – and therefore the volume of the various means of payment significantly affects their average unit costs. However, owing to the different ratios of fixed and variable costs, an economy that uses electronic means of payment in a higher ratio is more efficient than one that is cash-oriented.

Based on the methodology of the European Central Bank, *Turján et al.* (*2010*) performed this assessment for Hungary as well at an outstanding level of details, and the robust results led them to conclude that in Hungary the current cost structure and consumer habits still lead to the cost advantage of cash both on the household and the merchant side. On the other hand, in the case of a powerful shift of payment habits towards electronic means of payment, significant savings can be achieved.

In summary, it is safe to say that in the literature we can find compelling results, on the one hand concerning the contention that savings can be realised in total social costs with a higher ratio of more efficient means of payment, and, on the other hand, that the penetration of more efficient means of payment has a favourable impact on the general performance of the economy. However, so far no one has explored the impact mechanism of how exactly and through what channels the decline in the social costs of the system of retail payments impacts the development

of the macroeconomy. Consequently, it cannot be specified exactly for any country what would be the type and the extent of the changes caused in the individual macroeconomic variables by substitution of different degrees in the methods of payment of various efficiency. The reason is that, although the relationships between the real economy and the system of retail payments has already been assessed by several studies from an econometric point of view, no comprehensive methodology has yet been created for the placement of retail payments into the framework of equilibrium theory. *Starr* (*2003*) presented how transactional costs can be interpreted in the Arrow-Debreu model framework. However, only a few examples can be found for its practical application. *Griffith-Jones* (*2012*) prepared a report for the European Commission based on the results of the QUEST III model on the impact of the financial transaction tax, while *Escudé* (*2007*) inserted transactional costs into his DSGE model calibrated for the economy of Argentina. However, these approaches do not involve retail payments in a detailed enough manner to enable the analysis of the impacts of structural changes.

In addition to looking for evidence in the case of the Hungarian economy as well for the favourable macro-economic impact of more efficient retail payments, in our article we also explore its impact mechanism. Therefore, in our research we integrate the individual technological and behavioural relationships based on micro data with the fundamental structure of the macroeconomy. In this manner, in our study we go one step beyond the issues assessed in the literature so far and look for the answer to the question of who are those actors of the economy that would realise the cost savings arising from choosing more efficient methods of payment in a higher ratio, what would be the type and volume of the impact on the major macroeconomic variables, and furthermore how this would affect the competitiveness of the country. On the one hand, a more efficient system of retail payments can manage payments with fewer resources; therefore these resources can be utilised in other sectors. In parallel with that, the remaining resources can generate higher added value. In our study, we intend to quantify these impacts.

In our analysis, we narrow down the subject of the research to the macroeconomic impact of substitution of retail cash payment transactions with debit card payments. We justify our choice by pointing out that in the ratio of card payments, Hungary is still significantly behind the average of the European Union, but the number and value of these payments is growing dynamically, and therefore the structure of payment habits in this area may improve significantly even in the foreseeable future. When switching between these two methods of payment, we only assess retail payments made by households (which comprise the overwhelming majority numerically anyway).

In the following part, as the first step, we present the methodology of our research. We describe the baseline scenario providing the start point of the analysis in the

third section of the article, i.e. the current usage ratios and cost structures of the payment methods applied in retail payments and our various assumptions applied to the substitution between the methods of payment. The fourth section contains the results of our calculations on the changes occurring in total social costs and the fifth section is on the macroeconomic impacts concerning the individual assumptions of substitution. We end the article by formulating our conclusions.

2. Methodology

In accordance with our research question, we assess the economic impacts of substitution between methods of payment (to be totally precise, between retail cash and debit card payments). The first step in this is the estimation of the attainable social cost savings. However, the decrease in the social costs of the payment system is not the ultimate economic impact. The calculation based on the changes in the social costs of methods of payment does not answer the question of what will happen to the released resources, how will the pricing practices of the actors in the supply chain of retail payments change, with special regard to cross-pricing between methods of payment, and furthermore to what extent the savings will ultimately improve the competitiveness of the economy and increase the ultimate consumption options.

In order to answer these questions, however, we must screen out several impacts which could influence the final result, but which are not directly related to the choice between methods of payment, the first being the impact of the increase of turnover. In recent years, both the cash stock in the economy and electronic means of payment have been growing dynamically. Even though the increasing volume reduces unit costs, to an extent that varies according to the method of payment, the cost of the entire system increases when more payment transactions need to be managed. This does not mean a deterioration in the competitiveness of the economy, a payment system expanding to a larger extent than the growth rate of the economy is a natural process in countries catching up in financial culture. To screen out this effect, in our study in each case we performed our calculations using the existing volume and value data of retail payments (observed in 2015) and only change the ratio between cash and debit card transactions within retail payments. Owing to this, the demonstrated macroeconomic and competitiveness impact can be considered entirely a result of substitution between methods of payment.

In addition, we disregard any impacts which are not directly manifest in the cost or fee structure of the actors under assessment. For example, an increase in the ratio of electronic retail payments is usually accompanied by a decrease in the ratio of the shadow economy, which could further strengthen the favourable macroeconomic impacts of substitution between methods of payment. However, quantifying this is very difficult and is not the topic of our study.

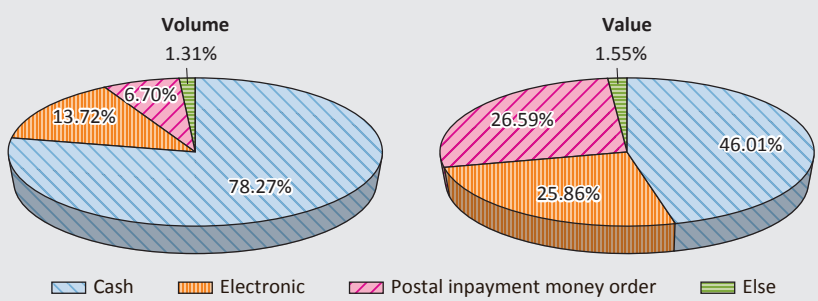
By contrast, we include in our analysis those pricing methods which are not based on prime cost, such as cross-pricing, oligopolistic pricing, and a change in the structure of the economy, i.e. a rearrangement of resources among different technologies of production, in order to provide a more accurate picture of the channels and impact mechanisms through which changes in payment habits may contribute to improving the performance and competitiveness of the economy.

