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Abstract

This study provides insight into the costs of cash, debit card and credit card payments made at the point of sale in Canada in 2014. For each payment method, it examines the total resource costs, which capture the overall use of resources by society as a whole. Using extensive survey data from retailers, financial institutions and cash transportation companies as well as internal and external data sources, the results show that the resource costs of payments in Canada are non-negligible (0.78 per cent of GDP). Credit cards are most costly in terms of resource costs per transaction, while cash carries the highest resource costs per dollar transacted. Debit cards are the least costly, both in terms of costs per transaction and costs per dollar in sales. The study also demonstrates how the costs vary with transaction sizes. Considering the variable resource costs only, cash is found to be cheapest for transactions up to $6, while debit cards are the least costly for transactions larger than $6. The study also looks into the total private costs, which are the costs incurred by each stakeholder, thereby providing insight into how costs are affecting the use and acceptance of payment methods.

Bank topics: Bank notes; Financial institutions; Payment clearing and settlement systems; Digital currencies

JEL codes: D12, D23, D24, E41, E42, G21, L2

Résumé

Cette étude permet de mieux cerner les coûts des paiements effectués en argent comptant, par carte de débit et par carte de crédit dans les points de vente au Canada en 2014. Pour chacun de ces modes de paiement, nous examinons l'ensemble des coûts en ressources, qui rendent compte de l'utilisation globale des ressources par la société tout entière. Les résultats, fondés sur de nombreuses données d'enquête auprès des détaillants, des institutions financières et des sociétés de transport de fonds, ainsi que sur des sources de données internes et externes, montrent que les coûts en ressources associés aux paiements au Canada ne sont pas négligeables (0,78 % du PIB). Les paiements par carte de crédit sont les plus coûteux par transaction sur le plan de l'utilisation des ressources, tandis que les paiements en argent comptant entraînent les coûts en ressources les plus importants par dollar de vente. Les règlements par carte de débit sont les moins coûteux par transaction et par dollar de vente. Par ailleurs, nous montrons comment les coûts varient selon le montant des transactions. Du point de vue des seuls coûts variables en ressources, les paiements les moins coûteux découlent des transactions en argent comptant allant jusqu'à 6 $ et des

transactions par carte de débit de plus de 6 $. L'étude porte également sur l'ensemble des coûts individuels, à savoir les coûts assumés par chaque partie prenante, ce qui permet de mieux comprendre leur incidence sur l'utilisation et l'acceptation des différents modes de paiement.

Sujets : Billets de banque ; Institutions financières ; Systèmes de compensation et de règlement des paiements ; Monnaies numériques
Codes JEL : D12, D23, D24, E41, E42, G21, L2

Summary and Key Findings

The Bank of Canada (the Bank) conducted a comprehensive study to analyze the costs of cash, debit cards and credit cards used by Canadian consumers at the point of sale (POS) in Canada in 2014. For each payment method, the study assesses the overall use of resources by society as a whole. Moreover, the study examines the total private costs incurred by the key stakeholders, i.e., consumers, retailers, financial institutions and infrastructures, the Royal Canadian Mint (the Mint) and the Bank. This paper discusses the methodology and reports the main findings of the study.

Various extensive surveys were conducted to collect cost information from retailers, financial institutions and cash transportation companies. A separate study was established to measure the time costs for consumers and retailers to make and receive payments. As well, internal and external data sources were employed to assess the costs for consumers, the Mint and the Bank, and to estimate the number and value of payments made at the POS in Canada in 2014.

The key findings of the study are:

- *The costs of cash and card payments at the POS in Canada are non-negligible. Total resource costs amounted to $15.3 billion, which corresponds to 0.78 per cent of GDP.*
- *Stakeholders incur costs in providing, accepting and using payments at the POS and their shares vary by payment method.*
- *Debit cards are the least costly in terms of total resource costs, followed by credit cards, whereas cash is the most costly.*
- *On average, debit cards are the least costly in terms of resource costs per transaction (volume) as well as resource costs per dollar transacted (value). Credit cards carry the highest resource cost per transaction, while cash is most costly in terms of resource costs per dollar transacted.*
- *Considering variable resource costs per transaction, cash is cheapest for transactions up to $6, while debit cards are the least costly for transactions larger than $6.*
- *If stakeholders make their payment choices based on their private costs alone, consumers would prefer to use credit cards, while retailers and financial institutions would prefer debit card payments.*

It is important to recognize that the study focuses solely on the costs that can be measured. The use, acceptance and provision of payment methods by individual stakeholders, however, also depends on the overall revenues and benefits those methods generate. Therefore, to better understand the overall efficiency of payment methods, as well as the drivers of the use and acceptance of payments, further work on the benefits and revenues is recommended. Moreover, the study uses information over 2014. Because of recent changes in the payments environment, such as a further growth in the use of contactless debit card and credit card payments and ongoing efforts by financial institutions to reduce costs, the cost estimates may have changed.

1 Introduction

Consumers can use different methods to pay for their point-of-sale (POS) purchases and many parties incur costs for these payments. For example, for a cash payment, the central bank and financial institutions incur a cost to produce bank notes and make them available to the public, the consumer incurs a cost to withdraw the cash from an automated teller machine (ATM) or bank teller, and merchants incur a cost to count and accept the cash and process and deposit it at the end of the day. The Bank of Canada (the Bank) has a great interest in understanding these costs and how they differ between payment methods.

1.1 Background

The Bank plays an important role in retail payments by issuing Canadian bank notes and promoting the efficiency and safety of the payments system. To improve its understanding of the use of cash and other payment methods, the Bank regularly conducts a Methods-of-Payment (MOP) Survey (see, for example, Fung et al. (2015)). However, comprehending the costs is also important. Knowing the absolute and relative costs of cash will enable the Bank to improve its understanding of the demand for bank notes and how to improve the efficiency of its currency provision. A detailed study on the costs of cash and card payments also creates new research opportunities. Understanding the cost of paying will allow for new insight—for example, into the interaction between the retailer and consumer sides of the payments market. Furthermore, transparency about the costs will enable a discussion of how these costs could be reduced and allow all market participants to make better-informed decisions as to what payment methods to use, accept or provide. This may eventually help improve the overall efficiency of the Canadian payments system.

