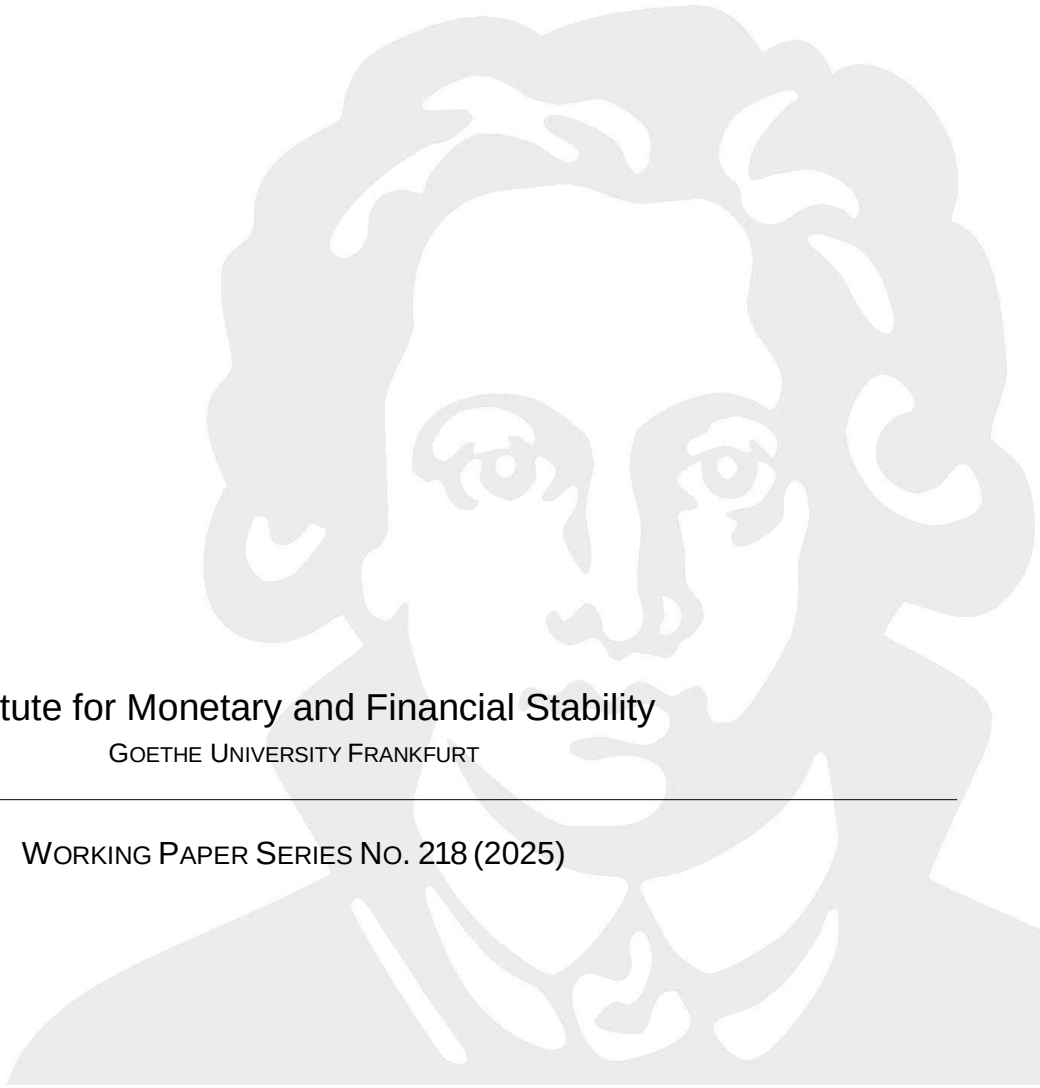
Malte Krueger & Franz Seitz

Costs of Means of Payment for Consumers:

Literature review and some sensitivity analyses



Institute for Monetary and Financial Stability

GOETHE UNIVERSITY FRANKFURT

WORKING PAPER SERIES NO. 218 (2025)

Institute for Monetary and Financial Stability
Goethe University Frankfurt
House of Finance
Theodor-W.-Adorno-Platz 3
D-60629 Frankfurt am Main
www.imfs-frankfurt.de | info@imfs-frankfurt.de

Costs of Means of Payment for Consumers: Literature review and some sensitivity analyses*

Malte Krueger[§] & Franz Seitz[#]

§) Technische Hochschule Aschaffenburg
Würzburger Str. 45
D-63743 Aschaffenburg
Germany
malte.krueger@th-ab.de

#) Weiden Technical University of Applied Sciences
Hetzenrichter Weg 15
D-92637 Weiden
Germany
f.seitz@oth-aw.de

March 2025

Abstract
Payment costs for consumers are difficult to determine, are not recorded in an internationally harmonized manner and vary significantly from country to country. They are incurred in many forms, for example as fees for account management, for cash withdrawals at ATMs or for payment cards; but also as financial damage in the event of loss or fraud. On the other hand, this also includes time costs, e.g. for cash withdrawals or the payment process, and costs of data disclosure. To determine the total costs and for international comparisons, different key figures are calculated, such as the cost per transaction, as a percentage of the transaction value or relative to GDP. After clarifying the concept of costs, the focus of our paper is on a critical review of the literature on cost studies at the consumer level. In particular, the results of existing work are compared, the most important cost categories are identified and sensitivity analyses are carried out. We find some key cost drivers and show how the results are driven by key assumptions.

Keywords: cash, debit card, credit card, costs, consumer

JEL: D12, E41, E42

* We thank S. Hardt, F. Knümann, R. Rotzler, M. Uhl and H. Wörlen for valuable comments.

1. Introduction

Which means of payment consumers use depends on various factors. Individual payment preferences and habits have an influence, as do the prevailing value systems in a society or infrastructural conditions. The latter include, for example, the distribution, availability and acceptance of payment methods as well as access to them. Costs play a central role in all of these factors. Banks, consumers and retailers are likely to give priority to offering, using and accepting means of payment that incur relatively low costs for them. It should also be noted that not all payments are the same. For example, a lot of data is stored for card payments, but not for cash payments. The associated restriction of privacy or data disclosure for card payments can be seen as a cost. Alternatively, the ability to remain anonymous can be seen as a benefit of cash.

There are now a number of studies that examine the costs of means of payment. The focus is on individual sectors and occasionally on the economy as a whole. Most studies focus on the retail sector and payment service providers. So far, only a few studies have looked at the costs at consumer level. Consumers are the ones who decide which means of payment they want to use when choosing between several payment methods. Although a retailer can decide for itself which payment methods it accepts and which it does not, in many cases retailers also offer the payment options requested or used by consumers. However, the costs incurred for using the means of payment are ultimately borne by the consumer - possibly through a surcharge. It therefore makes sense to look for cost-efficient solutions from the consumer's perspective.

When talking about payment costs from the consumer's point of view, many people might first think of fees incurred, for example for bank accounts, cash withdrawals or payment cards. However, these types of costs are not the only ones that consumers incur when they use payment methods. For example, losses caused by cash loss or payment card fraud also represent costs. There are also costs such as time spent, e.g. for going to the ATM, paying at the till or checking account statements. While fees and the opportunity costs of time expenditure are quite common when considering costs, there is another form of costs that are increasingly being incurred but often go unnoticed: Costs in the form of data disclosure by consumers. Consumers "pay" with their data, so to speak.[1]

Due to the specifics of national payment systems, cost studies usually focus on individual countries. As the country-specific calculations are based on different circumstances and

[1] In Germany, this form of payment has been legally equivalent to a payment in the BGB (Sections 312 (1a), 327 (3)) since 2022 with the implementation of the European Directive on Digital Content and Services.

assumptions, they are placed on a comparable basis in this paper. Building on this, the sensitivity of the results to the underlying assumptions and the cost types taken into account is then analyzed.

This overview of consumer costs in payment transactions and the international cost comparison were created as part of a Bundesbank project. However, they were not included in the final report (Knümann et al., 2024). The same applies to the detailed discussion of the problems involved in estimating payment transaction costs. As both the international overview and the discussion of the "cost issue" promise added value, these two aspects are made available in a separate publication. Understandably, some overlaps with Knümann et al. (2024) cannot be avoided.

The paper is structured as follows: Chapter 2 first clarifies the cost concept used. Chapter 3 then evaluates previous studies on the costs of payment methods from a consumer perspective. The focus is on cash, debit and credit cards. However, other non-cash means of payment are also considered. Various key figures are calculated on a comparable basis, broken down into resource and private costs. Chapter 4 deals with general challenges in determining the costs of means of payment on the consumer side and also provides some sensitivity analyses on the main causes of the different results. Chapter 5 is devoted to a particular cost aspect that has also received little attention to date, namely the negative external effects associated with the use of means of payment, e.g. crime and environmental damage. Chapter 6 summarizes and draws some conclusions.

2. Definitions and cost terms

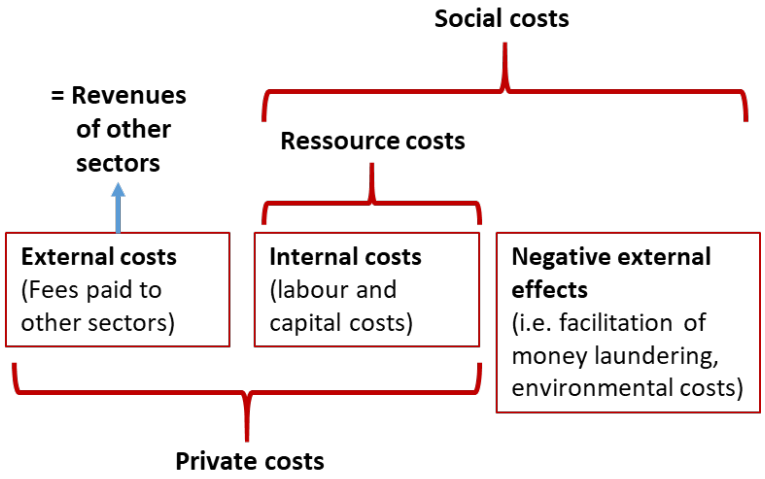
Krueger & Seitz (2014) showed how different the national developments in the payment method landscapes and the use of payment methods are. This also has an impact on the costs of payment methods and - derived from this - on (national and international) cost comparisons. Hayashi & Keeton (2012, 1f.) state: "The studies have reached different conclusions..., suggesting that cost rankings can depend on the *specific characteristics of a country's payments system* and the *scale* at which a payment method is used in the country. (...) These differences suggest a need for each central bank to *conduct its own cost study*." Similarly, Schmiedel et al. (2013, 45) conclude: "The existing literature shows that, in spite of recent efforts, there is still only limited knowledge and information available for making valid comparisons of the costs of making payments across European countries." In a similar vein, Sintonen & Takala (2022, 4): "Comparing the results across countries and drawing conclusions about the cost-efficiency of

different countries is not straightforward, however, as the studies differ in many ways, e. g. the level of digitalization, the structure and concentration of the retail payments market and the scope of the analysis."

There are now a considerable number of macroeconomic cost studies that include several or all parties involved in the payment process.[2] Other studies focus only on individual parties or sectors, mainly retail and/or banks (e.g. Banco de Portugal, 2007; Deichner et al., 2019; Guibourg & Segendorf, 2007). An isolated consideration of consumers has so far been the exception in the literature (e.g. Knümann et al., 2024).

While macroeconomic studies usually calculate resource costs, sectoral studies tend to focus on private costs.[3] As there are a number of overlaps between the cost categories used in the literature, the relationships between the most important cost types are illustrated in Fig. 1.[4]

Figure 1: Important cost concepts



Source: own figure.

[2] See Abele & Schäfer (2016), Ardizzi & Giucca (2013), Banque Nationale de Belgique (2005), Bergman et al. (2007), Brits & Winder (2005), Carbo-Valverde et al. (2008), Danish Payments Council (2018), Danmarks Nationalbank (2012), Deák et al. (2022), Gresvik & Haare (2009), Humphrey et al. (2003), Jonker (2013), Kosse et al. (2017), Norges Bank (2014; 2022), Nyandoto (2011), PaySys Consultancy (2006), Schwartz et al. (2008), Segendorf & Jansson (2012), Simes, Lancy & Harper (2006), Sintonen & Takala (2022), Stewart et al. (2014) , Sveriges Riksbank (2023), Takala & Virén (2008), Trütsch et al. (2024), Turjan et al. (2011) as well as the multi-country contributions by Carbo-Valverde & Rodriguez-Fernandez (2019), Schmiedel et al. (2012) and Retail Banking Research (2010). Shampine (2007, 2009) provides a critical general assessment, taking into account qualitative factors, benefits and welfare aspects. An overview of selected studies including policy recommendations is provided by Koivuniemi & Kemppainen (2007), Hayashi & Keeton (2012) and Sintonen & Takala (2022) as well as Junius et al. (2022) purely in relation to Europe.

[3] The cost concepts used can be found in Krueger & Seitz (2014, Chapter 3). There, the sectoral interdependencies are illustrated in a diagram. An even more detailed presentation can be found in Bruggink & Lepecq (2016, 6). The term social costs, which is often used synonymously with resource costs, is confusing, as it has already been used as a fixed term in the field of public economics for over a century, specifically in the area of environmental economics and negative externalities. The term external costs is also used in allocation theory and environmental economics in the context of negative externalities, but is nevertheless used here in a different way.

[4] Other definitions of costs are: direct versus indirect costs or fixed versus variable costs.

Social costs include the internal costs of the individual sectors (the resource expenditure) and the external effects. The latter are not usually taken into account in cost studies, which means that in these cases "resource costs" correspond to "social costs".[5] At sectoral level, in addition to the internal costs of a sector (resource costs), there are also external costs. Both together make up the private costs. External costs are payments (prices, fees) that are made to other sectors. These can be considerable for individual sectors, but represent revenue for other sectors and are therefore eliminated in a macroeconomic view through consolidation. All external costs thus cancel each other out in terms of amount, but can lead to different changes in the behavior of the parties involved and thus to a real consumption of resources.