Based on the above considerations, using the data on the number and value of current retail payment transactions and assuming different cash and debit card payment ratios, we first quantify the social cost savings attainable given the individual assumptions. Subsequently, using a general equilibrium model which also takes into account the costs of payment transactions, we estimate the anticipated impacts of these social cost savings on the macroeconomy and competitiveness, and furthermore, we present those channels and impact mechanisms through which these impacts are realised. For these latter assessments, we use the static general equilibrium HUPS model presented by *Ilyés–Varga* (*2015a*) and calibrated for the Hungarian system of retail payments and economy, with minor adjustments.

3. Assessment of the current situation and our assumptions applied for substitution between methods of payment

In a European comparison, the Hungarian economy is fundamentally cash-oriented. Based on *Ilyés–Varga* (*2015b*), at present the ratio of purchases with payment cards is currently relatively low in terms of volume and value (*Figure 1*), even though payment account and debit card coverage is relatively high, at 75 and 71 per cent, respectively. Owing to this, from the aspect of the entire society, there is still room for development in the use of more efficient methods of payment. However, in recent years card usage has grown strongly, in a double-digit rate, even in years when the number of accounts decreased.

Figure 1
Distribution of households' monthly payment transactions by method of payment



Source: Ilyés–Varga (2015b)

Based on the study of *Turján et al*., as a result of the intensity of use, cash has a significant average cost advantage compared to payment by debit card (*Table 1*). In fact, our estimations based on data of 2009 show that, in terms of volume, the Hungarian household sector made its payments in cash to an extent exceeding 90% in retail transactions. As a result, the average cost of payments by debit card is almost 3 times as high as that of cash transactions. Concerning purchases by credit card, this difference is more than tenfold. However, the ratio of variable costs is much lower in the case of electronic payments. For this reason, if the ratio of payments by payment cards significantly increased compared to cash transactions, substantial savings could be accomplished in the costs of the entire society.

Table 1
Cost structure in Hungary in 2009

	Cash	Debit card	Electronic transfer	Direct debit	Postal inpayment money order	Paper-based credit transfer	Credit card
Fixed (%)	33.50	62.30	52.50	63.20	17.00	8.60	73.90
Variable (%)	66.50	37.70	47.50	36.80	83.00	91.40	26.10
Total (billion HUF)	208.82	30.22	40.07	7.73	38.96	35.01	19.56
Volume (million units)	2,835	150	230	77	271	47	25
Specific cost (HUF)	73.66	201.13	174.22	100.39	143.76	744.89	796.09

Source: Turján et al. (2010)

In our article, we assess the economic impacts of substitution between methods of payment compared to the above initial situation. Therefore, as the baseline scenario, we use the cash-to-card ratio characteristic of retail payments, calculated according to the retail transaction figures for the year 2015. According to the available data and our estimations, in these categories at present and on average, in the retail sector 89% of turnover is paid for in cash and 11% by bank cards. Based on the values, the ratio of cash is somewhat lower, since in the case of transactions with higher values the customers use bank cards for payment in a ratio higher than the average. Naturally, in retail purchases and especially in other retail payments, such as the payment of invoices, we also register other methods of payment with lower turnover, such as bank transfer or direct debit. When we discuss in this article the turnover of retail payments, this excludes the turnover handled by these other methods of payment, since we include these with the same quantity and with the same value in our model in the case of every assumption of substitution. In other words, these are also included in our calculations, but we only assume substitution between transactions made in cash on the one hand and by debit cards on the other hand.

Table 2
Our assumptions on the substitution of methods of payment

	Description	Ratio of card usage within retail payments (by volume)
Baseline scenario	The ratio of payments made by debit cards within retail payments registered in 2015	11%
Low level of substitution	The ratio expected to be accomplished in Hungary according to the forecasts	25%
Medium level of substitution	Average ratio registered in the European Union in 2015	50%
Significant level of substitution	**The reverse of the existing situation, which means an outstanding level of card use**	**89%**

Compared to the baseline scenario, in our analysis we assess the macroeconomic impacts of three substitutions of different levels (*Table 2*). First, we assume a payment structure that seems attainable even in the relatively short term: we selected this as the expected ratio by 2020 of retail debit card payments, based on the projection of the current trends. As a result of the dynamic, double-digit annual growth in the number and value of purchases by payment cards, a significant shift is expected even over this short time horizon, although payments in cash also show an increasing trend. According to our estimation based on the projection of the trends, in 2020 the ratio of the number of retail card payments could reach 25 per cent. Therefore, our first assumption is that compared to the current situation we substitute cash payments, constituting 14 per cent of all retail payments, with debit card payments. In accordance with the methodological considerations, we emphasise that the projection applies to the ratios expected in 2020, with the volumes and turnover values registered in 2015.

In our second assumption, we presume the substitution of cash payments at a medium level in total. In this assumption, as a point of reference we define the accomplishment of the ratio of card payments that is currently registered on average in the retail sector in the European Union. Since we have no statistics that would enable us to determine this ratio clearly, we have made the estimation using the data of EU countries on average cash stock to GDP and the number of per capita transactions paid with payment cards. Based on these, concerning Hungarian retail turnover, retail payments reaching the EU level of efficiency would mean electronic payments reaching an extent of almost 50 per cent, and in terms of value as much as two-third of all purchases would be paid for by card.

In the third case, we expect the highest level of substitution, which could even be considered extreme, assuming that the current usage ratios of methods of retail

payments are reversed, i.e. the ratio of payments with cards would be close to 90 per cent. Currently, this ratio only exists in the most developed countries with the highest level of electronic retail payments, e.g. the Netherlands and Sweden.