In 2006, the Bank conducted a survey among Canadian retailers (see Arango and Taylor (2008)). It provided a first step toward understanding the costs of POS payments. Overall, cash was found to be the least costly method of payment for low-value transactions. However, the payments landscape has significantly changed since then. Innovations such as contactless cards have entered the scene, the card industry has adopted a code of conduct launched by the Department of Finance Canada in 2010 to encourage choice and competition in the debit and credit card market,[1] and the use of cash has continued to decline (Fung et al. (2015)). Also, the 2006 study focused on retailers and variable costs only; costs for other stakeholders were not examined. Therefore, an updated and broader study is warranted.

1.2 Scope of study

This study analyzes the costs of different payment methods in Canada in 2014. The focus is on the main payment methods used by Canadian consumers at the POS, which are cash, debit cards and credit cards, with the latter including regular as well as prepaid credit cards.[2] Costs related to the use of these instruments for person-to-person, e-commerce or

[1] See https://www.fin.gc.ca/n10/10-029-eng.asp.

[2] The focus is on cards issued in Canada only. Although no actual credit is involved with prepaid credit cards, the term "prepaid credit card" is used in this study to refer to Visa and MasterCard prepaid cards.

bill payments, and payments outside Canada, are out of scope. Cheques are excluded as well, since consumers rarely use them at the POS.

For each payment method, the study assesses the total costs in terms of overall use of resources by society, which is relevant for understanding the cost-efficiency of payments from a social perspective. Moreover, to better understand the decisions made by individual stakeholders, the study examines the total private costs incurred by consumers, retailers, financial institutions and infrastructures, the Royal Canadian Mint (the Mint) and the Bank. Revenues and benefits are out of scope, so only gross costs are assessed. For reasons of confidentiality, the costs for financial institutions, cash transportation companies and other infrastructure providers are reported as one aggregate total. Similarly, the costs for the Mint and the Bank are also aggregated.

To allow for a fair comparison across instruments, this paper considers only the payment function of credit cards. Costs related to their credit functionality, such as credit losses and the costs of outstanding credit balances, are out of scope. Costs related to the 21-day grace period and the evaluation of the credit worthiness of new applicants by contrast are considered as a payment cost and included.[3] Similarly, beyond their payment function, debit cards can be used as a means of authentication for online banking and for cash withdrawals. However, only a debit card's POS payment function is covered in this study. The costs of cash withdrawals, including those made using a debit, credit or prepaid card, are included in the cost of cash.

1.3 Contribution and comparison with other studies

This study is similar to those of other central banks in a number of ways—see, for instance, Hayashi and Keeton (2012) and Schmiedel et al. (2013). These studies share some common conclusions, including that the costs of payments are non-negligible and that cash payments often carry the lowest cost for small transactions. However, different conclusions are reached about the absolute costs of different payment methods. The European Central Bank (ECB), for example, assesses the costs in 13 European countries and shows that the resource cost of payments ranges from 0.42 to 1.35 per cent of gross domestic product (GDP) per country (Schmiedel et al. (2013)). An Australian study by Stewart et al. (2014) estimates the resource costs of retail payments at 0.54 per cent of GDP. This suggests that costs can depend on the specificity of a country's payments system. Moreover, the studies differ in terms of methodology, scope and year. This indicates that comparisons should be made with caution and underlines the need for the Bank to conduct its own study.

Appendix A presents the key characteristics of several cost studies. This study contributes to the understanding of the costs of payments in a number of ways. First, it is based on an extensive retailer survey. As discussed later in Section 4.2, data are collected from over 1,000 retailers. This is considerably more than in the Bank's 2006 survey (Arango and Taylor (2008)) and in most other studies. In particular, small and medium-sized retailers are well represented (see Figure 1). Second, this study covers the costs of the key stakeholders in

[3] In Canada, consumers usually have 21 days from the time they receive their credit card statement to pay off the new balance before incurring any interest costs. The costs related to this grace period are considered as a cost related to the payment function of credit cards. The evaluation of the creditworthiness of new applicants is included, as this is a standard procedure, even when the card is used only for payments.

the payments chain. The Bank's 2006 survey focused only on retailers, while the current study also includes the financial sector and the bank-note- and coin-issuing authorities. It also assesses consumer costs, which are not considered in every study. Moreover, as discussed in Section 4, this paper directly surveys cash transportation companies instead of using information provided by retailers and banks. This study further contributes in that a distinction is made between fixed and variable costs. As a result, this paper is able to show how the costs of payments vary with transaction sizes.

1.4 Caveats of study

Despite the broad coverage, there are a number of caveats to bear in mind when interpreting the results. First, the study focuses on the year 2014, but the payments market has further changed since then. For example, Canada's largest credit card companies reduced their retailer fees in 2015[4] and new payment options have been launched. Therefore, the estimates may have changed over time as well. Second, a discussion of the efficiency of alternative methods of payment should take into account a wider range of considerations than just the gross costs as measured in this study, such as the revenues and benefits they offer to various stakeholders and their indirect impact on the rest of the society, i.e., their externalities. Ideally, an all-comprehensive cost-benefit analysis would entail every item listed in Figure 2. Since benefits and externalities are difficult to quantify, this paper focuses on the costs only, and only those that can be measured directly, i.e., the two highlighted boxes at the bottom of the figure. Third, while the focus is on the use of payment methods at the POS, the estimated cost of cash includes all issuance and distribution costs, irrespective of how the cash is finally used by the public. Since cash can be used for purposes other than POS payments—such as person-to-person payments or maintaining a supply of cash on-hand—the total cash costs may overestimate the cost of cash used for POS payments only. Fourth, while the study is based on an extensive sample of retailers, the large businesses covered in the study are not fully representative of all large retailers in Canada. Therefore, any statistical references should be used with some caution. Finally, the estimates are subject to various other key assumptions, which are summarized in Appendix B. These should be kept in mind when interpreting the results.

1.5 Structure of paper

The next sections describe the Canadian payments landscape (Section 2) and the cost definitions used for the analysis (Section 3). Section 4 discusses the various methods used to calculate the costs for each stakeholder. Section 5 presents the findings and compares the results with those found abroad. The paper closes with a conclusion and discussion in Section 6.