The following section focuses on private households (consumers). Table 1 provides an overview of the cash, debit card and credit card costs relevant to consumers. A distinction can be made between monetary and non-monetary costs. The monetary costs include regular and occasion-related fees, as well as financial losses due to the loss of a means of payment or fraud. Non-monetary costs typically include opportunity costs of time, but also costs incurred by consumers through data disclosure. The latter have rarely been quantified in the literature to date.[6] However, the commercial use of customer data is playing an increasingly important role. Companies from the financial sector in particular, e.g. tech companies, often use customer data in a commercial manner and thus offer their services for comparatively low fees or, in some cases, completely free of charge. From the consumer's perspective, these services appear to be free of charge at first glance, but in such cases consumers "pay" by disclosing their personal data.[7] This means that consumers can use services in exchange for disclosing personal data. Companies can use this data to place personalized advertising, for example.

Taking the costs of data disclosure into account seems sensible due to the increasing economic relevance, but is associated with many uncertainties. The prerequisite is that consumer data is regarded as an economic good and the disclosure of this (intangible) good is regarded as a consumption of value. In addition, the question arises as to whether other non-monetary cost categories should not also be taken into account if data pricing is classified as a relevant cost factor, such as the inconvenience of using a payment method that is time-

[5] However, there are already isolated estimates of the environmental costs of means of payment, see e.g. ECB (2023a), Roos Lindgreen (2018). For the costs of money laundering, see https://www.unodc.org/unodc/en/money-laundering/overview.html. See also section 5.
[6] Knümann et al. (2024) is an exception.
[7] As already mentioned in the introduction, in Germany "payment with data" has been legally equivalent to a monetary payment since 2022.

consuming or complicated.[8] Last but not least, it could be that some customers do not even perceive the data disclosure itself as a cost. On the other hand, there is the increasing commercial use of customer data and corresponding business models, which indicate that consumer data is also an increasingly relevant economic asset and that its disclosure represents a consumption of value. Data disclosure is thus also differentiated from other (immaterial) non-monetary factors. Overall, it therefore seems justified to include the disclosure of customer data as a relevant cost item - or conversely, non-disclosure as a benefit.

Table 1: Payment transaction costs for consumers

			Cash	Debit card	Credit card
Monetary costs	a	Account fees	x[3]	x[3]	x[3]
	b	Card fees	x[4]	x	x
	c	ATM fees	x		
	d	Transaction fees		x	x
	e	Surcharge[5]	x	x	x
	f	Custody fees	x		
	g	Interest foregone/opportunity costs	x[1]	x[2]	
	h	Theft/fraud	x	x	x
Non-monetary costs	i	Payment time	x	x	x
	j	Time to acquire cash	x		
	k	Checking of account statement		x	x
	l	Data disclosure, giving up anonymity		x	x
	m	Negative externalities[6]	x	x	x

Note: "x": costs incurred in principle 1) corresponds to the income from (opportunity cost) seigniorage from the central bank's perspective. 2) Debit cards are linked to a current account, on which non-interest-bearing balances are often held, so that seigniorage is incurred by the commercial banks. 3) Both the use of a card and access to cash are usually linked to holding a current account. It therefore makes sense to allocate the costs of a current account to both "cash access" and "card payments". 4) Cash is almost exclusively withdrawn using a card (usually a debit card, and often a credit card abroad). Therefore, card fees are also partly costs of cash withdrawals. 5) Surcharges for card payments that fall under EU Regulation (2015/751) on interchange fees have been prohibited in the EU since 2018 in accordance with the PSD2. In Germany, this is codified in Section 270a BGB. However, discounts depending on the means of payment are permitted. 6) In addition to the valuation problem, there is also an assignment problem on the consumer side.

The sum of all these (monetary and non-monetary) costs represents the *private costs* of consumers. Subtracting those costs that represent revenue for another sector (fees, interest, data, etc.), the so-called *external costs* (a+b+c+d+e+f+g+h+l), results in the *internal costs* for consumers (i+j+k). The private costs are therefore made up of the external costs in the form of paid services from third parties and own resource outlay (internal costs, resource costs), see also Carbo-Valverde & Rodriguez-Fernandez (2019), Danmarks Nationalbank (2012), Kosse

[8] In an even broader view, it could also be taken into account, for example, that certain purchases (e.g. digital goods or on large e-commerce platforms) cannot be made with cash or can only be made in an extremely complicated way. With the increase in e-commerce, this could represent growing opportunity costs for cash in the future.

et al. (2017), Norges Bank (2014), Schmiedel et al. (2013), Stewart et al. (2014), Trütsch et al. (2024). [9]

It should be noted that not only explicit but also implicit costs from other sectors can be relevant for consumers (not included in Table 1). This is the case when costs are passed on to consumers by retailers and banks, thereby increasing product prices. For example, restrictions on interchange fees between acquirers and card issuers could lead to an increase of card fees for consumers. It is also conceivable that merchants could pass on the increased costs of a single payment method to product prices and increase them because no surcharge is allowed for the use of a particular payment method. (Evans & Mateus, 2011; Górka, 2018, section 1.2.5; Tims, 2018). External costs therefore include both explicit and implicit costs charged to consumers by retailers for the use of payment methods (see Dark et al., 2018).

The resource costs can differ significantly from the private costs depending on the payment instrument (Stewart et al., 2014). The private costs are primarily sector-specific. They are essential for individual decisions.[10] With regard to the consumer, Stewart et al. (2014, 3f.) state for the case of Australia: "Across instruments, the private cost to consumers is relatively similar despite large differences in resource costs." In contrast, Carbo-Valverde & Rodriguez-Fernandez (2019) show in a multi-country study (52 countries from all continents), which includes both resource and external costs, that the private costs for consumers and retailers are driven by fees.[11]

Within the cost concepts defined in this way, a distinction can be made between *direct* costs (directly attributable to a means of payment) and *indirect* costs (not exclusively attributable to a means of payment) (see e.g. Kosse et al., 2017; Norges Bank, 2022; Turjan et al., 2011). The former include, for example, the time required to obtain cash or fees for withdrawing cash. Fees for debit cards, on the other hand, are indirect costs because they can be used to withdraw cash but also to make non-cash payments. In addition, some costs *are fixed* and others are *variable* (see e.g. Kosse et al., 2017; Segendorf & Jansson, 2012; Stewart et al., 2014; Trütsch et al., 2024; Turjan et al., 2011). *Transaction-related* variable costs vary with the number of

[9] This would also include the so-called "hidden costs" of payment methods, see Bruggink & Lepecq (2016) and Chakravorti (2014). The total costs incurred by consumers for each means of payment can also be interpreted as the corresponding willingness to pay.

[10] It is unclear to what extent the netting of costs or the distinction between private costs and resource costs is justified. In economic terms, there are relatively few zero-sum games. Rather, it is a question of better or worse off in terms of benefits that lead to changes in behavior. And if this is the case, the resource costs in an economy will also change if fees change.

[11] For Germany and using a broad definition of costs (e.g. including data disclosure), Knümann et al. (2024) show that this only applies to credit cards. BIS (2020, 74) contains empirical evidence that payments are more expensive where the banks' interest margin is relatively high.

transactions (e.g. time costs for a card payment or cash withdrawal), while *value-related* variable costs depend on the transaction value (e.g. the costs of card fraud). Fixed costs are transaction-independent. Account management fees should be mentioned here. The distinction between fixed and variable costs makes it possible to compare the costs of certain payment types with varying transaction values (see Kosse et al., 2017, Chapter 5; Krueger & Seitz, 2014, Chapter 3). It can also provide information on the extent to which different payment instruments are influenced by economies of scale. For example, if payment instruments have high fixed costs but low variable costs, the average costs may fall as the number of transactions increases. However, the distinction between fixed and variable costs requires detailed knowledge of the structure of the costs. Rough estimates often seem to be used here. This relativizes the value of the determined cost functions. In particular, the question arises as to whether the estimated cost functions are really reliable enough to determine break-even points down to the cent. [12]

In this context, it is also important not only to look at the current situation, but also to keep an eye on future developments. Among other things, it will be important to see how the cost and fee situation for non-cash means of payment will change if cash is increasingly pushed back at the point of sale (see Bolt et al., 2013; Shy, 2022).

3. International comparison of the cost of means of payment

Cost studies usually only take into account a subset of all costs - if only because of the difficult data situation. For comparison purposes, different key figures are then calculated for cash and cashless transactions, e.g. share of costs in total costs or in per cent of GDP, cost comparison of different forms of payment, including over time, costs per transaction and in per cent of sales (for examples, see the list in Kosse et al., 2017, 43, and Krueger & Seitz, 2014, Chapter 3).[13] In the case of cashless payment instruments, the focus is primarily on debit and credit cards (physical and contactless), in some cases also mobile forms of payment via smartphone or smartwatch. Other payment media are only included in exceptional cases

Since the turn of the century, the number of cost studies in the area of payment transactions has risen sharply. However, many of these studies do not include an estimate of consumer costs. We want to focus on this in particular and will only analyze studies that include these costs in the following. These are different country studies covering 12 countries, as well as a multi-country study with data on 52 countries (see Table 2).

[12] More on this in section 4

[13] Krueger & Seitz (2014, Chapter 3) also contains a discussion and critique of the key figures.

In their multi-country study, Carbo-Valverde & Rodriguez-Fernandez (2019) compare the (private and resource) costs of cash and debit cards.[14] They find a clear heterogeneity in the results. The lowest cash costs for consumers can be found in Europe, Africa and the Asia-Pacific region, while the highest costs are in North, Central and South America. No such clustering can be observed for debit cards. Here, high costs are found in the USA, Sweden, Poland and Russia. However, for all countries included, cash is cheaper than debit cards and the costs are driven by fees. [15]

Table 2: Cost studies with information on consumers' payment costs

Country	Year of investigation	Study
Australia	2013	Stewart et al. (2014)
Australia	2007	Schwartz et al. (2008)
Australia	2005	Simes et al. (2006)
Belgium	1998	De Grauwe et al. (2000a, b)
Denmark	2016	Danish Payments Council (2018)
Denmark	2009	Danmarks Nationalbank (2012)
Germany	2004	PaySys (2006)
Germany	2017	Carbo-Valverde & Rodriguez-Fernandez (2019)
Germany	2023	Knümann et al. (2024)
Canada	2014	Kosse et al. (2017)
Multi-country study	2017 (52 countries)	Carbo-Valverde & Rodriguez-Fernandez (2019)
Norway	2020	Norges Bank (2022)
Norway	2013	Norges Bank (2014)
Norway	2007	Gresvik & Hair (2009)
Poland	2015	Przenajkowska et al. (2019
Sweden	2021	Sveriges Riksbank (2023)
Sweden	2009	Segendorf & Jansson (2012)
Switzerland	2022	Trütsch et al. (2024)
Hungary	2019	Deák et al. (2022)
Hungary	2009	Turján et al. (2011)
Uruguay	2016	Álvez et al. (2020)
USA	2013	Chakravorty & Mazzotta (2013)
USA	2003	Garcia Swartz et al. (2004a, b)

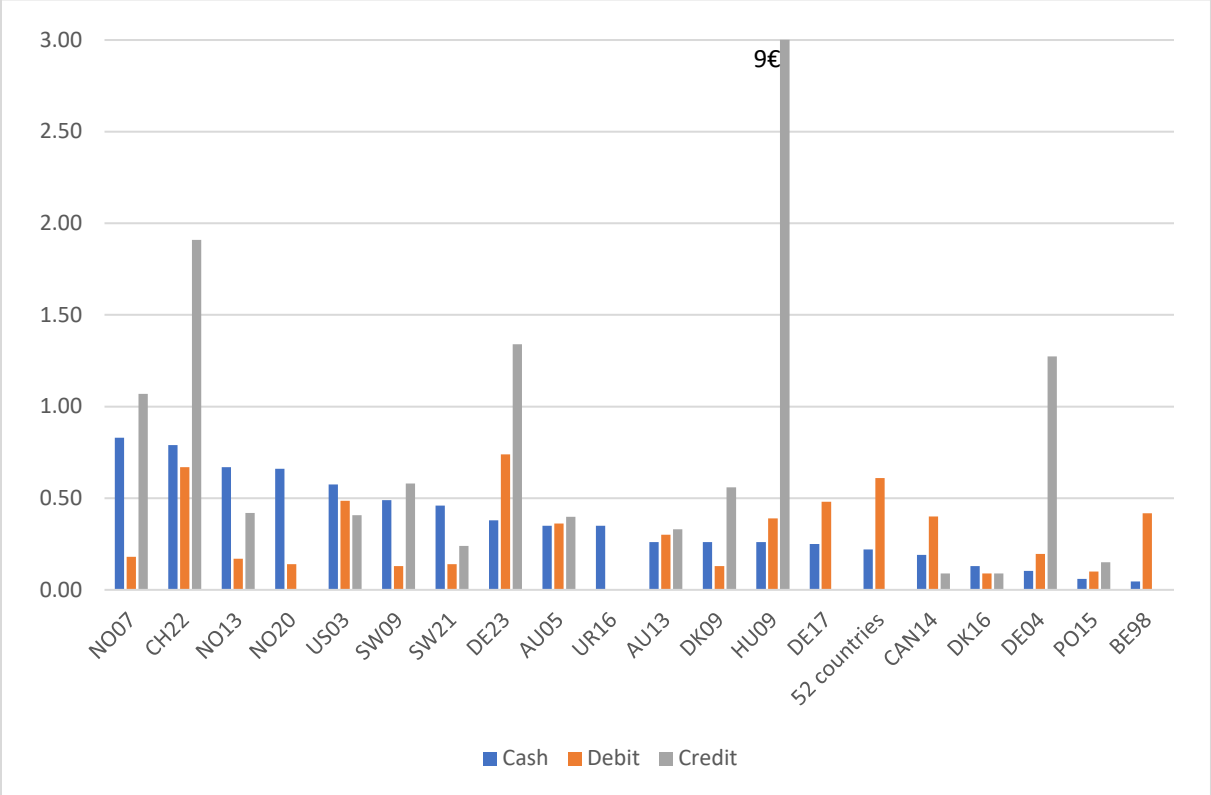
Source: own table.