4. Impacts of substitution between methods of payment on social costs

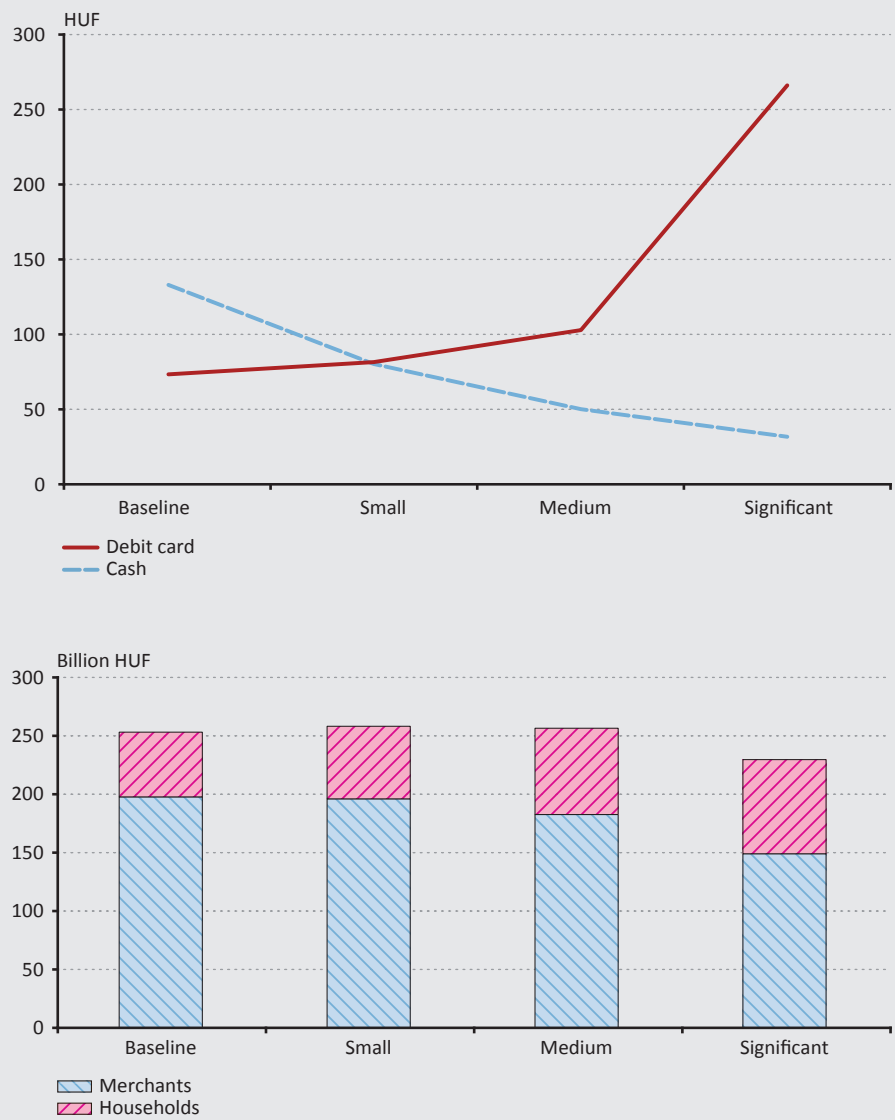
The assessment of the impacts of switches between methods of payment is based on the calculation of social costs. By social cost, we mean the entire costs of the supply chain of retail payments, excluding the fees paid by actors of the supply chain to each other. According to the calculations of *Turján et al*. (*2010*), based on data from 2009, the size of the system of retail payments can be estimated at 1.09% of GDP, based on the social costs spent on it. This method of calculation contains the costs incurred by all the actors themselves, e.g. the household sector, businesses and payment providers, and the costs of the resources necessary for operation of the system. It is important to emphasise at this point already that owing to its nature, the calculation of social costs is a partial analysis: for example, it does not further break down intermediate consumption or the part assigned to retail payments from the tax burdens of the affected actors.

As the first step, we supplemented the basic ideas of the survey underlying the cited study with the trends seen in the last five years. The data of the study, which can be considered as preliminary to our research, apply to the year 2009, and therefore they need a certain degree of adjustment to enable the analysis to be conducted. We adjusted the costs of the actors by inflation for 2015, modified the payment of fees according to the data registered in the meantime relating to the fees applied by payment providers, and thus they already reflect the situation following the introduction of the transaction tax and free cash withdrawal. By contrast, we disregarded certain cost factors surveyed in the cited study, according to the methodology of *Ilyés–Varga* (*2015a*), for example, the different time needs of the use of the various methods of payment.

Based on the partial analysis, it can be stated that the average unit cost of payment by debit card can be reduced to the level of cash even with a lower level of substitution of methods of payment (*Figure 2*). In the case of a medium level of substitution, payment by debit card already enjoys a significant cost advantage compared to payment in cash, and with a significant level of substitution this difference increases drastically.

However, the turning point in the full social average costs of methods of payment does not necessarily equal the level of substitution at which the costs perceived by the actors are reversed. If we break down the costs to merchants and residents, it can be seen that from the total social costs (which already show a decrease in the case of a significant level of substitution) the ratio of the part assigned to residents