[4]See: http://www.fin.gc.ca/n14/14-157-eng.asp.

2 The Canadian Retail Payments Landscape

2.1 Payment trends

Over the past 20 years, Canada has witnessed a gradual shift away from cash and toward debit and credit cards (Arango et al. (2012)). More recently, the decrease in the market share of cash has mainly been driven by increased usage of credit cards, in particular contactless credit cards (see Figure 3 and Figure 4; see also Fung et al. (2015)). The market share of cash in terms of value, however, remained virtually stable between 2009 and 2013. The observed reduction in the use of cash in favour of electronic means of payment is in line with research by Fung et al. (2014) and Chen et al. (2017) that predicts a significant reduction in the share of cash as a result of the introduction of contactless credit cards.

The shift towards contactless credit cards may be explained by different factors. First, contactless payment cards differ from regular payment cards in terms of speed and convenience, which are features that Canadian consumers rank as most desirable (Arango and Welte (2012)). Moreover, the increase in contactless payments goes hand in hand with the massive rollout of contactless credit cards by Canadian financial institutions and the wide deployment of contactless terminals by retailers over the past years.[5] Finally, the rising share of credit card payments in general might be attributable to the generous reward programs in Canada. Henry et al. (2015) show that about two-thirds of respondents to the Bank of Canada 2013 MOP survey received rewards on their main credit card and that these respondents were less likely to use cash.

Despite the recent developments, Wakamori and Welte (2017) find that consumers still have a preference for using cash for POS transactions, especially small-value ones. Indeed, cash still constitutes a major share of POS transactions in Canada and in other countries (Bagnall et al. (2016)). According to Henry et al. (2015), cash is still seen as a convenient, low-cost, secure and widely accepted means of payment. Moreover, it is used most commonly among respondents who are older, have a lower income or are less educated.

2.2 Key stakeholders in retail payments

The Canadian cash and payment card market is composed of many stakeholders, each of which incurs a cost for enabling, using or accepting payments. Figure 5 provides an overview of the key stakeholders considered in this study.

Consumers usually pay a periodic fee to have a bank account and a credit card, and depending on their banking package, they may also pay a fee to withdraw cash or use their cards. Other costs include the (travel) time spent to make payments or withdraw cash, the risks of holding and using payment methods, and forgone interest on outstanding cash or prepaid credit card balances. The costs for retailers include periodic fees and per-transaction charges for accepting card payments and depositing cash, rental or depreciation costs of terminals, and security and fraud costs. Retailers also incur a time cost to count and deposit their cash receipts. Differences in business structure, bargaining power and payment acceptance may cause smaller retailers to face different costs than larger ones. The Bank

[5]The effect of retailer acceptance is in line with previous research by Arango et al. (2015) and Huynh et al. (2014), which demonstrates the role of card acceptance in explaining payment choice and cash holdings.

of Canada's 2013 MOP survey, for example, shows that the use of payment methods varies with the size of the retailer, which might give rise to differences in costs.

Banks and credit unions, hereafter referred to as financial institutions, play a major role in the cash and payment card chain as well. They offer chequing, credit and prepaid card accounts to consumers and in some cases provide acquiring services to retailers. Financial institutions also incur costs for the operation of ATMs and the handling and processing of cash. Other costs include card processing and costs related to fraud losses and prevention. Being responsible for the issuance of Canadian bank notes and coins, the Bank and the Mint, respectively, are main actors in the cash chain. They incur costs to design, produce, store and transport bank notes and coins, as well as to combat counterfeiting. Finally, the Canadian cash and payment card industry involves many other players, which are primarily infrastructure providers, such as Payments Canada—the owner and operator of Canada's retail payments system. Other infrastructure providers are Interac (the provider of the national debit card scheme), credit card companies, cash transportation companies, white-label ATM providers and payment card acquirers.

3 Cost Definitions

The focus of this paper is on the costs of cash, debit cards and credit cards that can be measured. We differentiate between private costs and resource costs, indirect and direct costs, as well as total, average and variable costs. This section provides an explanation of these different cost concepts.

3.1 Private and resource costs

The concept of private and resource costs has been commonly used for measuring the costs of payment methods. Private costs are the total costs incurred by each individual stakeholder. These include both the resources employed by the stakeholders themselves and all transfers made to other parties. For example, banks consume resources to offer payment services and products in the form of labour, equipment and premises. In addition, they pay cash transportation companies for the shipment of bank notes to and from branches and ATMs. All these costs taken together constitute the private cost to banks. Similarly, retailers incur a resource cost in terms of time spent on back-office activities related to payments, but they also pay fees to their financial institutions and payment processors. All of these costs together comprise the private costs to retailers. See Figure 2 for a few more examples of resource costs and transfers made.

While the private costs are most relevant in understanding the behaviour of individual stakeholders, from a social cost-efficiency perspective, the total resource costs are more informative. The total resource costs reflect the overall use of resources in the entire society, and are calculated by adding together the resource costs of each stakeholder. In some studies, these resource costs are also referred to as social costs (see, for example, Schmiedel et al. (2013)). However, since externalities are excluded from the study and to avoid confusion with the definition of social costs used in economics, this paper uses the term resource costs instead of social costs, as in Stewart et al. (2014). The total resource costs cannot be

calculated by adding together the private costs of each stakeholder, as this would double-count the resource costs that stakeholders pass on to each other through fees. Moreover, from a society's point of view, the fees paid by one party are offset by the fees received by the other.

Note that the stakeholders considered in this paper also pay fees to entities that are not separately addressed in this study. The Bank, for example, pays fees to electricity companies or bank-note material providers. While measuring the private costs of these entities is outside of the scope of this study, their resource costs do contribute to the total resource costs to society. Therefore, the fees paid to these parties are assumed to equal their resource costs and are added to the resource costs of the paying stakeholder (in this example, the Bank). This ensures that these costs are captured in total resource costs. It should be noted, however, that total resource costs might be overstated if the fees charged by other entities contain a profit margin. Similarly, fraud costs are considered to be a resource cost to the injured party and hence a cost to society as a whole, as the benefiting entities (i.e., fraudsters) are not separately analyzed in this study.