[14] The European countries included are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom.

[15] The cost advantage of cash is understated, as the cash costs in this study relate to an average ATM transaction. As larger amounts are withdrawn at ATMs, these costs are spread over several payment transactions.

As the following figures show (sorted by the amount of cash costs), the results differ significantly from study to study and country to country, regardless of the indicator used.[16] The wide range of results is also striking, even for estimates for one country (see Australia, Denmark, Norway, Switzerland). Based on the costs per transaction, there are considerable differences for all payment instruments[17], regardless of whether the private costs (see Fig. 2) or the resource costs (see Fig. 3) are considered. For example, private cash costs range from €0.05 to €0.83, while the extreme values for debit cards are €0.13 and €0.67.[18] For credit cards, the differences are particularly extreme, with a minimum of €0.09 and a maximum of almost €9. The resource costs for cash range from €0.03 (multi-country study: €0.02) to €0.50, for debit cards from €0.04 to €0.37 and for credit cards from €0.02 to €0.41.

Figure 2: Private costs per transaction (in euros)



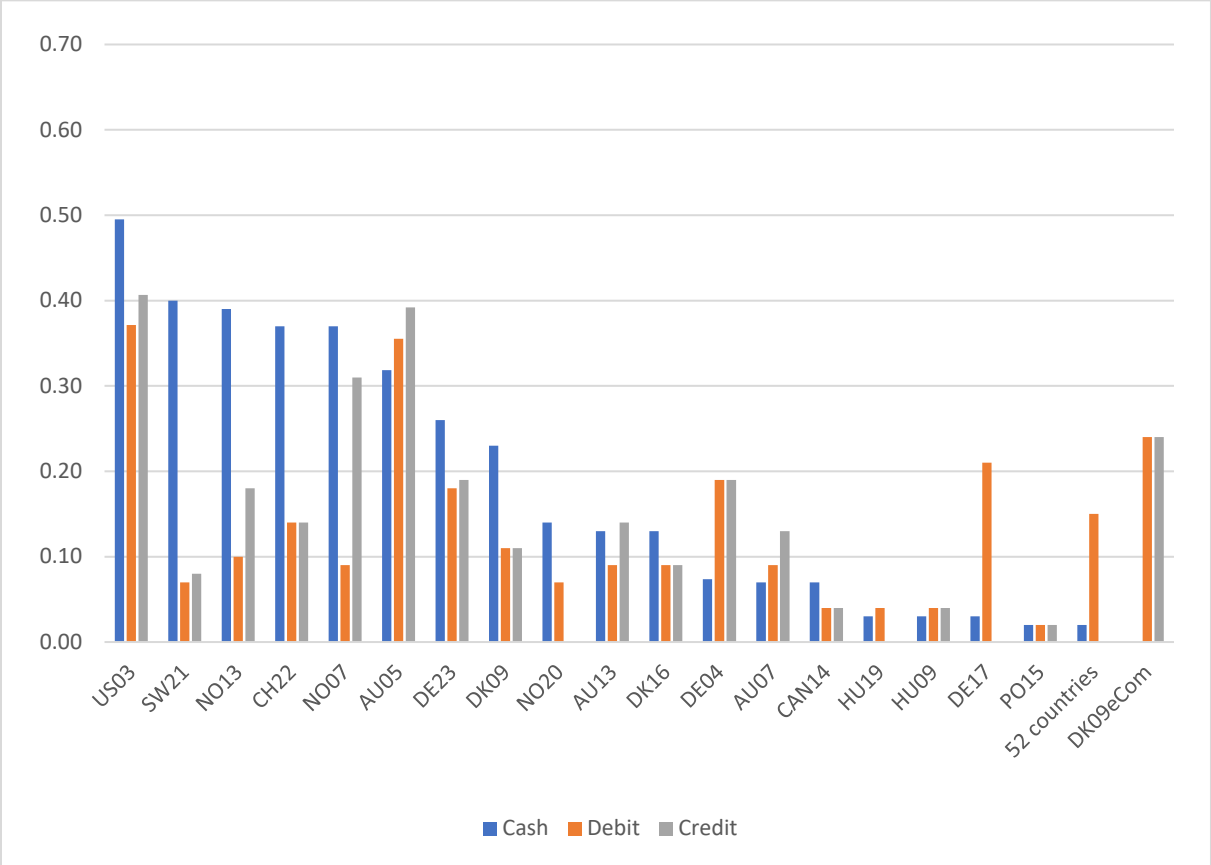
Source: see the studies cited in Table 2. DE17 from multi-country study (refers to ATM transactions); DK09/DK09eCom: face-to-face/distance selling; US03 (AU05): for selected transaction amounts: Cash $10 ($11), card $50 ($54). Conversion to € using the av. exchange rate for the year of the study.

The range of estimated resource costs for card payments is smaller than for private costs. It should also be emphasized that there is no uniform picture with regard to the relative costs of

[16] Studies that also include the costs of other sectors come to a similar conclusion, see e.g. Krueger & Seitz (2014), Chapter 3.
[17] The graphical representation of the results is limited to the three most important instruments: cash, debit card and credit card. For the costs of the other instruments and further information, see the appendix.
[18] The multi-country study arrives at an average value of €0.61 (for 52 countries).

the three payment instruments. In some studies, cash is associated with the highest costs for consumers - both on the basis of resource costs and on the basis of private costs (e.g. Norway, Sweden 2021, US 2003). In other countries, the three instruments are roughly on a par (e.g. Australia for private costs, Poland for resource costs). Finally, there are also countries where cash is the cheapest for consumers (e.g. Hungary, DE 2017, Poland, multi-country study). Looking at the costs over time and per country, there appears to have been a downward trend in costs.

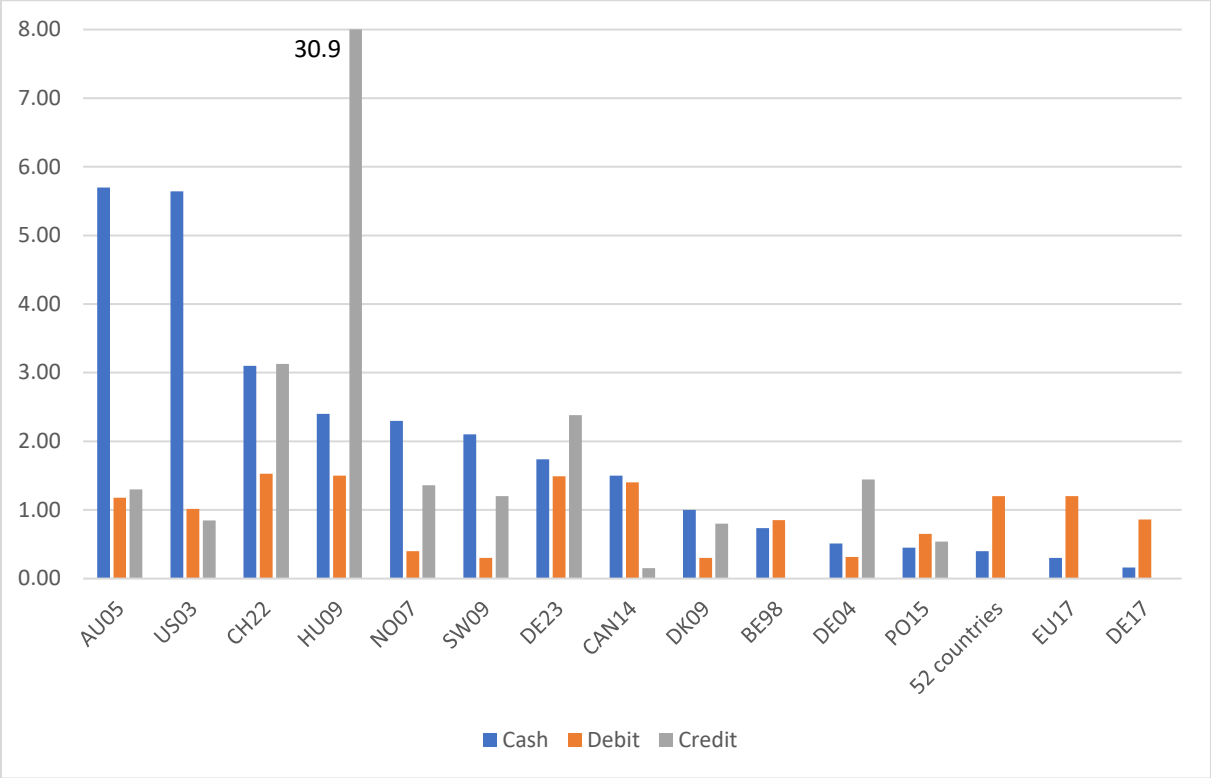
Figure 3: Resource costs per transaction (in euros)



Source: see the studies cited in Table 2. DE17 from multi-country study (refers to ATM transactions); DK09/DK09eCom: face-to-face/distance selling; US03 (AU05): for selected transaction amounts: Cash $10 ($11), card $50 ($54). Conversion to € based on av. exchange rates for the year of the study.

When the costs are set in relation to the transaction amount, there are also considerable differences between countries and payment instruments. The private costs (see Fig. 4) range from 0.16% to 5.7% for cash, from 0.3% to 1.5% for debit cards and from 0.15% to 30.9% for credit cards. However, the high value of 30.9% for Hungary is an outlier. The second-highest value is only 3.13%. The resource costs (see Fig. 5) range from 0.02% to 5.2% for cash, from 0.13% to 1.16% for debit cards and from 0.07% to 1.28% for credit cards.

Figure 4: Private costs as a percentage of the transaction amount



Source: see the studies cited in Table 2. DE17(EU17) from multi-country study (refers to ATM transactions); US03 (AU05): for selected transaction amounts: Cash $10 ($11), card $50 ($54).

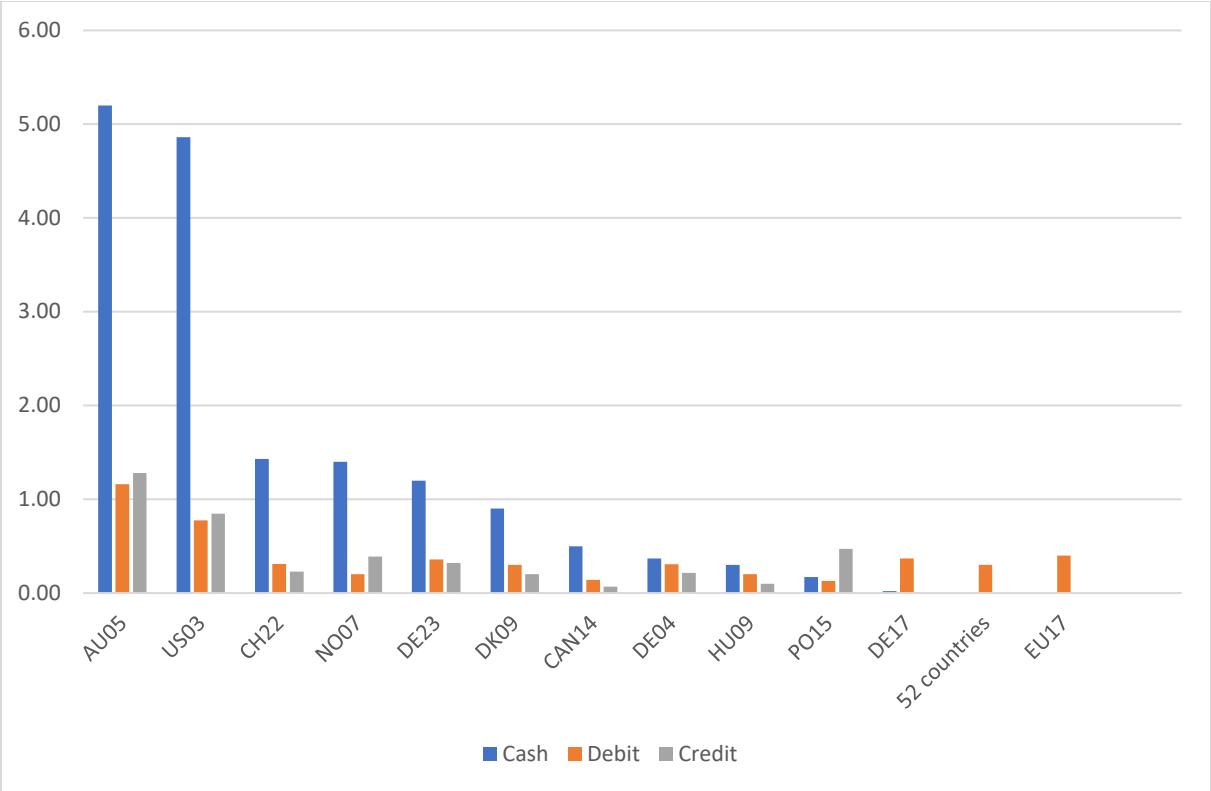
In many cases, however, a clear ranking of costs can be determined for the key figure "costs as a percentage of the transaction amount". In most countries, cards are cheaper than cash both in terms of private costs and especially in terms of resource costs. The biggest differences can be found in Australia (2005), the USA (2003), Sweden (2009) and Norway (2007). This is due to the fixed cost element, which, when viewed on the basis of "costs as a percentage of the transaction value", has a greater impact the smaller the transaction values are. Many small amounts are paid with cash in particular.[19] However, there are also some cases in which cash is the cheapest means of payment in terms of private costs (e.g. DE17, EU17, PO15). The resource costs of debit cards are always lower than those of cash, while those of credit cards are only higher in the case of Poland (2015).