Figure 2
Impact of substitution on unit cost and social cost

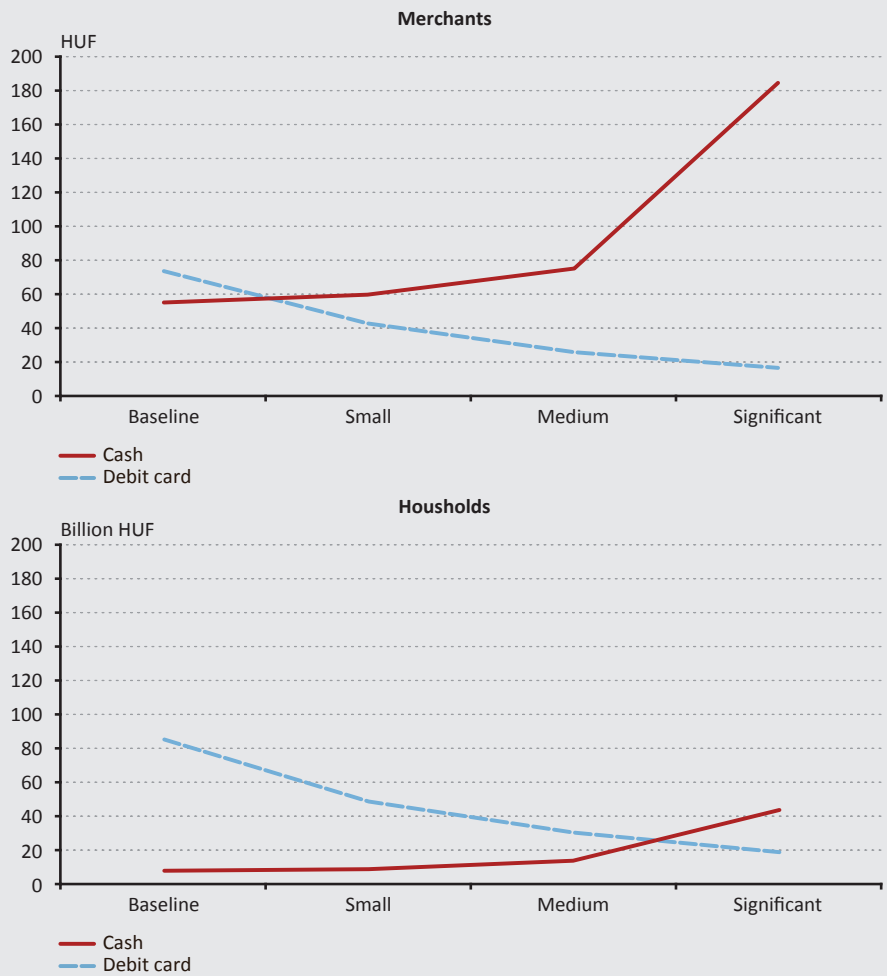


Source: authors' own calculations and the supplemented, adjusted data of Turján et al. (2010)

rises gradually (*Figure 2*). The reason is that in the case of payments by debit card residents directly bear the costs in a higher ratio. On the other hand, the costs of cash payments are incurred indirectly among the costs of merchants and payment providers.

If we consider the unit costs, a difference is registered among the actors of the economy (*Figure 3*). While on the side of merchants accepting card payments the sequence is reversed even in the case of a low level of substitution of methods of payment, the cost advantage of cash only disappears if there is a significant level of

Figure 3
Unit costs of merchants and residents in the case of card use and cash



Source: authors' own calculations and the supplemented, adjusted data of Turján et al. (2010)

substitution. The main reason for that is free cash withdrawal and the transaction tax. However, both of these are individual effects and do not appear among social costs.

In summary, it can be determined from the analysis that in the case of a major structural change in retail payment habits, compared to the current state, the costs of the supply chain of payment services can be reduced by HUF 20–25 billion annually, while among methods of payment it grows slightly simultaneously with low and medium levels of substitution (*Figure 2*). However, it can also be observed that the changes in social costs are manifest at the level of the individual actors in different measures and on different courses. In addition, as mentioned, the calculation of social cost savings is a partial analysis, which considers the external actors as static and also disregards the flow of charges between actors. By contrast, experience shows that various actors incorporate payment charges into their decisions in different ways, and intermediary service providers apply a significant degree of cross-pricing and oligopolistic pricing. External actors are not static either, and from the aspect of the central budget the tax implications of the various payment methods differ significantly, and it is not necessarily simple for the resource markets to convert the costs. The costs of tied-up capital constitute a significant portion of the costs of electronic means of payment, such as purchases by debit card, while in respect of cash payments the labour costs of manual processing are more significant. In addition, the efficiency of the resources tied up in retail payments may be different than observed in other sectors of the economy. These impacts are not independent of each other and in several cases they may even be opposing, and because of this a partial analysis based on the changes in social costs may lead to inaccurate results.

Owing to these reasons, we extended our analysis into a general equilibrium theory framework, where we were able to include all the characteristics of the system of retail payments which are significant for the purposes of the analysis, and using a logic of equilibrium theory based on the balance of the usual relations between branches, we also present the bases of the decisions of the real sector and the household sector.

5. Macroeconomic impacts of substitution between methods of payment

In this study, we apply the HUPS model presented by *Ilyés–Varga* (*2015a*), calibrated to the Hungarian system of retail payments and the economy, and slightly adjusted to the question raised by the research. HUPS is a static quantified general model of equilibrium theory, in which the various actors take into account the costs of the completion of the transactions when making their decisions concerning the real economy. The model contains two groups of the corporate sector, these are branches of the real economy and actors of the supply chain of payment services. Owing to space limitations, we only present the most important behavioural equations and relations of the HUPS model. The cited study contains a detailed description of the structure, activations and variables of the model as well as the data sources and the modes of calibration.

Of the 15 branches distinguished by the model, each is represented by a representative agent. The representative actor maximises its profit, while taking into account that the acquisition of intermediate consumption and resources also has implications in terms of retail payments. The target function of the company is the following:

$$\pi_i^p = p_i \cdot Y_i - w \cdot L_i^D - \sum_j^I p_i \cdot X_i^j - p_m \cdot M_i - \sum_m^M \varphi_m \cdot PS_{mi}^D - \sum_m^M \varphi_m \cdot PS_{mi}^{Dv} - NTX_i \qquad (1)$$

where p is the price, *Y* is the level of production, *L* is the amount of labour force, *K* is the amount of capital, *X* is interim use, *M* is import, *PSD* and *PSDv* are the volume and value of the payment services used, φ_m is the fee of payment services and *NTX* is the net tax burden.

Companies need to deal with the following constraints:

The tax burden of the company is the sum of the value added tax (*VAT*), the taxes on capital (*TXK*), on labour (*TXL*) and on production (*TXY*):

$$VAT \cdot \left(p_i \cdot Y_i - \sum_j^i p_j \cdot X_i^j - p_m \cdot M_i \right) + r \cdot K_i^D \cdot TXK + TXL \cdot w \cdot L_i^D + OTX_i + TXY \cdot p_i \cdot Y_i = NTX_i \quad (2)$$

The technology of the representative company is the composition of CES functions and the Leontief production functions:

$$Y_i = \min\left(\left(AL_i^y \cdot L_i^{Dyc^{-\sigma i}} + AK_i^y \cdot K_i^{Dyv^{-\sigma i}} \right)^{-\frac{1}{\sigma_i}}, \ldots, A_x^i \cdot X_i^y, \ldots A_m \cdot M^y \right) \qquad (3)$$