See Appendix C for an illustration of the concept of private and resource costs.

3.2 Direct and indirect costs

The estimates presented in this paper include both direct and indirect costs. Direct costs arise when resources are used exclusively for a particular payment method. The costs of transporting cash, for example, are solely incurred for cash, whereas debit card processing costs are related only to debit card payments. By contrast, indirect costs are incurred for more than one payment method at the same time, and for other types of services as well. Chequing accounts, for instance, can be used for a variety of transactions, including cheque payments and electronic funds transfers. Hence, the cost of providing or having a chequing account cannot be directly assigned to one particular payment method. Indirect costs may also include those that are not directly related to payments at all if stakeholders are active in other lines of business. In that case, corporate-wide management costs, for example, are only partly related to stakeholders' payment activities. As discussed in Section 4, a variety of allocation keys are used to ensure an appropriate allocation of indirect costs across the payment methods studied.

3.3 Average and variable costs

Since the total costs of a payment method are strongly influenced by the intensity with which the payment method is used, it is useful to look at the average costs per transaction when comparing different payment methods. The average costs per transaction are generated by dividing the total costs of each payment method by the number of transactions made with it. However, this indicator does not take into account the size of the transactions. Therefore, this study also provides the average costs per dollar in sales, which reflects, for each single payment, how much of the transaction value is actually going to the costs of enabling, making and accepting this payment.

One of the limitations of the average costs per transaction or dollar in sales is that they are difficult to compare because of economies of scale and scope. It is for this reason that

this study also calculates the fixed and variable costs. Assuming a medium-term horizon of three to five years, fixed costs are those that are incurred irrespective of the number of payments made in the economy, such as the costs of machinery, premises and software. Variable costs are those that vary with the intensity with which a payment method is used. Transaction-related variable costs fluctuate with the number of payments, whereas value-related variable costs change with the transaction size.[6] The breakdown between fixed and variable costs is useful for calculating and comparing the variable costs of payment methods at different transaction sizes. These variable costs reflect the additional costs of making one additional payment of a certain value, while assuming that all fixed costs have already been paid for. Based on these costs, the threshold amount can be identified, which is the transaction amount above which one payment method becomes less costly than another.

4 Methodology

4.1 Overview

The Bank conducted various surveys to collect cost information from retailers, financial institutions and cash transportation companies. A separate study was established to measure the time costs for consumers and retailers to make and receive payments. Moreover, internal and external data sources were employed to assess the costs for consumers, the Mint and the Bank, and to estimate the number and value of payments made at the POS in Canada in 2014. This section discusses the various surveys and methods in more detail.

4.2 Survey of retailers

4.2.1 Methodology

The Bank conducted an extensive survey to collect 2014 cost data from Canadian retailers, the Retailer Survey on the Cost of Payment Methods (RCPM survey). The survey was distributed across retail stores, accommodation and food places and personal service providers as defined in the North American Industry Classification System (NAICS).[7] The retailers were sampled from different frames. For a detailed description of the sampling methodology, see Welte (2017).

To ensure that the contacted retailers were capable of providing the requested data and authorized to release it, two different questionnaires were used: one for retailers who independently own and operate a business and another for headquarters operating a chain. Both questionnaires asked for the same information, but the headquarters' survey was divided

[6]Examples of transaction-related variable costs include the time costs to consumers to make a card payment and the costs to banks and infrastructures to process the payment, as these are likely to be the same for a $5 transaction as for a $500 one. By contrast, the cost of counting and transporting bank notes is likely to increase with the value of cash handled. Similarly, fraud-related costs are likely to be higher for high-value card payments than for low-value ones.

[7]With specialized retail stores being NAICS 44, general retail stores being NAICS 45, accommodation and food places being NAICS 72 and personal service providers being NAICS 81.

into two sections. The first section had to be completed by someone at the head office, whereas the second one had to be filled out by individual sales locations.

The survey followed Dillman et al. (2008) and approached retailers with different survey modes to accommodate various preferences, including a paper questionnaire, an online survey and telephone interviews. Various incentives were used to further promote participation. See Appendix D for more details on the survey, sampling, survey modes and incentives.

Given the length of the questionnaire, information on the fixed and variable nature of the costs was not directly collected from the retailers. Instead, the breakdown of the retailers' costs into fixed and variable presented in this paper is based on other similar studies and external information. As a robustness check, the fixed and variable shares were also econometrically estimated from the data, following the method used by the European Commission (2015), which hardly affected the results.

4.2.2 Survey responses

To obtain a sizeable number of responses, almost 30,000 retailers were approached. Overall, more than 1,000 responses were received, representing a response rate of about 3.5 per cent, which is typical for this kind of voluntary business survey (see Table 2). The final sample of small and medium-sized independent retailers provides good coverage of small and medium-sized retail stores, food and drink places and personal service providers in Canada in terms of industry and region (see Table 3). Moreover, the large independent retailers and headquarters included in the sample represent about 41 per cent and 18 per cent of the total turnover in the Canadian retail and restaurant sectors.[8]

Because of the relatively low number of responses from headquarters and large independent retailers (hereafter jointly referred to as large retailers), those responses were analyzed separately from small and medium-sized independent retailers. Also, Jiongo (2017) demonstrates that the cost structure of the large independent respondents was similar to those operating a chain, which further supported combining them and analyzing their responses separately from small and medium-sized independent retailers.

One of the challenges of surveys is unit and item nonresponse. Unit nonresponse refers to retailers not replying to the survey at all, whereas item nonresponse refers to particular questions not being answered. Since both may introduce a bias, various techniques have been used to address nonresponse. Hatko (2017) provides a detailed description of the techniques used to correct for nonresponse among small and medium-sized independent retailers, whereas Jiongo (2017) describes the imputation methods used for large retailers.

As discussed in great detail in Chen and Shen (2017), survey weights have been created for the small and medium-sized retailer sample to ensure the survey results can be appropriately extrapolated to the national level. However, given the relatively small number of respondents, calibration methods were used for the scale-up of the large retailers' answers (see Jiongo (2017)). The current study reports the aggregate costs of all retailers taken together. A breakdown of the results by size of retailer will become available under separate cover on the Bank's website.