There are also large differences in other key figures, such as the costs as a percentage of GDP. For example, the private costs (resource costs) of cash for consumers, measured as a percentage of GDP, vary from 0.71% in Hungary to 0% in Norway (0.18% in the USA to 0% in Sweden and Norway) (see Figures 6 and 7). The share of payment costs borne by consumers (see appendix) varies from 0% in Sweden (resource costs) to almost 75% in Hungary (private

[19] In order to eliminate the effects of different transaction values, Garcia-Swartz et al. (2006 a, b) and Simes et al. (2006) work with predefined standard amounts.

costs of credit cards). Cash accounts for between just under 5 % and up to 80 % of consumers' total means of payment costs (see Appendix, Table 1A). Chakravorty & Mazzotta (2013) find that cash costs for consumers also depend on socio-demographic characteristics, such as income situation and financial inclusion (see also Shy & Stavins, 2022).

Figure 5: Resource costs as a percentage of the transaction amount



Source: see the studies cited in Table 2. DE17(EU17) from multi-country study (refers to ATM transactions); US03 (AU05): for selected transaction amounts: Cash $10 ($11), card $50 ($54).

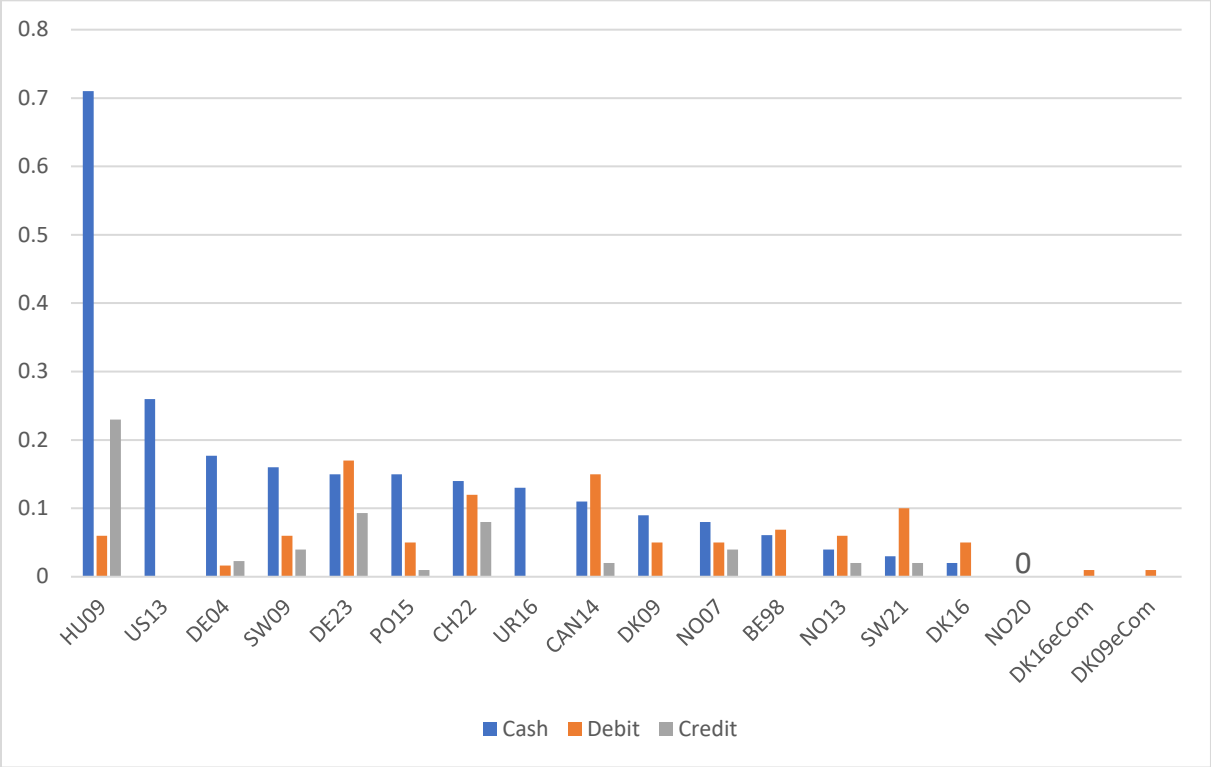
In addition to different methodologies, the status and development of payment transactions and the respective cost types taken into account, the following factors are the main contributors to this pronounced variability:

- the intensity of use of means of payment,
- the assumed volume of cash transactions[20]
- legal regulations (e.g. on no-surcharge, interchange fees) and competition on the payment transaction markets,
- the recording and evaluation of time
- interest rates used (to measure opportunity costs).

[20] Determining the cash portion of transactions used in the country is particularly important when cash is not only used for domestic transactions, but is also demanded for other reasons (e.g. store of value and precautionary motives) and held abroad. The latter is particularly relevant for the US dollar, the euro and the Swiss franc.

As a result, comparative statements over time and at an international level face considerable obstacles. Against this background, it is not advisable to transfer the results of a study to other countries (see e.g. Álvez et al., 2020) or to extrapolate the results to a larger group of countries, such as in Schmiedel et al. (2013) from 13 EU countries to all 27 EU countries (see also Hayashi & Keeton, 2012).

Figure 6: Private costs as a percentage of GDP

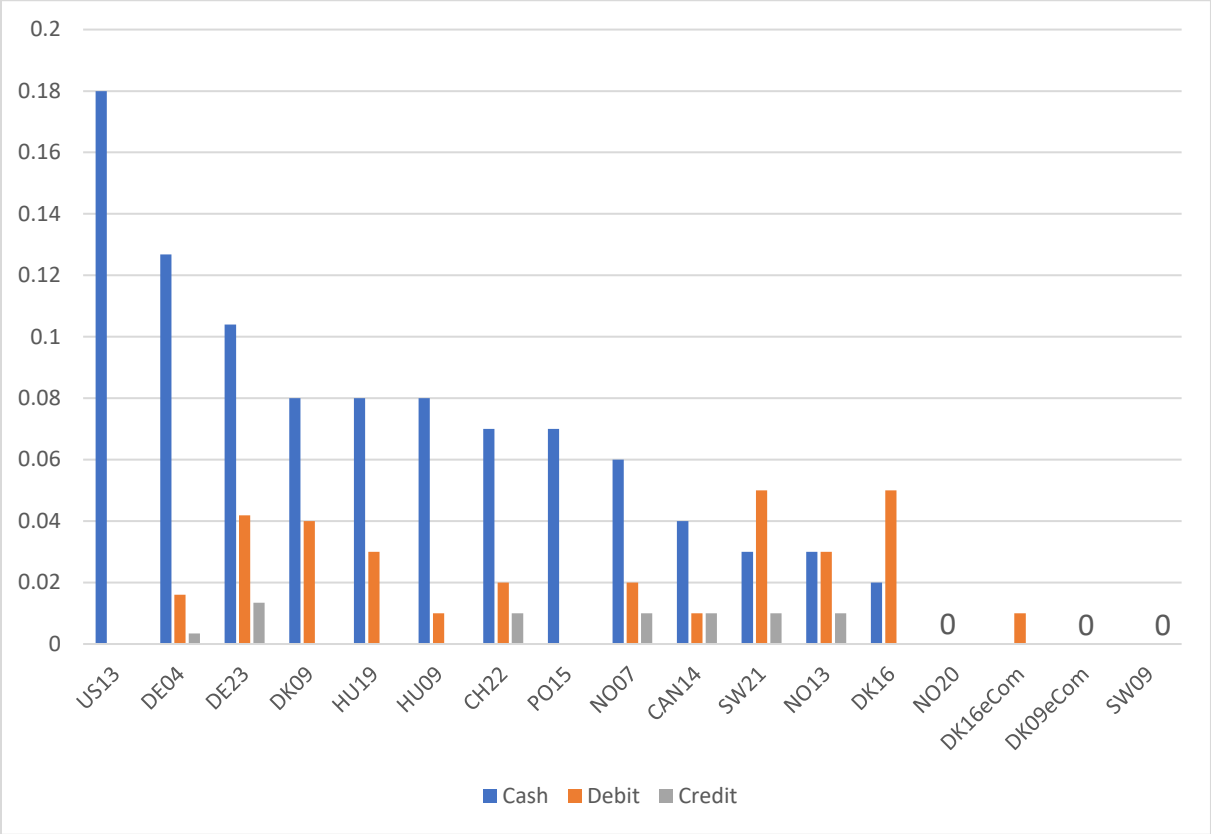


Source: see the studies cited in Table 2. Dk/DKeCom: POS/distance selling.

If a distinction is made between fixed and variable costs (e.g. Bergman et al, 2007; Brits & Winder, 2005; Kosse et al, 2017; Segendorf & Jansson, 2012; Trütsch, 2024; Turján et al, 2011), cost functions for payment media can be estimated as a function of the transaction value. A significant part of the costs of non-cash payment media is fixed (neither transaction- nor value-dependent), as it is generally related to the development of the infrastructure or in many cases does not depend on (the number and value of) transactions at consumer level. In contrast, cash incurs relatively high variable costs on the consumer side, but rather low fixed costs. Therefore, the relative advantage of cash decreases with the transaction amount (Cabinakova et al., 2019).[21]

[21] Fixed costs include, for example, the shoe-leather costs of consumers. Variable costs include the loss of interest in the sense of opportunity costs. The respective classification also depends on the time horizon under consideration. See also the explanations in chapter 2.

Figure 7: Resource costs as a percentage of GDP



Source: see the studies cited in Table 2. DK09/DK09eCom: POS/distance selling

If standard transaction amounts are determined with the help of cost functions, it should be noted that these also differ from country to country. The transaction value thresholds determined, above which a certain payment medium is more expensive or cheaper, also differ significantly depending on the sector considered. In the case of private households and consumers, there are generally higher values above which a cashless payment is advantageous. For example, Kosse et al. (2017) derive a threshold value of Can$ 5.51 for financial institutions, Can$ 20.13 for retailers and Can$ 77.87 for consumers when deciding between cash and a debit card. However, the purported accuracy of these results should not hide the fact that they depend on a number of (uncertain) estimates and the highly assumption-driven split between fixed and variable costs.

4. Challenges in determining costs and sensitivity analyses

According to the cost studies presented in the last section, the results differ considerably, both internationally and within a country and for different years. The divergences are first of all due to the fact that different types of costs are considered. But even where the same types of costs are estimated, there are sometimes considerable deviations. In the case of cash, it should also be noted that there are no statistics on cash transactions and sales. There are indirect estimation

methods for determining turnover. Krueger & Seitz (2014) present different approaches: Estimating cash transactions from the national accounts and/or value added tax statistics; determining cash withdrawals at ATMs and counters; conducting a payment behavior study with corresponding questions on cash spending. Based on these estimates of the average transaction amount, the number of cash transactions can then be estimated in a second step.[22] It also needs to be clarified which cash transactions are actually recorded. PaySys (2006) takes a broad approach that includes transactions between private individuals (P2P). The study therefore arrives at a very high number of transactions. This has an impact on the key figure "costs per transaction". If only retail payments were taken into account, the figures would be much higher.

Another important aspect is time costs, which are included in the cash procurement costs and payment time as well as the checking of payment receipts and account statements. The time required must be determined and valued. As the resource costs by definition do not include any fees, they essentially consist of these time costs. Depending on which of these time costs are included in the studies, what time is used and how time valuation is carried out, the results differ considerably. Knümann et al. (2024), for example, take all variants into account, while Carbo-Valverde & Rodriguez-Fernandez (2019), on the other hand, only include the payment time for non-cash payment media, in their case the debit card. De Grauwe et al. (2000a, b) do not include any time costs at all.

The time recording and valuation alone is not trivial, as the example of a cash withdrawal at an ATM shows. It initially seems plausible to determine the time it takes to get to the ATM and then assign a price to this in terms of opportunity costs ("Approach 1"). Many studies follow this approach (e.g. Chakravorty & Mazzotta, 2013; Danmarks Nationalbank, 2012; Gresvik & Haare, 2009; Kosse et al, 2017; Norges Bank, 2014; Przenajkowska et al, 2019; Sveriges Riksbank, 2022; Trütsch, 2024; Turjan et al, 2011). In this case, the time spent withdrawing cash is simply multiplied by a "representative" hourly wage rate and the total number of ATM withdrawals made per year. However, the question arises as to whether in reality the consumer really has the choice between increasing their working hours and making a payment. Under certain circumstances, the actual opportunity costs of leisure time would be the correct measure. Nevo & Wong (2019) also note that the value people place on time fluctuates significantly over the business cycle. Furthermore, Leclerc et al. (1995) point out that the value of time can vary, as time - unlike money - cannot simply be transferred. If, for example, someone has to wait

[22] To avoid this effort, Carbo-Valverde & Rodriguez-Fernandez (2019) use an average ATM transaction for their multi-country study.

unexpectedly, there is usually no possibility of working at the normal hourly rate during this time. Therefore, in many cases only part of the hourly wage is recognized as an opportunity cost of time (see, e.g., Knümann et al., 2024; Trütsch et al., 2024).

Against the background of the actual withdrawal amounts and the frequency of withdrawals, however, these costs do not appear to be substantial for the economic agents. Otherwise, consumers could simply reduce these costs by going to the ATM less often and withdrawing higher amounts each time. In 2023, for example, with an average ATM withdrawal amount of €253, an average of 27 withdrawals were made in Germany (Deutsche Bundesbank, 2024).[23] In some cases, people do not necessarily make an extra trip to the ATM, but rather get cash when they are already nearby. Chen et al. (2021) distinguish between consumers with high and low such (shoe-leather) costs and find that there are clear thresholds for the marginal effects of these costs and that the effects depend on socio-demographic factors (e.g. income, age). In addition, the possibilities for cash-back should also be considered.