The actors use *m* different payment methods for the purpose of performing their activities in the real economy. Companies may also use several methods of payment (e.g. bank transfer, payment in cash, etc.) for their activities in the real economy (e.g. sale of goods, payment of suppliers, payment of wages, payment of taxes, etc.). The *fm* parameter shows the ratio of the individual methods of payment in the value and number of payments related to various activities in the real economy:

$$f_Y^{im} \cdot p_i \cdot Y_i + \sum_j^J f_{xj}^{im} \cdot p_j \cdot X_i^j + f_L^{im} \cdot w \cdot L_i^D + f_K^{im} \cdot r \cdot K_i^D + f_M^{im} \cdot p_m \cdot M_i + f_T^{im} \cdot NTX_i + PSFIX_v^{im} = PM_{mi}^v \qquad (4)$$

$$f_Y^{im} \cdot \theta_Y^{im} \cdot Y_i + \sum_j^J f_{xj}^{im} \cdot \theta_{Xj}^{im} \cdot X_i^j + f_L^{im} \cdot \theta_L^{im} \cdot L_i^D + f_K^{im} \cdot \theta_K^{im} \cdot K_i^D + f_M^{im} \cdot \theta_M^{im} \cdot M_i + PSFIX^{im} = PM_{mi} \qquad (5)$$

Where PM_m and PM_m^v are the number of items and total value necessary of the individual methods of payment for the given company, *PSFIX* is the volume of retail transaction not explained by the model, and *qm* is a parameter of projection, which shows how many payment transactions of the given method of payment belong to

the real value of the individual transactions in the real economy. The solution of the pricing problem, if λ_g^4 is the shadow price of payment services, λ_g^5 is the shadow price of the value of payment services and λ^8 is the shadow cost of taxation:

$$p_i = \sum_j p_j^T a_j^i + w_i^T \cdot \frac{L_i^{Dy}}{Y_i} + r_i^T \cdot \frac{K_i^{Dy}}{Y_i} + p_m^T \cdot a_{mi} + \sum_g^k \lambda_g^4 \cdot \left(f_Y^{ig} \cdot \theta_Y^{ig} + \sum_i^n f_{xi}^{ig} \cdot \theta_{Xi}^{ig} \cdot a_j^i \right) + \sum_g^k \lambda_g^5 \cdot \left(f_Y^{ig} \cdot p_i + \sum_i^n f_{xi}^{ig} \cdot a_j^i \cdot p_i \right) + \lambda^8 \cdot VAT \cdot \left(p_i - \sum_i^n p_i a_j^i \right) + \lambda^8 \cdot TXY \cdot p_i \quad (6)$$

When making an optimal decision, the actor of the branch will supplement the usual pricing formula with the marginal cost of transaction completion, by which it can translate all interim uses and primary resources into the full price. That way, the cost decrease or increase is directly incorporated in the price of the product, and the price of primary resources reflects their entire marginal profit.

The payment service providers (PSP) produce services related to retail payments using the products of the same branches, the primary resources and the services of other service providers. Their decision function is basically the oligopolistic and cross-pricing of their full prime costs received based on profit maximisation.

The profit function of payment providers is the following:

$$\pi^{psp} = \sum_{m \in psp}^{M} \left(\varphi_m \cdot PS_m^{St} + \varphi_m^v \cdot PS_m^{Sv} \right) - w \cdot L_{psp}^D - r \cdot K_{psp}^D - NTX_{psp} - \sum_j^J p_i \cdot X_i^{psp} - \sum_m^M \left(\varphi_m \cdot PS_m^{Dt} + \varphi_m^v \cdot PS_m^{Dv} \right) \quad (7)$$

where PS^{St} and PS^{Sv} mean the volume and value of the supply of payment services. Based on their pricing functions, payment service providers allocate their fixed costs to their direct cost (*DC*), to obtain the final price using an oligopolistic mark-up profit rate and a cross-pricing rate:

$$\varphi_m^g = \left(1 + markup^{psp} + cross_m^{pspg} \right) \cdot \frac{\left(DC_m^g + \omega_{pspm}^{fg} \cdot \left(r_{psp}^T \cdot K_{pspm}^{Dfg} + w_{psp}^T \cdot L_{pspm}^{Dfg} \right) \right)}{PS_m^{Sg}} \quad (8)$$

where *w* is the rate of distribution of indirect costs. The oligopolistic mark-up adjusts the profit expectations that are different than the full profitability of the actors by product. The cross-pricing rate has been estimated based on empirical experiences, the revenues of the bank and pricing practices. Fundamentally, it consists of three parts: increasing factors for the purpose of maintaining the entire profitability of the bank, direct reallocations between services, primarily between volume and value, or even the inclusion of the costs of purchases made with payment cards in the annual card fee, and finally, the direct passing on of the individual tax impacts.

In several cases, the calculated price differs from prime costs significantly, and therefore concerning the entire economy the rest of the actors making rational decisions will make suboptimal decisions. The resultant deterioration of efficiency can be directly measured in deadweight loss.

The state actor operates on the basis of the pay-as-you-go logic, its expenses (G_E) follow the revenues (G_R):

$$G_R = G_E \tag{9}$$

Its revenues are the profit of state-owned companies, net prices and the deficit of the budget, its expenses are community consumption, social transfers and the costs of the payment services used:

$$G_R = NTX_G + D_G + \pi^G \tag{10}$$

$$G_E = C_G^D + TR_G + DP_G \tag{11}$$

For the state operator, the completion of payments is exogenous for the decision.

The household representative actor is an entity that maximises its profit, in which it takes into account the costs of the completion of payments.

$$U(C_i) = \left(A_1 \cdot C_1^{-\beta_h} + \cdots + A_j \cdot C_J^{-\beta_h}\right)^{-\frac{1}{\beta_h}} \tag{12}$$

Its budgetary constraint is the identical amount of consumption, costs of payment services, and net taxes, along with capital income, labour income and transfers.

$$\sum_i^J p_i \cdot C_i + \sum_m^M \left(\varphi_m \cdot PS_{mh}^D + \varphi_m^v \cdot PS_{mh}^{Dv}\right) + NTX_h = r \cdot K^S + w \cdot L^S + \pi^h + OTX_h \tag{13}$$

$$C = \sum_i^J p_i \cdot C_i \tag{14}$$

The supply of resources of the various sectors is fixed. The model distinguishes three primary resources, capital, labour and import:

$$C = \sum_i^J p_i \cdot C_i \tag{15}$$

$$L^S = L_0^S - \sum_m^M L_{mh}^D \tag{16}$$

$$M^S = M_0^S \tag{17}$$

In order to present the impacts accurately, HUPS also has an income distribution module based on the system of integrated national accounts and following the logic of the social settlement matrices. Accordingly, some of the capital incomes go abroad, the state actor creates social transfers from taxes, and we also take into account the income transferred home from abroad. Social settlement is static, it operates calibrated to the ratios of the year 2014.