[8]The definition of small, medium and large independent retailers is based on the number of employees, with small ones having fewer than 5 employees, medium ones having 5 to 49 employees and large ones having more than 49 employees.

See Box 1 for the main lessons learned from the RCPM survey. Moreover, Figure 6 provides an overview of how the current paper and the work of Welte (2017), Jiongo (2017), Chen and Shen (2017) and Hatko (2017) fit together.

Box 1: Lessons learned from the RCPM survey

Various experiences were gained during the RCPM survey:

- Screening calls: Nonresponse and project mailing costs were reduced in the course of the fieldwork when first making screening calls to identify retailers that were out of operation and to check their addresses before sending survey packages.
- Adaptive sampling: The representativeness of the sample benefited from contacting retailers in multiple waves and adapting the sample as responses came in.
- Personal visits: Personal visits were useful to recruit respondents from particular industries, such as small restaurants.
- Personalized outreach: Response rates among large retailers strongly benefited from direct personal outreach to verify the name, title and mailing information of the most appropriate individual.
- Trade associations: Assistance from retail and restaurant associations was invaluable in gathering responses. This included help in drafting the questionnaires and reaching out to members through newsletters, emails and letters to promote participation.

4.3 Financial institutions and infrastructure providers

4.3.1 Financial institutions

After carefully considering other potential methods (see Appendix E), directly gathering cost information from financial institutions proved to be the most suitable approach for measuring their costs. Therefore, a separate survey was designed. The survey was completed by the largest Canadian banks, the main credit unions and several smaller banks. Compared with the number of transactions from Interac, the Canadian Bankers' Association and other sources, the data set covers about 96 per cent of all debit card transactions made in Canada, almost 78 per cent of all regular credit card payments and 94 per cent of all prepaid credit card transactions.[9] The costs have been scaled up to the national level based on the total number and value of cash withdrawals and card payments in Canada. This assumes that the non-participating banks and credit card brands have the same cost structure as those in the sample.

[9]The credit card transactions in the data set mainly include Visa and MasterCard transactions. Other credit card brands, such as American Express, were not reported, hence the 78 per cent coverage.

The survey asked for all costs incurred to provide cash services and issue debit and (prepaid) credit cards in 2014.[10] Moreover, information was collected about the fixed and variable nature of the costs and whether they constituted transfers paid to other stakeholders. The data were collected at the headquarter level to capture the costs to the entire institution, including those incurred at individual branches.

One of the main challenges pertained to the allocation of indirect costs across individual payment methods. To help with this and to ensure comparability of the responses, the Bank developed an automated data collection tool based on the activity-based costing (ABC) framework. Respondents were free to use this tool or to use their own accounting methods. See Appendix E for an overview of all activities considered, as well as the allocation keys used to allocate the indirect costs.

Bank employees worked closely with the respondents to ensure the appropriateness of the methodology and the quality and consistency of responses. Collaboration included meetings to discuss the required and available information, and extensive contact during and after the data submission period to clarify questions and ambiguities. To ensure the quality and reliability of the data, deliberate quality control procedures were implemented. Individual responses were rigorously checked for internal consistency and compared with responses from other participants and, where possible, with other data sources.[11] If needed, clarification was sought from the respondents who, in most cases, submitted revised data or provided information that allowed the Bank to adjust the data. In case of item nonresponse, assumptions were made based on the breakdown of other respondents.[12]

Banks that are members of the Canadian Bankers Association (CBA) provided their input to the CBA, which then submitted the aggregated data to the Bank. All other financial institutions were directly engaged on a bilateral basis. To ensure anonymity, the results have been merged with those of the cash transportation companies and other infrastructure providers and presented as one aggregate total.

The financial institutions were not able to provide information about their domestic POS transactions only, so their data also covered online and international payments. Therefore, the calculations in this study assume similar average unit costs for online and POS payments, as well as for domestic and international payments.[13]

See Box 2 for the key lessons learned from the survey of financial institutions.

[10] Some institutions provided data based on their 2014 fiscal year starting on 1 November 2013. They indicated that the changes between November and December 2013 and November and December 2014 are limited and that these changes should not have a notable effect on the total estimated costs for the 2014 calendar year.

[11] Other sources include internal data from the Bank's 2013 MOP survey, Tompkins (2015), statistics published by the Canadian Bankers Association, as well as proprietary information provided by the Canadian Prepaid Providers Organization (CPPO), Interac, Nielsen and other market participants.

[12] Different scenarios were estimated, but changing the assumptions minimally affected the final estimates.

[13] Although the majority of fraudulent card payments occur online and are thus more likely to be riskier and more costly, it is not always the case that the source of the fraud is an online rather than a POS transaction. Moreover, the survey data suggest that fraud costs make up a limited part of total card costs to financial institutions. Therefore, the assumption of equal average costs is assumed to minimally affect the final results.

Box 2: Lessons learned from survey of financial institutions

Several experiences were gained from the survey of financial institutions:

- Co-operation: Close co-operation with respondents was essential to ensure the methodology was appropriate and inputs were as accurate as possible. Collaboration occurred on different levels depending on the preferences of each financial institution—bilaterally with individual respondents and indirectly through the intermediation of the Canadian Bankers Association (CBA).

- Aggregation: The Bank directly received submissions from individual respondents as well as aggregated data compiled by the CBA. The advantage of the former approach is that it offers full insight into the data and accelerates cross-validation. However, the latter approach has proven useful to recruit participants, especially given the sensitivity of the data request. Collaboration with the CBA was invaluable for cross-validation in this case.

- Time span: Sufficient time was allocated for both the data collection and cross-validation. Oftentimes, different departments had to be consulted to collect the requested information, and several rounds of interaction were needed to clarify questions and ambiguities.

- Consistency vs. flexibility: One particular challenge was the allocation of indirect costs. A mutually acceptable balance had to be found between the level of consistency of responses and the degree of flexibility to alleviate response burden. Therefore, respondents were given the option to either use the automated data collection tool offered by the Bank or use their own allocation methods. This flexibility was much appreciated, but it might have resulted in different allocation methods, which underlines the importance of proper cross-validation.