The revealed preferences thus show that consumers apparently do not consider the (opportunity) costs of ATM withdrawal to be too severe. Therefore, some authors follow a model-led approach ("Approach 2"), e.g. based on the Baumol-Tobin model, to determine the cost per cash withdrawal from the number of ATM transactions per person and an interest rate (opportunity cost of holding cash), see e.g. Carbo-Valverde & Rodriguez-Fernandez (2019), Segendorf & Jansson (2012), PaySys Consultancy (2006). A major problem with this approach is estimating the opportunity cost of holding cash. Should a credit or debit interest rate be applied? It should also be taken into account that cash is subject to a risk of loss and that this is a decision under uncertainty, including a risk premium.

Approach 1 generally leads to significantly higher costs than approach 2 (see Krueger & Seitz, 2014, Chapter 3 and Knümann et al., 2024, 30ff.). Accordingly, the time costs dominate the total cash costs (private and resource costs) for consumers in case 1. In approach 2, on the other hand, they are negligible, i.e. the resource costs tend towards zero and the private costs are dominated by fees (see Carbo-Valverde & Rodriguez-Fernandez, 2019).

Let us illustrate the different results by means of an example: In the study by Segendorf & Jansson (2012) for Sweden (see Table 2), the time costs of cash for private households are estimated using a inventory model. Both the time taken to withdraw cash and the waiting time at the checkouts in stores (length of the payment process) enter the model. Using an interest rate of 0.27%, which was extremely low by the standards of the time, results in time costs of

[23] In 2008, there were 42 withdrawals with an average withdrawal amount of € 215.

just under SEK 20 million in 2009 (approx. €1.9 million).[24] If an interest rate of 2.5% were applied instead, the costs would amount to SEK 170 million (approx. €16 million; 0.01% of GDP). In contrast, in the study by the Danish Central Bank (2012) from the same year, time costs are the key cost drivers on the consumer side. They amounted to DKK 1.352 billion (approx. €182 million; 0.08 % of GDP), i.e. an almost hundredfold increase. These figures were calculated by multiplying the time consumers reported in a survey for withdrawals and waiting times at cash registers by an average net hourly wage rate. Of the total costs incurred by private households for cash and non-cash payments, around 85% are attributable to time costs in the Danish study. And of this, around 80 % is attributable to cash withdrawals.

Knümann et al. (2024) calculate the time costs for Germany in 2023 with both approaches. Although they only use 50% of the hourly wage for the reasons mentioned above, approach 1 results in cash procurement costs of EUR 0.20 per cash transaction and 0.92% of the transaction amount. Approach 2, on the other hand, reveals costs of EUR 0.04 per cash transaction and 0.17% of the transaction amount, even taking into account higher debit interest and the risk of cash loss, i.e. again significantly lower values than in Approach 1.

Due to the importance of time costs, some estimates for consumers focus specifically on these costs (see e.g. Vallée, 2018; VISA, 2018). In Cabinakova et al. (2019) and Deutsche Bundesbank (2023), these are recorded as part of a cost study for retailers. However, the time costs incurred for the payment process at the checkout are mirrored by the buyer (consumer). Only the valuation must be carried out using a representative net wage rate instead of an average labour cost rate. In the study by Cabinakova et al. (2019), the total costs of checkout times for cash amounted to €1.9 billion (0.06% of GDP), for debit cards €654 million and for credit cards €85 million in 2017. This corresponds to €0.12 per cash transaction and €0.16 per debit or credit card transaction (with PIN).[25] In relation to GDP, the values for cash costs are comparable with the above-mentioned studies from Denmark and Hungary, which use this direct approach. In absolute terms, however, they are relatively high.

In this context, Vallée (2018) uses the example of DIY stores with many small transactions to show that the explicit modelling of the decision-making process when choosing a payment method makes cash the most time-efficient payment method for a transaction. This means that in a given time interval, more payments can be made with cash than with debit and credit cards. This is ultimately due to the special properties of cash (see also Krueger & Seitz, 2017, Chapter

[24] This low value means that the consumer's share of the resource costs of cash tends towards zero, while the share of private costs is 31%.
[25] With a signature, the cost of the cards increases to €0.21.

3). As the choice of payment method depends on a number of unobservable variables (e.g. preferences and habits), Vallée (2018) explicitly controls for this with the instruments "transaction value" (transaction characteristics) and "duration of the previous payer's payment transaction" (payment method selection). With the increasing spread of contactless and mobile card payments, especially for small amounts, it should be possible to make more card payments in a given time interval. On the other hand, the study points out that the type of transaction is important when choosing the optimal payment method.

Estimating lost interest income is also by no means trivial. First of all, it has to be decided whether the entire cash holdings should serve as the basis or only the (much smaller) transaction amounts. It must also be clarified which interest rate should be used to calculate the opportunity costs. A credit interest rate is generally used. However, a number of people are in debit with their account (see Knümann et al., 2024, section 3.4.3 and https://de.statista.com/statistik/daten/studie/1364394/umfrage/umfrage-zu-gruenden-fuer-eine-kontoueberziehung-oder-nutzung-eines-dispos/), meaning that the debit interest rate is relevant for these economic agents. The probability of loss/theft must also be taken into account.

There are even considerable uncertainties when it comes to calculating the fees. The basic problem is that access and deposit of cash is closely linked to the current account. Most customers use their debit card to obtain cash. This raises the question of how account fees and card fees should be split. In any case, a portion should be allocated to cash. However, such an allocation is inevitably arbitrary. In the case of credit cards, there are usually explicit (annual) fees. In the case of debit cards, this is often not the case and a portion of the account fees would therefore have to be allocated (see e.g. Carbo-Valverde & Rodriguez-Fernandez, 2019).

Another challenge is comparing the costs of different payment instruments. This is problematic because the typical payment amount differs from instrument to instrument. For example, the average card payment is generally much higher than the average cash payment. In addition, the average value of card payments also differs. According to the ECB, it was around 29/48 euros for debit cards (non-remote/remote) in the EU in the first half of 2024, compared to more than 34/68 euros for credit cards, with huge differences between EU countries (https://data.ecb.europa.eu/data/datasets/PAY/dashboard). For this reason, Garcia-Swartz et al. (2006a, b) and Simes et al. (2006) calculate the costs for fixed payment amounts. This is intended to improve the comparability of costs (see also the tables in the appendix). Methodologically more convincing is the approach of establishing cost functions for each payment instrument. However, the results of such estimates rely on strong assumptions. In

addition, such estimates often do not include consumer costs or do not show them separately. One exception is Kosse et al. (2017) for Canada. The authors estimate that the cost of a debit or credit card transaction is around 6 Canadian cents (4.1 euro cents), regardless of the amount. For cash, they arrive at 6 Canadian cents plus 1.5 Canadian cents (total 5.1 euro cents) per 10 Canadian dollars (€6.80) payment amount.

Only a few studies attempt to also integrate benefit aspects of payment instruments (e.g. Felt et al., 2021; Garcia-Swartz et al., 2006a, b; Knümann et al., 2024; Simes et al., 2006). "Benefit" in this case means that other useful services are provided in addition to pure payment processing. These are, for example

- Flexible granting of credit,
- Payment documentation,
- Cash-back at the checkout,[26]
- Bonus points and comparable gratuities,
- Protection of privacy/data protection,
- Control of expenditure,
- Float (delayed account debit).

Most of the benefit categories relate to cashless payments. However, "data protection, protection of privacy" is a particular benefit of cash (or data collection represents a cost of non-cash payments).[27] The first exemplary experiments can be found in Garcia-Swartz et al. (2006a, b), who estimate the marginal benefit (in monetary units) of "privacy" for consumers on the basis of the food and electronics retail trade. The benefit of anonymity of cash payments and the protection of privacy is measured by the discounts granted under loyalty card programs ("loyalty card discounts"). According to the authors, these represent the implicit benefit of disclosing private information. Knümann et al. (2024, section 3.2.4) go one step further to quantify this effect. On the one hand, they evaluate questions on the willingness to pay for the deletion of data generated during a standard card payment as part of a survey on payment behavior. On the other hand, they refer to the bonuses within the German Payback program. Taking the average of both approaches, Knümann et al. (2024) calculate costs of EUR 0.43 per

[26] This shows that it is not always easy to separate the costs and benefits of cards and cash, as the card also provides access to cash. Improved access to cash through cash-back is interpreted as a benefit of the card. This, in turn, reduces the costs of cash.
[27] On the benefits of cash in general, see Krueger & Seitz (2017).

card transaction or 0.86% of card turnover. This means that the costs of data disclosure account for almost 60% of the total costs for debit cards and around a third for credit cards.

Socio-economic differences are an additional factor to be taken into account. Felt et al. (2021) quantify the private costs (net) incurred by consumers for the use of cash, credit cards and debit cards for the USA and Canada for various income classes. The net costs considered include bank fees (card and account maintenance fees, cash withdrawal fees), reward programs from credit or debit card companies, and merchant costs of accepting payment instruments, which are reflected in higher consumer prices. The authors find that credit card transactions are cross-subsidized by cheaper debit cards and cash payments (see also Schuh et al., 2010). Of the three types of costs, the (non-transparent) pass-through to consumer prices represents the largest block for consumers.[28] Measured in terms of the respective transaction value, consumers in the lowest income bracket bear the highest net costs, while those in the highest income cohort bear the lowest. The pricing of means of payment and the passing on of means of payment costs to (payment means independent) sales prices therefore have regressive distributional effects.[29] All parts of the net costs contribute to this.[30]

Overall, cost studies on the consumer side are associated with non-negligible quantification and evaluation problems. In summary, this involves the following aspects:

- Data protection, anonymity and privacy that are obviously particularly important to the population (ECB, 2021a; Roberds & Schreft, 2009).
- Cash is not only held for transaction purposes, but also for other reasons (e.g. hoarding, store of value, precautionary and crisis demand), see Zamora-Pérez (2021).
- The determination of the cash transaction share, including P2P (see e.g. Krueger & Seitz, 2014, section 2.2).
- An analysis of the efficiency of the pricing of payment media (see e.g. Krueger, 2009).
- The cost studies are usually based on household surveys where the survey design may have huge consequences for the results (OECD, 2012). In this context, the high sensitivity or resistance of consumers (but also companies) to questions about their cash holdings should be noted in particular (see e.g. Jonker & Kosse, 2009).

[28] The costs for merchants from payment transactions are dominated by the so-called "merchant service costs" for card payments (BIS, 2020, 74). These are the fees paid to banks, acquirers and network operators.
[29] However, Krueger (2015) shows that these regressive effects may not occur if retailers pursue product differentiation.
[30] The acceptance costs of payment methods for retail are lowest for cash across all income classes in both countries, followed by debit cards. Credit cards incur by far the highest costs per consumer.

5. Negative external effects

Another cost aspect is negative external effects, such as the impact of the use of means of payment on crime or environmental costs. However, it is very difficult to attribute these to individual sectors.

The environmental costs ("ecological footprint") of different means of payment (see Fig. 1) have not yet been included in existing cost studies. However, there have been a few studies in recent years that specifically address this problem. Hanegraaf et al. (2020) examine the entire life cycle of cash (banknotes and coins) from production to disposal for the Netherlands in terms of environmental impact (measured by an eco-indicator) and impact on climate change (measured by CO_2 equivalents). The strongest environmental impact comes from the operational phase (energy use of ATMs, transportation) and the production of coins. A similar conclusion is reached by ECB (2023a) for euro banknotes as a whole and Arvidsson et al. (2024) in the case of Sweden. Consequently, this impact could be significantly reduced through the increased use of renewable energies or a more cost-efficient cash cycle (Arvidsson et al., 2024, ch. 2; ECB, 2023a, ch. 4; Hanegraaf et al., 2020, 19ff.; Lepecq, 2020). Shonfield (2013) finds that the environmental impact of polymer banknotes is lower than that of paper/cotton banknotes due to their longer lifespan (see also Marincovic et al., 2011).

In order to classify the costs, they must be compared with those of a close substitute, e.g. the debit card (see Arvidsson et al., 2024, chap. 3-6; Hanegraaf et al., 2020, chap. 4; Roos Lindgreen et al., 2018).[31] In the case of the Netherlands, cash has higher costs both per average transaction and overall due to the high environmental damage caused by metal mining in coin production. In Sweden, however, the high environmental costs per transaction are due to the fact that cash is now only used for a small number of payments. Hanegraaf et al. (2020, 137) therefore standardize the calculated values with the economic values generated by the respective payment media. They use the respective resource costs as a proxy for this purpose. This makes the impact of the cash system on climate change comparable to the impact of the debit card system. Overall and in all studies, the environmental costs of means of payment are extremely low compared to the total environmental costs generated by the production of goods and services. Using a life cycle analysis similar to that of Hanegraaf et al. (2020), the ECB

[31] In addition to debit cards, Arvidsson et al. (2024) also consider other payment cards, payment apps, Swish and bank transfers. One challenge in this context is the allocation of the environmental and energy costs of the cashless infrastructure to individual non-cash payment methods. Roos Lindgreen et al. (2018) only distinguish between card use, the payment terminal at the point of sale and data centers (similar to Arvidsson et al., 2024). The ECB (2023a) does not compare cash in terms of its environmental impact with another means of payment, but with other products such as the production and use of a T-shirt.

(2023a), for example, calculates that cash had an environmental impact in 2019 equivalent to driving 8 km by car per inhabitant. This is equivalent to 0.01% of the total environmental impact.