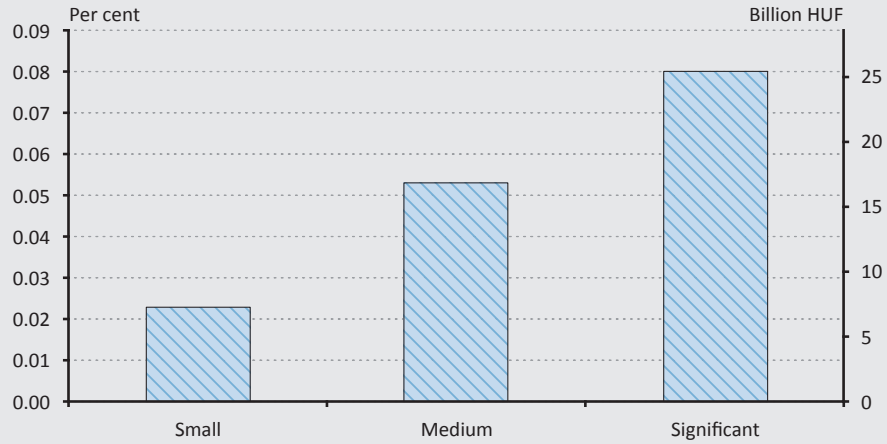
In our research, we calibrated the model applied to the macroeconomic data for the year 2014. The reason is that the detailed national account data for 2015 were not yet fully available at the time the article was written, and therefore estimations would have been necessary in many respects. The retail transaction data used for calibration are taken from 2015. The model slightly differs from the one presented by *Ilyés–Varga* (*2015a*), in that we primarily changed the structure of methods of payment. We detached the credit card function costs from the costs of transactions with payment cards taken into account in the study. The reason is that in accordance with the question raised in our article we considered the debit card as the primary electronic substitute of cash use in retail turnover. For this reason, the payment cards included in the model only mean cards with debit function, the costs of the credit function are represented among other methods of payment in the model in this article.

In the model calculations, we modified the ratio between cash and card transactions by the household sector according to the assumptions presented in Section 3 of the article, leaving everything else unchanged in the model. The results thus obtained were more accurate than the partial analysis in Section 4 of the article, since the level of detail of the applied model makes it possible to distinguish the transactions performed by the individual sectors on the one hand, and, on the other hand, we can also assess the indirect economic impacts of changes in retail payments, thanks to the general equilibrium approach.

Figure 4 contains the aggregate results of the calculations. Since the HUPS model is quasi-price-homogeneous, the price level is fixed. The selected benchmark is the implicit GDP deflator; therefore, each change in GDP corresponds to a volume change in the statistical sense. The available resources are fixed, which means that GDP is an aggregate unit of measurement of the entire productivity of the system. It is clear from the chart that the impact predicted by the model is positive even at a low level ratio of substitution, even though based on the partial results of Section 4 the social costs of retail payments still increase slightly in this case.

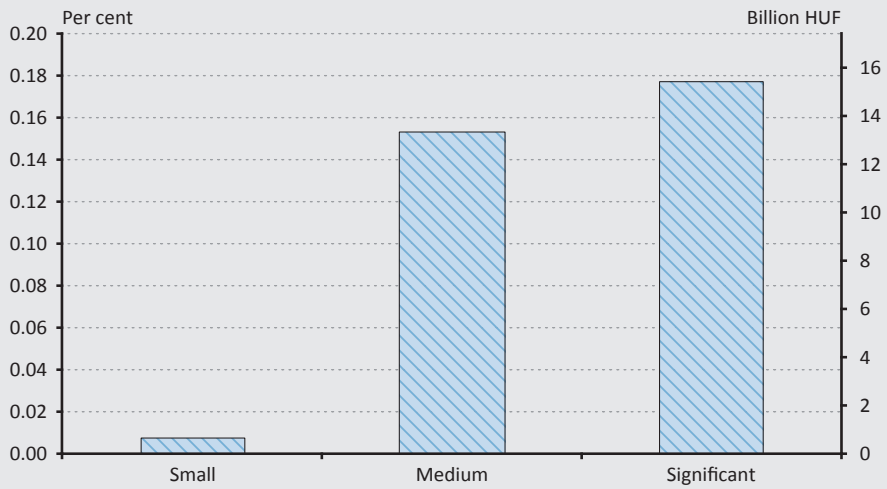
The cause of the difference is that the HUPS model framework is capable of quantifying significantly more impacts than the calculation of social cost savings. As a general efficiency indicator, the incremental real GDP summarises every such element. The U form still exists, but the incremental turning point is shifted forwards. In order to accurately understand the macroeconomic impacts, we can trace back the effects step by step to the original assumptions.

Figure 4
Impact of the various scenarios on real GDP
(departure from the baseline scenario of the model)