4.3.2 Cash transportation companies

The Canadian cash transportation market can be classified as a duopoly.[14] Given the role of cash transportation companies in the Canadian cash cycle, a separate survey was established to collect cost information directly from both companies. In addition to the values of cash transported and processed in 2014, the questionnaire also asked for all costs incurred for these activities. Examples include the costs of staff, fuel, vehicles, equipment, storage facilities, security systems, robbery and insurance. The focus was on Canadian bank notes and coins only, so costs related to foreign currencies, cheques and non-cash-related services were excluded.[15] To distinguish resource costs from fees paid to other stakeholders, the lat-

[14] Based on documents from the Canadian Competition Bureau (`http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/03695.html`) as well as internal sources.

[15] In addition to transporting and processing cash, Canadian transportation companies offer a broad spectrum of services, such as transportation and storage of valuables, guard and patrol services, and investigation

ter were requested separately. Close co-operation with respondents was crucial to ensure an accurate understanding of the methodology and to secure the quality of the responses.

The breakdown between fixed and variable costs is based on other cost-of-payment studies and discussions with participants. Overall, the total costs of cash transportation companies are assumed to be mainly variable, especially with the value of cash used in the economy. Yet a considerable portion of total costs is presumed to be fixed, as a minimum level of infrastructure is required, irrespective of the number or value of cash payments made.[16]

As explained above, the results of the cash transportation companies are merged with those of the financial institutions to ensure anonymity.

4.3.3 Other infrastructure providers

The costs incurred by other key players in the payments market, such as Payments Canada, Interac, credit card companies, payment card acquirers and white-label ATM providers, are indirectly estimated based on the fees paid by financial institutions, retailers and consumers, assuming that these fees are a fair reflection of the underlying resource costs. The estimated costs are aggregated with the resources provided by financial institutions and cash transportation companies. It should be noted, however, that the true resource costs of these other infrastructure providers might be overestimated if their fees charged to the market contain a profit margin. In the absence of further information, this study assumes zero profits, hence the total reported resource costs for financial institutions and infrastructures are likely to represent an upper bound.

4.4 The costs of bank-note- and coin-issuing authorities

Bank of Canada internal accounting information over the year 2014 is used to calculate the total costs incurred by the Bank to issue Canadian bank notes. This includes the costs of: raw materials; labour; equipment and premises employed for producing, processing and distributing bank notes; and all other bank-note-related activities, such as research, policy and communication. In addition, part of the Bank-wide overhead costs is included, such as the costs of the Bank's corporate service departments, the Board of Directors and the Bank's head office. The allocation of these indirect costs is based on the ratio of the number of full-time equivalent (FTE) Bank employees working on bank-note-related activities to the number of FTEs working on the Bank's other core functions.[17]

The granularity of the data allows us to clearly distinguish the Bank's resource costs from the fees paid to other stakeholders considered in this study, such as cash transportation companies. The breakdown of costs into fixed and variable is based on careful consultations

and detective services. Costs related to these activities are out of scope of the current study.

[16]The coin/bank note composition of cash payments may change over time. This may affect the fixed and variable nature of transportation costs, as a change in coin usage affects the weight of the trucks and consequently fuel and maintenance costs. Since information about the current composition of cash payments is unavailable and given the aim of this study, the variable costs of cash are calculated considering a medium-term time horizon within which the composition of a cash payment is assumed to be fixed.

[17]An alternative approach is to allocate the overhead costs based on the ratio of FTEs working on bank-note-related activities to the total number of Bank employees; however, this would overlook the fact that the bank-wide overhead costs would not have been incurred in the absence of the Bank's core functions.

with relevant experts within the Bank. Overall, the production and transportation costs of bank notes are mainly variable with the use of cash in the economy, whereas processing and distribution costs contain considerable fixed and variable components. The costs of other bank-note-related activities and Bank-wide overhead are essentially fixed over a medium-term horizon of three to five years.

The costs incurred by the Mint to issue Canadian circulation coins in 2014 are estimated based on internal calculations using a variety of sources, such as the Mint's annual reports. Although the Mint also produces collector and foreign coins, the focus here is on Canadian circulation coins only, as these are used in daily life for Canadian POS transactions. Alternative scenarios were estimated to test for different assumptions. Overall, changing the assumptions minimally affected the final results. For reasons of sensitivity, the estimated costs for the Bank and the Mint are aggregated and reported together.

4.5 Measuring consumer costs

Various sources are used to estimate consumer costs of cash and cards in 2014. Chequing account fees and transaction fees for debit card payments and cash withdrawals are estimated using information from the Bank's 2013 MOP survey and the Financial Consumer Agency of Canada (FCAC).[18] Canadians do not pay transaction fees for credit card payments, but do incur an annual charge plus a fee and interest costs for credit card cash withdrawals. The annual charges are taken from the 2013 MOP survey, whereas withdrawal costs are estimated using FCAC data. Fees tied to prepaid credit cards are approximated using information from financial institutions and credit card companies.

Other costs for consumers include the time spent making payments. These are estimated using the results of the time duration study (see Section 4.6). In the absence of further information, the time costs of withdrawing cash (i.e., travel and transaction time) are approximated based on estimates from other studies. Travel time to withdraw cash is assumed to be proportional to the concentration of ATMs. The average for Canada is computed using the times reported for Australia (Schwartz et al., 2008) and the United States (Garcia-Swartz et al., 2006), and the relative concentration of ATMs across Canada. The transaction time of a cash withdrawal is taken from the Norwegian cost study (Norges Bank, 2014).[19] Owing to the lack of information, time spent on other payment-related activities such as paying credit card bills or checking statements, as well as transport costs incurred to withdraw money are disregarded.

Consumers' time is valued using half the average hourly after-tax wage. Other studies value consumers' time using full wages; however, it is unlikely that consumers would otherwise work the time they spend on paying. Instead, the trade-off is most likely in leisure time and not directly in earnings. Therefore, similar to Schwartz et al. (2008) and in the absence of further guidance, half the average hourly after-tax wage is used.