It makes sense to also include crypto assets and digital currencies (such as Bitcoin or central bank digital currency) when dealing with environmental costs of payment means. There are now numerous calculations on the enormous energy consumption of cryptos and the Bitcoin system in particular (e.g. Delahaye, 2024; OECD, 2022; Tiberi, 2021; Thum, 2018). This is largely due to the consensus mechanism used to verify transactions on the blockchain (Bada et al., 2021). In addition, the blockchain trilemma (Abadi & Brunnermeier, 2019) states that it is impossible to achieve correct recording of transactions, cost efficiency and decentralization of the system at the same time. Central banks around the world are now working intensively on introducing central bank digital currency (CBDC) as a supplement to cash (BIS, 2021). This also raises the question of the ecological footprint, which depends crucially on the design of CBDC. Specifically, the question is whether CBDC is accessible to everyone, whether there are transaction restrictions or holding limits and whether CBDC is account-, blockchain- or token-based (see Itai Agur et al., 2022, Chapter 4). Tödter (2021) calculates environmental costs of a blockchain-based digital euro of €50 billion per year under conservative assumptions (e.g. on the number of transactions, electricity consumption, social discount rate) with the current energy mix and assuming a significantly more energy-efficient system compared to bitcoins. However, current plans envisage an account-based digital euro.[32] The ECB (2021b) estimates the energy consumption of the settlement of the CBDC it is testing at just a few KW per second, in which several thousand transactions can be carried out.

Some cost studies (e.g. Carbo-Valverde & Rodriguez-Fernandez, 2020; VISA, 2018; Bouveret, 2017; Trundy, 2015; E.A.S.T., various years) integrate (broadly defined) costs arising from crime. As a rule, these costs are only calculated in total, but not attributed to individual participants in the payment process. Central banks have reasonably reliable information about counterfeit banknotes. The extent of counterfeiting and the resulting direct costs are usually low in developed countries (e.g. ECB, 2024, Chapter 6; Viles et al., 2015; Judson & Porter, 2010). Nevertheless, the "deadweight losses" due to loss of confidence in the currency and measures to protect against counterfeiting can be enormous (Viles et al., 2015). It

[32] An in-depth study of the digital euro from a consumer, retailer and industry perspective is provided by Godschalk et al. (2024).

also should be borne in mind that there is a high level of underreporting of the costs of cash theft and loss and of losses caused by fraud with debit and credit cards.[33]

The most comprehensive study on fraud costs, both in terms of the types of costs covered and the countries included (52 countries worldwide), is Carbo-Valverde & Rodriguez-Fernandez (2020). Their study covers the years 2014-2018 and compares cash with debit and credit cards.[34] It is important that the concept of fraud is consistent across the different payment types so that meaningful comparisons can be made. The following activities are included in the empirical econometric analysis: cash-related fraud, ATM fraud, point-of-sale fraud, card-not-present (CNP) fraud. To estimate cash-related fraud, the scope of the shadow economy is determined and then, in a second step, a distinction is made between a cash-related illegal component (e.g. illegal drug and arms trafficking, organized crime) and a basically legal part that leads to tax evasion (e.g. the typical illegal worker who repairs a car or helps build a house). Card fraud includes, for example, card trapping and skimming, counterfeit cards, attempts to commit fraud without physically using the credit card, identity theft and pretending to have a false identity.

Carbo-Valverde & Rodriguez-Fernandez (2020) find a significant shift from cash fraud to card fraud in their sample period. Typically, card fraud increases with card use (ECB, 2020, 26f.; ECB/EBA, 2024, 29). Cash use in shadow economy activities has decreased significantly and accounted for less than 25% of the estimated volume in the 52 countries surveyed in 2018.[35] Germany, together with Switzerland, Austria and Australia, has the lowest figures, which are also significantly lower than in Sweden and Norway, countries with low cash use (Carbo-Valverde & Rodriguez-Fernandez, 2020, 47f.). On the other hand, CNP, for example, has increased more than sixfold. In Europe, CNP accounts for over 80% of card fraud (ECB, 2023b). In Germany, card fraud is declining overall in terms of transaction value (Carbo-Valverde & Rodriguez-Fernandez, 2020, 75; ECB, 2020, 23). However, CNP has also increased significantly here in recent years, if the coronavirus years 2020 and 2021 are excluded (Carbo-Valverde & Rodriguez-Fernandez, 2020, 73; ECB, 2020, 29; ECB, 2023b).

[33] Data on card fraud in the EU can be found in ECB (2023b) and ECB/EBA (2024). Reports on counterfeit euro banknotes are regularly published in press releases by the Deutsche Bundesbank and the ECB.
[34] Illegal activities and fraud involving crypto assets, on the other hand, are not taken into account due to a lack of information.
[35] Although cash in circulation has increased significantly worldwide, see e.g. Ashworth & Goodhart (2020) and Rösl & Seitz (2021).

6. Summary and conclusions

This literature review put the costs calculated in the available cost studies on a comparable basis, determined different key figures and, building on this, presented some sensitivity analyses and problematic aspects. The result was that there is no clear ranking of costs. This depends specifically on the indicator used, the types of costs taken into account and the methodology used. There is considerable scope for discretion, particularly when recording and evaluating time and data disclosure costs. It was also shown that the function of the current account is not only to process cash and non-cash payment transactions, but that the current account also has an important function in the area of cash supply and disposal.

Consumers react to price signals and changes in cost-benefit ratios. However, a clear and convincing signal must be given for a decision against the actual payment preferences. Overall, there should be cost transparency for consumers when it comes to payment methods. This also implies guaranteeing freedom of choice for all basic means of payment.

Costs are important, but ultimately an economic cost-benefit analysis from a society's perspective must be carried out. In a market-based system, the focus should be on the consumer as long as they have complete freedom of choice. A functioning payment infrastructure in terms of acceptance of, access to and affordability of means of payment and an efficient payment cycle is expedient in this context. This is also the task of central banks and governments, as a functioning payment system is an essential infrastructure, just like the water and electricity supply.

However, the costs have not only a static, but also a dynamic dimension. Like other networks, payment systems are characterized by positive feedback effects. In addition, payment innovations and efficiency gains can change cost structures. Regulation can also have an influence. Finally, central bank policy with respect to the payment system is important. The neutrality postulate and the possible issue of central bank digital currency are just two keywords in this respect.

References

Abadi, J. & M. Brunnermeier (2019), Blockchain Economics, Princeton University, Working Paper.

Abele, H. A. & G. K. Schäfer (2016), The Cost of Cash and Debit Cards in Austria, Journal of Financial Market Infrastructures 4(4), 1-16.

Álvez, M., R. Lluberas & J. Ponce (2020), The Cost of Using Cash and Checks in Uruguay, Journal of Central Banking Theory and Practice 2, 109-129.

Ardizzi, G. & P. Giucca (2013), The Social Costs of Payment Instruments in Italy - Surveys of firms, banks, and payment service providers, Institutional Issues, November

Arvidsson, N., F. Harahap, F. Urban & A. Nurdiawati (2024), Climate Impact Assessment of Retail Payment Services, Sveriges Riksbank, Working Paper Series No. 431, March 2024.

Ashworth, J. & C. A. E. Goodhart (2020), The Surprising Recovery of Currency Usage, International Journal of Central Banking 16, 239-277.

Bada, A. O., A. Damianou, C. M. Angelopoulos & V. Katos (2021), Towards a Green Blockchain: A review of consensus mechanisms and their energy consumption, 17th International Conference on Distributed Computing in Sensor Systems (DCOSS), July 14-16, 2021, Online, 503-511.

Banco de Portugal (2007), Retail Payment Instruments in Portugal: Costs and Benefits.

Bank for International Settlements (2020), Annual Economic Report 2020, June.

Baumol, W. J. (1952), The Transactions Demand for Cash: An Inventory Theoretic Approach, Quarterly Journal of Economics 66, 545-556.

Bergman, M., G. Guibourg, & B. Segendorf (2007), The Costs of Paying - Private and Social Costs of Cash and Card Payments, Sveriges Riksbank Working Paper Series no. 212

Banque Nationale de Belgique (NBB) (2005), Costs, Advantages and Disadvantages of Different Payment Methods, December

Bergman, M., Guibourg, G. & B. Segendorf (2007), The Costs of Paying - Private and Social Costs of Cash and Card, Sveriges Riksbank, Working paper series 212, September.

BIS (2021), CBDCs: An opportunity for the monetary system, Annual Economic Report 2021, 65-95.

Bolt, W., N. Jonker, & M. Plooij (2013): Tourist Test or Tourist Trap? Unintended consequences of debit card interchange fee regulation. De Nederlandsche Bank Working Paper 405, December.

Bouveret, A. (2017), Cyber Risk for the Financial Sector: A Framework for Quantitative Assessment, IMF Working Paper 18/143, June.

Brits, H. & C. Winder (2005), Payments are no Free Lunch, De Nederlandsche Bank, Occasional Studies, Vol. 3, No. 2.

Bruggink, D. & G. Lepecq (2016), The Hidden Costs of Card Payments, CashEssentials, December.

Cabinakova, J., F. Horst & F. Knümann (2019), The Costs of Cash Payments in the Retail Sector, Study to determine and evaluate the costs arising from cash payments in the retail sector, Deutsche Bundesbank in cooperation with EHI Retail Institute.

Carbo-Valverde, S., D. Humphrey, J. M. L. Zegarra & F. Rodriguez-Fernandez (2008), A Cost-Benefit Analysis of a Two-Sided Card Market, Fundacion de las Cajas de Ahorros, Working Paper No. 383

Carbo-Valverde, S. & F. Rodriguez-Fernandez (2019), An International Approach to the Cost of Payment Instruments: the case of cash, May.

Carbo-Valverde, S. & F. Rodriguez-Fernandez (2020), Fraud in Cash and Electronic Payments: taxonomy, estimation and projections, A report for the International Security Ligue.

Chakravorti, B. (2014), The Hidden Costs of Cash, Global Business HBR Digital Article, June 26, 2014.

Chakravorti, B. & B. D. Mazzotta (2013), The Cost of Cash in the United States, The Institute for Business in the Global Context, September.

Chen, H. M. Strathearn & M. Voia (2021), Consumer Cash Withdrawal Behavior: Branch networks and online financial innovation, Bank of Canada, Staff Working Paper 2021-28, June.

Coletti, G., A. Di Iorio, E. Pimpini & G. Rocco (2023), Report on the Payment Attitudes of Consumers in Italy: Results from the ECB SPACE 2022 survey, Banca d'Italia, Research Paper Markets, Infrastructures, Payment Systems Number 42, November.

Danish Payments Council (2018), Background to Series on the Costs of Payments in Denmark, September.

Danmarks Nationalbank (2012), Costs of Payments in Denmark.

Dark, C., C. Fisher, K. McBey & E. Tellez (2018), Payment Surcharges: Economics, Regulation and Enforcement, Reserve Bank of Australia, Bulletin, December, 1-20.

Deichner, N., H. Seidenschwarz & E. Stahl (2019), Gesamtkosten von Zahlungsverfahren im deutschen E-Commerce 2019 - Eine empirische Erhebung unter Online-Händlern, ibi research.

Delahaye, J.-P. (2024), Bitcoin: Electricity consumption comparable to that of Poland, Polytechnique insights, October 30th, 2024.

DESTATIS (2020), Prices for private current accounts in October 2020 6.4% higher than in the same month of the previous year, Number of the Week No. 48, November 24, 2020.

Deutsche Bundesbank (2018), Payment Behaviour in Germany in 2017, Fourth study of the utilisation of cash and cashless payment instruments, Frankfurt/Main.

Deutsche Bundesbank (2021), How do Private Households in Germany feel about the Digital Euro? First results from surveys and interviews, Monthly Report October 2021, 65-85

Deutsche Bundesbank (2022a), Payment Behavior in Germany 2021, Frankfurt/Main.

Deutsche Bundesbank (2022b), Access to Cash in Germany - Results of a representative population survey, Monthly Report December 2022, 57-69.

Deutsche Bundesbank (2022c), Demand for Euro Banknotes at the Bundesbank: Current developments, Monthly Report April 2022, 71-88.

Deutsche Bundesbank (2023), Schnelles Bezahlen mit Bargeld und kontaktlosen Zahlungsmitteln möglich, press release, 10.01.2023.

Deutsche Bundesbank (2024), Payment Behavior in Germany 2023, Frankfurt/Main.

European Central Bank (2020), Sixth Report on Card Fraud, August.

European Central Bank (2021a), Eurosystem Report on the Public Consultation on a Digital Euro, April.

European Central Bank (2021b), Digital Euro Experimentation Scope and Key Learnings.

European Central Bank (2022), Study on the Payment Attitudes of Consumers in the Euro Area (SPACE) - 2022, December.

European Central Bank (2023a), Product Environmental Footprint Study of Euro Banknotes as a Payment Instrument, December.

European Central Bank (2023b), Report on Card Fraud in 2020 and 2021.

European Central Bank (2024), Annual Report 2023.

European Central Bank/European Banking Authority (2024), 2024 Report on Payment Fraud.

European Association for Secure Transactions (E.A.S.T.), European Payment Terminal Crime Reports, various years.

Evans, D. S. & A. Mateus (2011), How Changes in Payment Card Interchange Fees Affect Consumers Fees and Merchant Prices: An Economic Analysis with Applications to the European Union, SSRN Electronic Journal, June.

Felt, M.-H., F. Hayashi, J. Stavins & A. Welte (2021), Distributional Effects of Payment Card Pricing and Merchant Cost Pass-through in Canada and the United States, Bank of Canada, Staff Working Paper 2021-8, February.

Garcia-Swartz, D. D., R. W. Hahn & A. Layne-Farrar (2004), The Economics of a Cashless Society: An Analysis of the Costs and Benefits of Payment Instruments, Working Paper 04-24, AEI-Brookings Joint Center for Regulatory Studies.