Source: calculations using the adjusted HUPS model

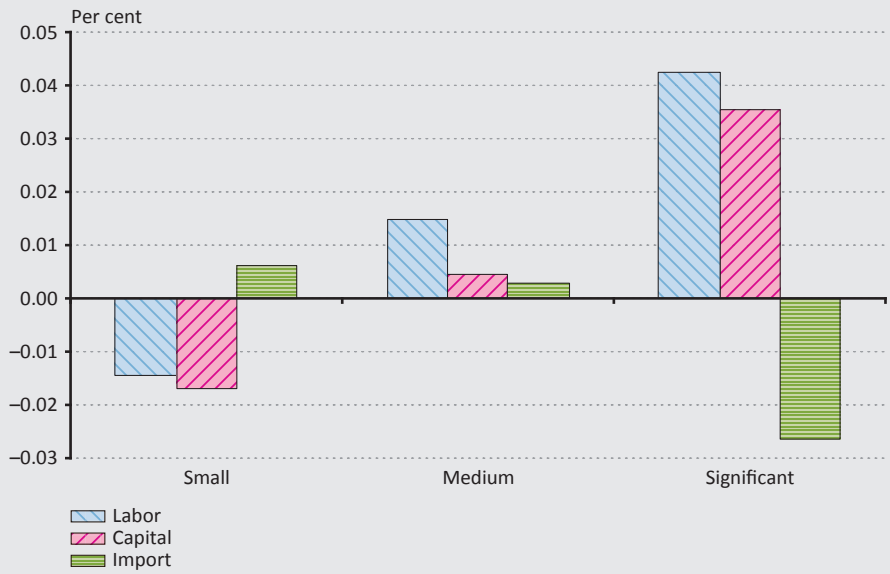
Figure 5
Development of household real consumption in the various scenarios
(departure from the baseline scenario of the model, a volume index weighted by base)



Source: calculations using the adjusted HUPS model

The surplus production deriving from substitution between methods of payment is registered in two places; first, in the increase in consumption of the household sector (*Figure 5*). Since the system adjusts the price level, the incremental consumption derives from incremental income. The increment is nominally lower than the entire GDP increment, since other sectors also receive their share of the increased efficiency.

Figure 6
Development of real incomes in the various areas
(departure from the baseline scenario of the model)



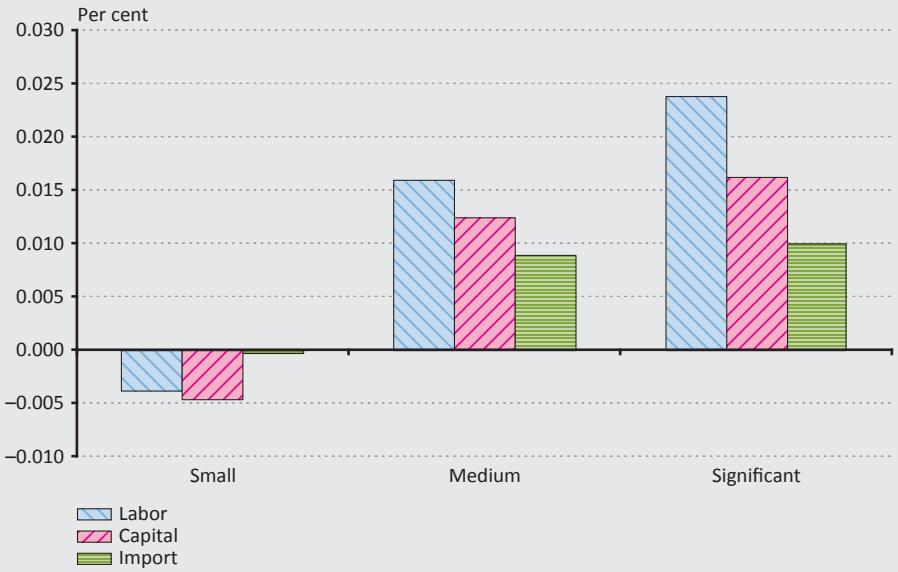
Source: calculations using the adjusted HUPS model

The scenario of real income is significantly different than the scenario of the consumption of the household sector (*Figure 6*). There are two reasons for this. On the one hand, the model analyses the relationships between the various income categories and social transfers following the practice of the Social Accounting Matrices (SAM). Accordingly, a significant portion of capital incomes go abroad, while the income of the household sector is increased by benefits paid by the state. The other cause is the different scenarios of the three different primary resources. The course of labour and capital is led by the usual U form, while imports are significantly affected by the fact that the ratio of activities involving different import ratios changes in the various scenarios.

The increase in real income is caused, on the one hand, by the indirect efficiency improvement of the resources. Businesses are able to pay higher wages and dividends, because production becomes more efficient in general. Since after the substitution payments can be managed at lower per-unit costs, businesses achieve higher resource efficiency, for the most part through the mediation of the commercial branch that sells the produced goods to the household sector. On the other hand, it increases real income as a direct impact that resources that are removed from retail payments are added to the real sector and expand production.

However, the re-allocated resources only expand the activities of the real sector to an extent lower than their previous efficiency (*Figure 7*). The efficiency of the primary resources applied in the model is typically higher in the sector of financial

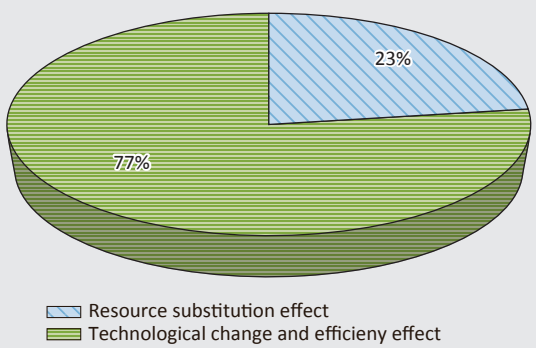
Figure 7
Resources in the production of the real sector
(departure from the baseline scenario of the model)



Source: calculations using the adjusted HUPS model

activities, to which retail payments belong, as compared to the remaining part of the economy. This difference is quite significant in the case of capital efficiency. We can partially break down the impact of substitution on economic growth, based on the usual growth accounting. By allocating the GDP growth according to the CES functions generally applied in the model we can make the statement that for the

Figure 8
Breakdown of GDP growth as a result of efficiency improvement and expansion of resources



Source: calculations using the adjusted HUPS model

larger part growth may be associated with the increase in the efficiency of resources already existing in the real sector, and not with the reallocation of the resources released in the field of payment services (*Figure 8*).

Based on the results of our model calculations, substitution between methods of payment ultimately improves the competitiveness of the economy through three channels. The classic, direct channel is the utilisation of resources drawn from payment transactions in the real sector. This channel can be partially analysed through savings on social costs. However, the model-based analysis shows that in our case this channel is less significant, since the efficiency of several sectors typically falls behind that of payment services; therefore the impact is lower than the full nominal volume of savings. The second channel is the general efficiency improvement of the resources, accomplished by more efficient payment services, manifested for the most part through the mediation of the commercial sector. Therefore, substitution between methods of payment also improves the efficiency of resources already existing in the real sector. Since HUPS is a disaggregated model, the impact is manifest in a way typical of the input-output models.