Consumers also incur forgone interest costs for the cash they have on hand and for a non-interest-bearing prepaid or chequing account. These costs are approximated using in-

[18]The FCAC collects information on banking and credit card fees for a wide range of products offered by Canadian financial institutions. This information is made available on the FCAC website.

[19]The Norwegian study is the only recent study presenting an estimate of the transaction time of cash withdrawals.

formation from the 2013 MOP survey and an annual interest rate of 1 per cent.[20] Other costs pertain to fraud, such as cash theft, counterfeiting and card fraud. However, since card fraud losses are typically absorbed by card issuers or retailers, and given the low counterfeiting and robbery rates, consumers' fraud costs tied to POS payments are likely to be limited in Canada and are therefore ignored in the present analysis.[21]

Most of the above costs do not relate solely to POS payments. Chequing accounts are often also used for other purposes, such as bill payments, and payment cards can be used beyond the physical POS, such as online or over the phone. Similarly, cash withdrawals can also be made for person-to-person transactions or other purposes, such as maintaining a supply of cash on-hand. Hence, various allocation methods are used to estimate consumer costs related to the use of cash and cards at the POS only. All fees are allocated based on the number of POS transactions relative to the total number of transactions made from a chequing account. Costs related to forgone interest are allotted based on the relative value of POS transactions compared with the total value of transactions made from the account.[22] Moreover, a correction is applied for the use of cash for non-POS purposes, using information from the 2013 MOP survey.

Overall, the total resource costs for consumers include only time-related costs; all other costs constitute a fee paid to other stakeholders. Periodic and per-transaction fees, for example, are transfers to financial institutions or other independent ATM owners, whereas forgone interest is basically a transfer of interest margin income for financial institutions. When calculating the variable costs, all periodic fees are assumed to be fixed, per-transaction fees and time costs are considered to vary with the number of payments, and forgone interest is assumed to vary with the value of payments. Cash withdrawal costs are assumed to be both fixed and variable.

The final cost estimates are subject to various assumptions, including, for example, the interest rate used to calculate forgone interest costs, the fees charged by white-label ATMs and the number of interest days charged for credit card cash withdrawals. Further analyses demonstrate that the final estimates are quite stable to different scenarios. They seem most sensitive to drastic changes in the value of consumers' time[23] and to changes in the ratio of cash withdrawals made at own-bank ATMs and other ATMs.[24] In the absence of further information, the final estimates are based on values used in other studies or values that lie in the middle of the range of plausible options.

[20]The average overnight money market rate is used to proxy the short-term interest rate for consumers.

[21]The total value of counterfeit Canadian bank notes passed in 2014 amounted to $2.4 million (Royal Canadian Mounted Police (2016)). Moreover, the rate of reported robbery and burglary is relatively low (Boyce (2015) and Conference Board of Canada (2013)).

[22]Based on numbers and values taken from the 2013 MOP survey and Tompkins (2015).

[23]Increasing (decreasing) the value of consumers' time to 75 per cent (25 per cent) of average after-tax wages increases (decreases) total consumers' costs of cash by 17 per cent and the cost per cash transaction by $0.06.

[24]Increasing (decreasing) the ratio from 70/30 to 80/20 (60/40) decreases (increases) total cash costs by 12 per cent and the costs per cash transaction by $0.04.

4.6 Time duration study

The time needed to make a payment at the counter, i.e., the tender time, constitutes an opportunity cost to consumers and a labour cost to retailers. To measure this time, the Bank undertook a time duration study in the fall of 2014. Observers visited 29 stores to take note of the duration of all payments made over a six-hour period. Since tender times might vary with the size and type of store, the sample consisted of a large variety of locations, such as gas stations, coffee shops, convenience stores, drug stores, supermarkets and home improvement stores. Visits were made on all seven days of the week and from early morning to late evening to account for any day- or time-related effect. To avoid potential regional biases, the sample was split among Montréal, Toronto and Ottawa.

The transaction duration was defined as the number of seconds between the moment that the total sum to be paid is made known to the customer and the moment that the receipt and billing slips are printed and taken out of the register. Time used for social or productive activities that were not directly related to payment, such as scanning the purchases, packaging or socializing with clients, was included only as long as these activities happened while the customer was waiting for the transaction to be authorized and approved. If not, any such time was subtracted from the total time to measure only the payment activity.

Besides the duration, observers recorded the payment methods used and the transaction amounts. Other factors that could affect the time were also logged, such as the day and time of the transaction, the gender and estimated age of the client and cashier and the number of cash registers in operation. Observers also logged any irregularities, such as technical problems with card terminals or customers asking for cash back. See Appendix F for further details on the Bank's time duration study.

A total of 5,891 transactions were recorded. The median transaction duration of each payment method is estimated with a quantile regression model, using the method of payment, transaction size and all auxiliary variables as covariates.[25] The results are presented in Figure 7. Cash transactions were found to be quickest, with a median duration of 11.61 seconds. The duration of card payments strongly depends on the underlying technology. Contactless debit and credit card transactions take about 15 seconds, whereas these could extend to almost 26 seconds when using the chip and PIN or the swipe technology.[26] Other studies show large country differences (Stewart et al. (2014) and Schmiedel et al. (2013)). Yet overall, cash was often found to be either the fastest or one of the fastest payment methods, and contactless card payments were shown to be quicker than traditional card transactions (Polasik et al. (2010)).

[25] A quantile regression model was used to account for potential skewness in the distribution of the transaction durations. The results were similar to those of an ordinary least squares model, which implies that accounting for skewness did not affect the duration estimates.

[26] Contactless cards refer to payment cards that simply need to be waved or tapped over a terminal. Chip-based transactions require the card to be inserted into the terminal, whereas swipe transactions require the card to be swiped. All chip-based transactions as well as debit card swipe transactions require a PIN, whereas a signature is used for credit card swipe transactions.

4.7 Estimation of the number and value of POS transactions

Having accurate data on the number and value of payments made at the POS in Canada is important for measuring the costs of payments—for example, when assessing average costs per transaction. Table 4 provides an overview of the transaction estimates used in this study. The remainder of this section discusses how these estimates were derived.