Garcia-Swartz, D. D., R.W. Hahn, & A. Layne-Farrar (2006a), The Move Toward a Cashless Society: A Closer Look at Payment Instrument Economics, Review of Network Economics 5, 175-197.

Garcia-Swartz, D. D., R.W. Hahn, & A. Layne-Farrar (2006b), The Move Toward a Cashless Society: Calculating the Costs and Benefits, Review of Network Economics 5, 198-228.

Gehring, B., S. Graf & T. Trütsch (2019), Swiss Payment Monitor 2019, University of St. Gallen/Zurich University of Applied Sciences.

Godschalk, H., M. Kruger & F. Seitz (2024), The digital euro from a consumer, retailer and industry perspective. Study commissioned by the National Association of German Cooperative Banks (BVR), August.

Goldszmidt, A., J. A. List, R. D. Metcalfe, I. Muir, V. K. Smith & J. Wang (2020), The Value of Time in the United States: Estimates from nationwide natural field experiments, NBER Working Paper 28208, December.

Górka, J. (2018), Interchange Fee Economics: To Regulate or Not to Regulate?, Palgrave Macmillan, Cham.

Greene, W. (2019), Econometric Analysis, 8th ed., Pearson.

Gresvik, O. & G. Øwre (2003), Costs and Income in the Norwegian Payment System 2001: An application of the Activity Based Costing framework, Norges Bank Working Paper No 8.

Gresvik, O. & H. Haare (2009), Costs in the Norwegian Payment System, Norges Bank Staff Memo No. 4.

Guibourg, G. & B. Segendorf (2007), A Note on the Price- and Cost Structure of Retail Payment Services in the Swedish Banking Sector 2002, Journal of Banking and Finance 31, 2817-2827.

Hanegraaf, R., A. Larçin, N. Jonker, S. Mandley & J. Miedema (2020), Life Cycle Assessment of Cash Payments in the Netherlands, The International Journal of Life Cycle Assessment 25.

Hayashi, F. & W. R. Keeton (2012), Measuring the Costs of Retail Payment Methods, Federal Reserve Bank of Kansas City Economic Review, 2nd quarter, 1-41.

Humphrey, D., M. Willesson, T. Lindblom & G. Bergendahl (2003), What Does it Cost to Make a Payment?, Review of Network Economics 2, 159-174.

Itai Agur, J. D., X. Lavayssière, S. Martinez Peria, D. Sandri, H. Tourpe & G. Villegas Bauer (2022) Digital Currencies and Energy Consumption, IMF Fintech Note 2022/006, June.

Jonker, N. (2013), Social Costs of POS Payments in the Netherlands 2002-2012: Efficiency gains from increased debit card usage, DNB Occasional Studies, Vol.11, No. 2.

Jonker, N. & A. Kosse (2009), The Impact of Survey Design on Research Outcomes: A case study of seven pilots measuring cash usage in the Netherlands, De Nederlandsche Bank, Working paper no. 221, August.

Judson, R. & R. Porter (2010), Estimating the Volume of Counterfeit U.S. Currency in Circulation Worldwide: Data and Extrapolation, Federal Reserve Bank of Chicago, Policy Discussion Paper 2010-2, March.

Junius, K., L. Devigne, J. Honkkila, N. Jonker, L. Kajdi, J. Kimmerl, L. Korella, R. Matos, N. Menzl, K. Przenajkowska, J. Reijerink, G. Rocco & C. Rusu (2022), Costs of Retail Payments - An overview of recent national studies in Europe, ECB Occasional Paper Series No 294, May.

Knümann, F., M. Krueger & F. Seitz (2024), Costs and Benefits of Cash and Cashless Payment Instruments - Module 3: Costs of cash and card payments from a consumer perspective, study commissioned by the Deutsche Bundesbank.

Koivuniemi, E. & K. Kemppainen (2007), On Costs of Payment Methods: A survey of recent studies, Bank of Finland Working Paper no. 6, September

Kosse, A., H. Chen, M.-H. Felt, V. Dongmo Jiongo, K. Nield & A. Welte (2017), The Costs of Point-of-Sale Payments in Canada, Bank of Canada, Staff Discussion Paper 2017-4, March.

Krueger, M. (2009), The Pricing of Payments, ROME Discussion Paper No. 09-08, October.

Krueger, M. (2015), Do the Poor Pay for Card Rewards of the Rich?, Review of Economics 66, 129-153.

Krueger, M. & F. Seitz (2014), Costs and Benefits of Cash and Cashless Payment Instruments - Module 1: Overview and first estimates, study commissioned by the Deutsche Bundesbank, Frankfurt/Main.

Krueger, M. & F. Seitz (2017), Costs and Benefits of Cash and Cashless Payment Instruments - Module 2: The benefits of cash, Fritz Knapp Publisher, Frankfurt/Main.

Leclerc, F., B. H. Schmitt & L. Dubé (1995), Waiting Time and Decision Making: Is Time like Money?, Journal of Consumer Research 22, 110-119.

Lepecq, G. (2020), How Cash is Reducing its Environmental Footprint, Cash Essentials, 26.10.2020.

Marincovic C., K. Pritchard, M. Binder & N. da Silva (2011), Life Cycle Assessment of Canada's Polymer Banknotes and Cotton-Paper Banknotes, Final report.

National Forum on the Payments System (2004), The Costs of Payments: Survey of the costs involved in POS payment products, Working Group on Costs of POS Payment Products, March.

Nevo, A. & A. Wong (2019), The Elasticity of Substitution Between Time and Market Goods: Evidence from the Great Recession, International Economic Review 60, 25-51.

Norges Bank (2014), Costs in the Norwegian Payment System, Norges Bank Papers No. 5.

Norges Bank (2022), Costs in the Norwegian Payment System 2020, Norges Bank papers No. 3-2022.

OECD (2012), Understanding Pitfalls in the Design of Surveys, in: OECD (ed.), Measuring Regulatory Performance: A Practitioner's Guide to Perception Surveys, OECD Publishing, Paris.

OECD (2022), Environmental Impact of Digital Assets: Crypto-asset mining and DLT consensus mechanisms, OECD Business and Finance Policy Papers, OECD Publishing, Paris.

PaySys (2006), The Costs of Cash and Non-cash Payment Instruments in Germany, Frankfurt.

Png, I. P. L & C. H. Y. Tan (2021), Cost of Cash: Evidence from cashiers, Service Science, Articles in Advance, 1-21.

Przenajkowska, K., M. Polasik, K. Maciejewski & T. Koźliński (2019), Costs of Payment Instruments on the Polish Market, Narodowy Bank Polski.

Retail Banking Research (2010), The Future of Cash and Payments, January.

Roberds, W. & S. L. Schreft (2009), Data Security, Privacy, and Identity Theft: The economics behind the policy debates, Federal Reserve Bank of Chicago, Economic Perspectives 1Q/2009, 22-30.

Roos Lindgreen, E:, M. van Schendel, N. Jonker, J. Kloek, L. de Graaf & M. Davidson (2018), Evaluating the Environmental Impact of Debit Card Payments, The International Journal of Life Cycle Assessment 23, 1847 - 1861.

Rösl, G. & F. Seitz (2021), Cash and Crises: No surprises by the virus, Institute for Monetary and Financial Stability, Working Paper No. 150, February.

Schmiedel, H., G. Kostova, & W. Ruttenberg (2013), The Social and Private Costs of Retail Payment Instruments: A European Perspective, Journal of Financial Market Infrastructures 2, 37-75.

Schuh, S., O. Shy & J. Stavins (2010), Who Gains and Who Loses from Credit Card Payments? Theory and Calibrations, Federal Reserve Bank of Boston Public Policy Discussion Papers No. 10-03.

Schwartz, M. (2024), The New Cash Paradox, Cash, Payment & CBDC News, April.

Schwartz, C., J. Fabo, O. Bailey & L. Carter (2008), Payment Costs in Australia', in: RBA and University of Melbourne, Proceedings of a conference held in Sydney on November 29, 2007, 88-138.

Swiss National Bank (2023), Survey on Payment Methods among Private Individuals in Switzerland 2022.

Segendorf, B. & T. Jansson (2012), The Cost of Consumer Payments in Sweden, Sveriges Riksbank, Working paper series 262, June.

Shampine, A. (2007), Another Look at Payment Instrument Economics, Review of Network Economics 6, 495-508.

Shampine, A. (2009), The Evaluation of Social Welfare for Payment Methods, Oxford Business & Economics Conference June 24-26, 2009.

Shonfield, P. (2013), LCA of Paper and Polymer Bank Notes: Final study report for the Bank of England.

Shy, O. (2019), Cashless Stores and Cash Users, Federal Reserve Bank of Atlanta, Working Paper 2019-11a, August.

Shy, O. (2022), Interchange Fees with Cashless Stores, Cashless Consumers, and Cash-only Consumers, Economics Letters 212, March, 110284.

Shy, O. & J. Stavins (2022), Who Is Paying All These Fees? An empirical analysis of bank account and credit card fees, Federal Reserve Bank of Boston, Working Paper No. 22-18, August. Simes, R., A. Lancy & I. Harper (2006), Costs and Benefits of Alternative Payments Instruments in Australia, Melbourne Business School Working Paper No 2006-08.

Sintonen, M. & K. Takala (2022), Costs of Retail Payments in Finland: What paying costs? Bank of Finland, Expository Studies, A: 129.

Stewart, C., I. Chan, C. Ossolinski, D. Halperin & P. Ryan (2014), The Evolution of Payment Costs in Australia, Reserve Bank of Australia, Research Discussion Paper 2014-14, December.

Sveriges Riksbank (2023), Cost of Payments in Sweden, Riksbank Studies, NR 1 2023, March.

Tagesschau (2023), Kostenlose Girokonten immer seltener, 23.08.2023 (https://www.tagesschau.de/wirtschaft/verbraucher/bankgebuehren-girokonten-finanztest-100.html).

Takala, K. & M. Virén (2008), 'Efficiency and Costs of Payments: Some new evidence from Finland, Bank of Finland Research Discussion Papers no. 11.

Tamele, B., A. Zamora-Pérez, C. Litardi, J. Howes, E. Steinmann & D. Todt (2021), 'Catch me (if you can): Assessing the risk of SARS-CoV-2 transmission via euro cash', ECB Occasional Paper No. 259.

Thum, M. (2018), Die ökonomischen Kosten des Bitcoin-Mining, ifo Schnelldienst 2/2018, 71. Jahrgang, 18-20.

Tiberi, P. (2021), The Carbon Footprint of the Target Instant Payment Settlement (TIPS) System: A comparative analysis with Bitcoin and other infrastructures, Banca d'Italia, Research Paper Markets, Infrastructures, Payment Systems No. 5, May.

Tims, A. (2018), End of the Great Card Payment Rip-off? No, it's just a new one, The Guardian, 17.6.2018.

Tobin, J. (1956), The Interest-Elasticity of Transactions Demand for Cash, The Review of Economics and Statistics 38, 241-247.

Tödter, K.-H. (2021), Digitaler Euro und externe Kosten, Aktionskreis: Stabiles Geld, mimeo, February.

Trundy, S. (2015), Identity Theft and Loss Prevention, Fraud Prevention Blog, May 4, 2015.

Trütsch, T., J. Huber & N. Bralovic (2024), The Cost of Point-of-Sale Payments in Switzerland, University of St. Gallen.

Turján, A., É. Divéki, É. K. Harmath, G. Kóczán & K. Takács (2011), Nothing is Free: A survey of the social cost of the main payment instruments in Hungary.

Vallée, G. (2018), How Long Does It Take You to Pay? A Duration Study of Canadian Retail Transaction Payment Times, Bank of Canada, Staff Working Paper 2018-46, September.

Viles, N., A. Rush & T. Rohling (2015), The Social Costs of Currency Counterfeiting, Reserve Bank of Australia, Research Discussion Paper 2015-05, May.

VISA (2018), Cashless Cities: Realizing the Benefits of Digital Payments.

Zamora-Pérez, A. (2021), The Paradox of Banknotes: Understanding the demand for cash beyond transactional use, European Central Bank, Economic Bulletin 2/2021, 121-137.