The third channel is a structural change in the economy that does not directly affect production technologies. In the modelled economy, deadweight loss may occur as a result of a pricing system that is not entirely prime cost-based and based on the system of taxation. The HUPS model follows the pricing practice and the regulations applying to the activity, and therefore the market of various methods of payment is detached from their actual costs. The cross-pricing of the methods of payment was already demonstrated by the study of *Turján et al.* (*2010*), as was the fact that the extent of cross-pricing is quite significant in cash transactions and paper-based bank transfers. In recent years, in addition to this several regulatory changes have been implemented that further increased the difference. By contrast, in payments by card on the retail side the typical arrangement is costs charged on the annual card fee, which have been partly incorporated into the decisions of the consumers, and on the corporate side cross-pricing decreased as a result of the regulation of interbank commissions. Based on the detailed results of the model, the impact can be led all the way, the prime cost – shadow price – of payment services is significantly different than the market price in several cases, which runs all the way through the supply chain. Since the corporate actors apply the full price in their decisions on resource demands, and it is not characteristic of the actual cost, they make suboptimal decisions concerning the entire economy. They consume more than the optimal level of resources that utilise more intensively the method of payment with a reduced price through cross-pricing. For this reason, in accordance with the theoretical models, a deadweight loss occurs in the economy. Concerning the impact on the taxation system, following a similar logic, the structural change of substitution between the products with different tax burdens on the one hand and

the resources on the other hand modifies the deadweight loss. The results of the model also lead to the conclusion that the pricing of cash payments and the related tax burden is more distorted than in the case of transactions with debit cards, and therefore the substitution presumptions examined by us have a favourable impact on the performance of the economy through this channel as well.

In summary, it is safe to say that the savings calculated in the social cost calculation are realised directly to a lower extent as incremental production, since payment transactions typically have more added value per one resource unit than the rest of the sectors. However, indirect effects cannot be neglected, and in the case of changes in payment habits a switch between various, non-prime-cost-based methods of pricing (a shift towards pricing with less distorting effect) and other channels of economic effects also contribute to a significant extent to the improvement of the entire competitiveness of the economy.

6. Conclusions

In our study we analysed the question of how and to what extent substitution between methods of payment contributes to the performance and competitiveness of the economy. To this end, we assessed the substitution impacts between retail cash and debit card payment transactions in the case of the Hungarian economy. In our research, we first assessed the cost situation of the methods of payment under examination and demonstrated that, despite the constant increase in electronic payments, concerning average costs cash transactions still have an advantage. This advantage can be observed at every economic agent (payee, merchant) individually as well. As the first step for surveying the economic impact of substitution, we analysed the structure of the social costs of the two payment methods.

Using the social cost data of retail payments for 2010, adjusted and calibrated to the situation in 2015, we assessed the impacts of three different levels of substitution compared to the baseline scenario, i.e. in comparison to the ratio of card payments of 11 per cent currently registered in retail payments. We defined our assumptions on the extent of the substitution in such a manner that, with the small level of substitution, according to the projection of the current trends, we should recah the ratio of payment by card which is attainable within a few years in the retail sector (25%), in the case of medium-level substitution we should accomplish the current average rate of payment by cards in the European Union (50%), while in the case of a significant level of substitution we should get the reverse of the ratio of the baseline scenario (almost 90%). This latter figure can be considered an extremely high level of card use, which currently only a few European countries with the most developed payment system approach at best.

Based on our partial analysis, we demonstrated that by increasing the ratio of card use actual cost savings are attainable both at the level of society and at the individual level of actors in the economy. The process, however, is not linear. Owing to the different structures of cash and debit card transactions, at a small level of substitution the total cost for society rises temporarily; however, after the turning point it is possible to accomplish exponentially increasing actual savings with an increase in the level of substitution. Since social cost calculation in itself is not capable of quantifying the impact on the macroeconomy and on competitiveness, we were unable to gauge the utilisation of savings by this method. In addition, we were also not able to assess the impacts of complicated cross-pricing, changes in taxes, oligopolistic pricing and changes in the structure of technology. For this reason we extended our analysis and estimated the anticipated macroeconomic impacts of the previously identified social cost savings using a static general equilibrium model which takes into account the costs of payment transactions in detail as well and is calibrated to the Hungarian payment system and economy.

The applied model is capable of quantifying all of the impacts listed above and directly estimating their combined effect. Our results showed that the substitution of cash payments with transactions by debit cards has a favourable impact on the performance and competitiveness of the economy, increases real income, real consumption and the level of GDP, and also has a favourable impact on the tax income of the state. We also demonstrated that in contrast to the turning point in the average unit costs of the methods of payment under examination, the impact on total productivity can be registered even in the short term, including the case when we assume a low level of substitution of methods of payment. The reason is that the general equilibrium theory approach summarises impacts realised through multiple channels. On the one hand, the resources released in the field of payment services are utilised in the real economy, but only at a lower level of productivity than earlier, since the resource efficiency of the real economy is typically lower than that of the financial sector. However, the indirect effects of substitution between methods of payment also improve the performance of the economy. Owing to the increase in the ratio of electronic means of payment, the handling of payments becomes more efficient for every economic actor, and thus the companies' own technology improves, which also improves the efficiency of their existing resources as a multiplier effect. In addition, the substitution of the methods of payment presented in our article also has a favourable impact on the economy owing to the different level of cross-pricing of cash and debit card transactions. The reason is that according to our model calculations the pricing of debit card transactions causes a lower level of deadweight loss than more significant and more complex cross-pricing related to payments in cash.

Therefore, the savings identified in social cost calculation are realised directly to a lower extent as incremental production, since payment transactions typically have more added value per one resource unit than the rest of the sectors. However, indirect effects cannot be neglected, in the case of a change in payment habits a shift towards a less distorting manner of pricing and other indirect channels of the economy also substantially strengthen the favourable macroeconomic impacts. Based on our findings, in total we can formulate the conclusion that by promoting and accelerating the constant efficiency improvement of retail payments, economic policy is able to improve the performance and competitiveness of the entire economic system both directly and indirectly.

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