Table 1A: Cash - private costs/resource costs for consumers

Country	Year		% GDP		Per transaction (€)[1)]		Relative to transaction value (%)		Consumer share (%)[2)]		Share fixed/variable (%)		Cash share (%)[4)]	
Australia	2013				0.26	0.13				28			29	16
Australia[6)]	2007					0.07				20				15
Australia	2005	$10 trx.			0.35	0.32	5.70	5.20	58	54				
Australia	2005	$50 trx.			0.79	0.61	2.58	1.98	67	60				
Australia	2005	$100 trx.			1.34	0.97	2.19	1.59	70	63				
Canada	2014		0.11	0.04	0.19	0.07	1.5	0.5	25	12		23 (49)[3)]	41	62
USA	2013		0.26	0.18					22					
USA	2003	11,52$			0.57	0.50	5.64	4.86	72	62				
USA	2003	54,242$			1.70	1.39	3.54	2.89	88	72				
Uruguay	2016	only cash and cheques	0.13		0.35[14)]				21				80	
Denmark	2016			0.02		0.13				23				33
Denmark	2016	eCom												
Denmark	2009		0.09	0.08	0.26	0.23	1.00	0.90	26	23			64	66
Denmark	2009	eCom												
Norway	2020		0.00	0.00	0.66	0.14			26	8			14	9
Norway	2013		0.04	0.03	0.67	0.39			30	26			22	26
Norway	2007		0.08	0.06	0.83[9)]	0.37	2.30	1.40	41	38			28	39
Sweden	2021		0.03	0.03	0.46	0.40			30	30				12
Sweden	2009		0.16	0.00	0.49	0.00	2.10	0.00	31	0		0	56	50
Belgium	1998		0.06	0.00	0.05	0.00	0.73	0.00	8	0				
Hungary	2019			0.08		0.03				10				39
Hungary	2009		0.71	0.08	0.26	0.03	2.40	0.30	40	10			64	53
Germany	2023		0.16	0.10	0.38	0.26	1.74	1.20					36	65
Germany	2017				0.25	0.03	0.16	0.02	50	19			34	13
Germany	2004		0.18	0.13	0.10	0.07	0.51	0.37	82	87				
Switzerland	2022		0.14	0.07	0.79	0.37	3.10	1.43	17	10		0/81/9[13)]	41	68
Poland	2015		0.15	0.07	0.06	0.02	0.45	0.17	13				65	78
Multi-Country-Study	2017 (52 countries)				0.22	0.02	0.40	0.00	44	18			26	9
Multi-Country-Study	2017 (Europe)						0.30	0.00	41	6			22	4

Table 2A: Debit card - private costs/resource costs for consumers

Country	Year		% GDP		Per transaction (€)[1)]		Relative to transaction value (%)		Consumer share (%)[2)]		Share fixed/variable (%)	
Australia	2013				0.3	0.09				16		
Australia[6)]	2007					0.09				12		
Australia	2005	$10 trx.			0.36	0.36	5.90	5.80	69	68		
Australia	2005	$50 trx.			0.36	0.36	1.18	1.16	69	68		
Australia	2005	$100 trx.			0.36	0.36	0.59	0.58	69	68		
Canada	2014		0.15	0.01	0.40	0.04	1.40	0.14	48	11	-	
USA	2013											
USA	2003	11.52$			0.49	0.37	4.77	3.65	55	42		
USA	2003	54.24$			0.49	0.37	1.01	0.77	51	39		
Denmark	2016			0.05		0.09				24		
Denmark	2016	eCom		0.01						57		
Denmark	2009		0.05	0.04	0.13	0.11	0.30	0.30	27	26		
Denmark	2009	eCom	0.01	0.00	0.56	0.24	0.80	0.30	38	37		
Norway[12)]	2020	"cards"	0.00	0.00	0.14	0.07			25	16		
Norway[5)]	2013		0.06	0.03	0.17	0.10			37	26		
Norway[5)]	2007		0.05	0.02	0.18	0.09	0.40	0.20	24	17		
Sweden	2021		0.1	0.05	0.14	0.07			25	17[12)]		
Sweden	2009		0.06	0.00	0.13	0.00	0.30	0.00	21	0		
Belgium	1998	"cards"	0.07	0.00	0.42	0.00	0.85	0.00	66	0		
Hungary	2019	"cards"		0.03[12)]		0.04[12)]				6[12)]		
Hungary	2009		0.06	0.01	0.39	0.04	1.50	0.20	28	6		
Germany	2023		0.17	0.04	0.74	0.18	1.49	0.36				
Germany	2017				0.48	0.21	0.86	0.37	34	45		
Germany	2004		0.02	0.02	0.20	0.19	0.32	0.31	8	11		
Switzerland	2022		0.12	0.02	0.67	0.14	1.53	0.31	30	19		0/75/25[13)]
Poland	2015		0.05	0.00	0.1	0.02	0.65	0.13				
Multi-Country-Study	2017 (52 countries)				0.61	0.15	1.20	0.30	45	52		
Multi-Country-Study	2017 (Europe)						1.20	0.40	46	47		

Table 3A: Credit card - private costs/resource costs of consumers

Country	Year		% GDP		Per transaction (€)[1]		Relative to transaction value (%)		Consumer share (%)[2]		Share fixed/variable (%)	
Australia	2013				0.33	0.14				9		
Australia[6]	2007					0.13				8		
Australia	2005	$10 trx.			0.40	0.39	6.50	6.40	60	60		
Australia	2005	$50 trx.			0.40	0.39	1.30	1.28	52	56		
Australia	2005	$100 trx.			0.40	0.39	0.65	0.64	45	52		
Canada	2014		0.02	0.01	0.09	0.04	0.15	0.07	3	3	-	
USA	2013											
USA	2003	11.52$			0.41	0.41	3.99	3.99	48	48		
USA	2003	54.24$			0.41	0.41	0.85	0.85	40	40		
Denmark	2016		0.00	0.00		0.09				5		
Denmark	2016	eCom								15		
Denmark[8]	2009		0.00	0.00	0.56	0.11	0.80	0.20	20	4		
Denmark[8]	2009	eCom	0.00	0.00	1.86	0.24	1.90	0.25	64	8		
Norway[5]	2013		0.02	0.01	0.42	0.18			16	11		
Norway[5]	2007		0.04	0.01	1.07	0.31	1.36	0.39	20	12		
Sweden	2021		0.02	0.01	0.24	0.08			20	17[12]		
Sweden	2009		0.04	0.00	0.58	0.00	1.20	0.00	22	0		
Belgium	1998											
Hungary	2019	"cards"		0.03[12]		0.04[12]				6[12]		
Hungary	2009		0.23	0.00	8.99	0.04	30.90	0.10	74	1		
Germany	2023		0.09	0.01	1.34	0.19	2.38	0.32				
Germany	2017											
Germany	2004		0.02	0.00	1.27	0.19	1.44	0.22	11	0		
Switzerland	2022		0.08	0.01	1.91	0.14	3.13	0.23	26	4		0/71/29[13]
Poland	2015		0.01	0.00	0.15	0.02	0.54	0.47				
Multi-Country-Study	2017 (52 countries)											
Multi-Country-Study	2017 (Europe)											

Table 4A: Other means of payment - consumers' private costs/resource costs

Country	Jahr	Instrument	% GDP		Per transaction (€)[1]		Relative to transaction value (%)		Consumer share (%)[2]	
Australia	2013	BPAY and cheques				0.44				8
Australia[6]	2007					0.20				4
Australia	2005	$10 trx.ch			0.57	0.56	9.30	9.20	51	50
Australia	2005	$50 trx.ch			0.57	0.56	1.86	1.84	51	50
Australia	2005	$100 trx.ch			0.57	0.56	0.93	0.92	51	50
Australia	2005	$10 trx.3p			0.40	0.39	6.50	6.40	58	59
Australia	2005	$50 trx.3p			0.40	0.39	1.30	1.28	51	55
Australia	2005	$100 trx.3p			0.40	0.39	0.65	0.64	44	51
Australia	2005	$10 trx.sig			0.40	0.39	6.50	6.40	62	61
Australia	2005	$50 trx.sig			0.40	0.39	1.30	1.28	64	63
Australia	2005	$100 trx.sig			0.40	0.39	0.65	0.64	64	63
Canada	2014									
USA	2013									
USA	2003	11,52$ trx, sig			0.41	0.41	3.99	3.99	50	50
USA	2003	54,24$ trx, sig			0.41	0.41	0.85	0.85	46	46
USA	2003	11,52$ trx, Nch			0.62	0.58	6.08	5.73	60	56
USA	2003	54,242$ trx, Nch			0.62	0.58	1.29	1.22	50	47
USA	2003	11,52$ trx, Vch			0.57	0.55	5.64	5.38	61	58
USA	2003	54,24$ trx, Vch			0.57	0.55	1.20	1.14	60	57
Uruguay	2016	cheques		0.03						79
Denmark	2016	Bank transfer via Internet	0.02	0.02	1.03	1.00	0.16	0.16	21	21
Denmark	2009									
Norway	2020	bank transfer (giro payments)	0.00	0.00	0.29	0,04			26	3
Norway	2013	bank transfer[10]	0.08	0.03	0.51	0.21			28	19
Norway	2007	bank transfer[10]	0.07	0.02	0.92	0.28			32	22
Sweden	2021	direct debit	0.03	0.02	0.09	0.04			30	5
Sweden	2021	Swish	0.01	0.01	0.19	0.13			16	
Sweden	2009	bank transfer	0.02	0.00	0.26	0.00	0.20	0.00	16	0
Sweden	2009	direct debit	0.01	0.00	0.10	0.00	0.10	0.00	20	0
Hungary	2019	bank transfer		0.01		0.57				5
Hungary	2019	direct debit		0.00		0.06				12
Hungary	2009	bank transfer[10]	0.10	0.05	0.33	0.19	0.00	0.00	19	19
Hungary	2009	direct debit	0.01	0.00	0.16	0.04	0.50	0.10	24	12
Germany	2017									
Poland	2015	bank transfer	0.02	0.00	0.11	0.02	0.01	0.00		
Poland	2015	mobile payments	0.00	0.00	0.05	0.3	0.15	0.00		
Poland	2015	direct debit	0.00	0.00	0.03	0.01	0.01	0.00		

Notes to Tables 1A - 4A:
1) Conversion to € using the average exchange rate for the year of the study. 2) Share of costs per payment medium attributable to consumers. 3) Fixed costs in relation to transaction-related (value-related) variable costs, resource costs only. 4) Share of cash costs in total means of payment costs for consumers. 5) Debit cards: national system; credit cards: international cards; 6) Based on average representative transaction sizes; 7) face-to-face/distance commerce; 8) incl. seigniorage; 9) electronic and paper-based; 10) resource costs only; 11) all payment cards; 12) ratio of total fixed costs/transaction-based variable costs/turnover-based variable costs for consumers; 13) cash withdrawals as a proxy for cash transactions (lower limit). The "year" refers to the data on which the study was based.

IMFS WORKING PAPER SERIES

Recent Issues

217/2025	Alexander Meyer-Gohde, Johannes Huber	Iterative Refinement of the QZ Decomposition for Solving Linear DSGE Models
216/2025	Michael Haliassos, Thomas Jansson, Yigitcan Karabulut	Wealth Inequality: Opportunity for Me or for Others?
215/2024	Michael D. Bauer, Eric Offner, Glenn D. Rudebusch	Green Stocks and Monetary Policy Shocks: Evidence from Europe
214 / 2024	Michael D. Bauer, Daniel Huber, Eric Offner, Marlene Renkel, Ole Wilms	Corporate Green Pledges
213 / 2024	Athanasios Orphanides	The Federal Reserve's Evolving Interpretation and Implementation of Its Mandate
212 / 2024	Matthias Rumpf Michael Haliassos Tetyana Kosyakova Thomas Otter	Do Financial Advisors Have Different Beliefs than Lay People?
211 / 2024	Michael Haliassos	Wealth Accumulation: The Role of Others
210 / 2024	Kamila Duraj Daniela Grunow Michael Haliassos Christine Laudenbach Stephan Siegel	Rethinking the Stock Market Participation Puzzle: A Qualitative Approach
209 / 2024	Balint Tatar Volker Wieland	Policy Rules and the Inflation Surge: The Case of the ECB
208 / 2024	Reimund Mink	Helmut Schlesinger: Wegbereiter und Garant der deutschen Geld- und Stabilitätspolitik wird 100
207 / 2024	Alexander Meyer-Gohde	Solving and analyzing DSGE models in the frequency domain
206 / 2024	Jochen Güntner Magnus Reif Maik Wolters	Sudden Stop: Supply and Demand Shocks in the German Natural Gas Market
205 / 2024	Alina Tänzer	Multivariate Macroeconomic Forecasting: From DSGE and BVAR to Artificial Neural Networks
204 / 2024	Alina Tänzer	The Effectiveness of Central Bank Purchases of long-term Treasury

		Securities:A Neural Network Approach
203 / 2024	Gerhard Rösl	A present value concept for measuring welfare
202 / 2024	Reimund Mink Karl-Heinz Tödter	Staatsverschuldung und Schuldenbremse
201 / 2024	Balint Tatar Volker Wieland	Taylor Rules and the Inflation Surge: The Case of the Fed
200 / 2024	Athanasios Orphanides	Enhancing resilience with natural growth targeting
199 / 2024	Thomas Jost Reimund Mink	Central Bank Losses and Commercial Bank Profits – Unexpected and Unfair?
198 / 2024	Lion Fischer Marc Steffen Rapp Johannes Zahner	Central banks sowing the seeds for a green financial sector? NGFS membership and market reactions
197 / 2023	Tiziana Assenza Alberto Cardaci Michael Haliassos	Consumption and Account Balances in Crises: Have We Neglected Cognitive Load?
196 / 2023	Tobias Berg Rainer Haselmann Thomas Kick Sebastian Schreiber	Unintended Consequences of QE: Real Estate Prices and Financial Stability
195 / 2023	Johannes Huber Alexander Meyer-Gohde Johanna Saecker	Solving Linear DSGE Models With Structure Preserving Doubling Methods
194 / 2023	Martin Baumgärtner Johannes Zahner	Whatever it takes to understand a central banker – Embedding their words using neural networks
193 / 2023	Alexander Meyer-Gohde	Numerical Stability Analysis of Linear DSGE Models – Backward Errors, Forward Errors and Condition Numbers
192 / 2023	Otmar Issing	On the importance of Central Bank Watchers
191 / 2023	Anh H. Le	Climate Change and Carbon Policy: A Story of Optimal Green Macroprudential and Capital Flow Management
190 / 2023	Athanasios Orphanides	The Forward Guidance Trap
189 / 2023	Alexander Meyer-Gohde Mary Tzaawa-Krenzler	Sticky information and the Taylor principle
188 / 2023	Daniel Stempel Johannes Zahner	Whose Inflation Rates Matter Most? A DSGE Model and Machine Learning Approach to Monetary Policy in the Euro Area

187 / 2023	Alexander Dück Anh H. Le	Transition Risk Uncertainty and Robust Optimal Monetary Policy
186 / 2023	Gerhard Rösl Franz Seitz	Uncertainty, Politics, and Crises: The Case for Cash
185 / 2023	Andrea Gubitz Karl-Heinz Tödter Gerhard Ziebarth	Zum Problem inflationsbedingter Liquiditätsrestriktionen bei der Immobilienfinanzierung