4.7.1 Number and value of POS card payments

The number and value of debit card payments are taken from Interac, the provider of the national debit card scheme.[27] Since these statistics include online and potentially also cash-back transactions, the estimates might slightly overestimate the use of debit cards at the POS. Yet the 2013 MOP survey and information provided by financial institutions suggest that the share of Interac online and cash-back transactions is small.

Statistics from the Canadian Bankers Association (CBA) were used as a basis for the estimation of the value and volume of POS credit card payments.[28] Since these statistics include only the number and value of Visa and MasterCard transactions, an adjustment was made to include American Express, using information from Nilson (2015). Furthermore, internal information was used to exclude international, online and cash-back transactions to narrow the scope to domestic POS payments only. It should be noted that the CBA statistics cover the 2014 fiscal year (ending October 2014) instead of the calendar year. Information to correct for this is unavailable, but the effect is assumed to be limited. Moreover, the estimates generated in this way include only Visa and MasterCard transactions reported by CBA member banks, plus an adjustment for American Express transactions. As CBA member banks and American Express cover the majority of the Canadian credit card market, the effect of excluding other types of credit cards is assumed to be small.[29]

The final number and value of credit card transactions used in this study include the use of prepaid credit cards. These statistics were estimated based on information obtained from external payment service providers.

4.7.2 Number and value of POS cash payments

Because of the anonymous nature of cash transactions, generating reliable statistics on the number and value of cash payments made at the POS is challenging. Several methods were explored. The RCPM survey replicated the debit and credit card values (as discussed above) fairly well. Therefore, it was used as the basis for estimating the total value of cash payments. In particular, the overall share of cash in total retailer sales was extrapolated to the national level using the total value of Canadian sales at retail stores, food and drink places and personal service providers, as reported by Statistics Canada. The number of transactions was then calculated by dividing the total value by the weighted average POS

[27] See http://interac.ca/en/interac-debit-tab.html#transactions-merchants-terminals-dollar-value-users.

[28] See http://www.cba.ca/credit-card-statistics.

[29] 2013 MOP survey data suggest that 98 per cent of the Canadian population obtained a credit card from a CBA member bank or directly from American Express.

cash transaction value from the 2013 MOP survey.[30] Some of the retailers included in the 2013 MOP survey had also participated in the RCPM Survey. Since a comparison of their average cash transaction values from both studies showed great similarity, the values from the 2013 MOP survey are assumed to be a good reflection of the average cash value in Canada in 2014.

5 Key Findings

Finding 1: *The costs of cash and card payments at the POS in Canada are non-negligible. Total resource costs amounted to $15.3 billion, which corresponds to 0.78 per cent of GDP.*

Figure 8 summarizes the total private and resource costs broken down by payment method. The majority of costs are linked to cash and credit cards, the payment methods that account for the largest number and value of payments made in Canada.

Overall, the total resource costs of cash and debit cards seem to be consistent with other countries when taking into account the underlying transaction shares (see Table 12).[31] The costs of cash range from 0.07 per cent in Norway, where cash accounts for only about a quarter of the total transactions, to 0.49 per cent in the EU, where the large majority of payments are paid in cash. Similarly, the costs of debit cards vary between 0.05 per cent in Austria, where debit cards account for a small share of transactions, and 0.19 per cent in Sweden, where more than half the transactions are paid by debit. For both payment methods, Canada seems to be in the middle. The total resource costs of credit cards, however, are larger in Canada than abroad. As a result, the total costs of cash and cards taken together are relatively high as well. This seems in line, though, with the larger number and value of payments made in Canada, especially credit card payments.[32]

Finding 2: *Stakeholders incur costs in providing, accepting and using payments at the POS and their shares vary by payment method.*

Figure 9 breaks down the total private and resource costs by stakeholder. For private costs, the financial sector bears the majority of the cash costs, whereas consumers incur most of the costs of debit cards. The private costs of credit cards are almost equally shared between the financial sector and retailers. Considering resource costs only, the largest share is borne by the financial sector, followed by retailers. This holds for each payment method. The share of resource costs incurred by consumers, the Bank and the Mint is limited.

The finding that the central bank and minting authority contribute least to the total

[30] Given the low inflation rate between 2013 and 2014, the weighted average transaction value was not adjusted for inflation.

[31] For comparability, the results are reported both when including and excluding consumers' costs. Still, the studies differ in terms of methodology, the use of payment methods, and the year of study. Hence, caution should be taken when comparing the results.

[32] Internal calculations based on Stewart et al. (2014), Danmarks Nationalbank (2012), Jonker (2013), Norges Bank (2014) and Segendorf and Jansson (2012) suggest that the total value of cash and card payments as a percentage of GDP is highest in Canada, and that Canada ranks second in terms of number of cash and card payments made per capita.

resource costs of cash is in line with the results found abroad (see Table 12). Also, the breakdown of debit card and credit card costs by stakeholder is quite similar across most countries. The Canadian results, just like the Norwegian results, differ from the other studies in that the largest share of the resource costs of cash is borne by financial institutions and infrastructures, whereas in the majority of other studies, the financial sector and retailers are found to roughly carry the same share of the cash costs. The relatively high density of ATMs in Canada might be a potential explanation (see BIS (2015)).

Finding 3: *Debit cards are the least costly in terms of total resource costs, followed by credit cards, whereas cash is the most costly.*

Cash

In 2014, all Canadian stakeholders together incurred a total private cost of $8,808 million for providing and using cash (see Table 7). Financial institutions and infrastructures made up the largest share with $3,944 million. Their main cost drivers related to providing over-the-counter and ATM services. The retail sector incurred a total cost of $2,384 million, with the main cost driver being the back-office time spent on cash activities. About a quarter of the total costs of cash was carried by consumers: $2,240 million. The lion's share came from withdrawal fees, followed by time spent on obtaining cash and using it at the POS. The total private costs of the Bank and the Mint were $239 million, most of which was related to the production of bank notes and coins.

Column 4 in Table 7 isolates the fees paid by stakeholder. Those of the Bank and Mint refer to charges paid for the distribution of bank notes and coins. Financial institutions and infrastructures also paid transportation fees, on top of interchange fees for cash withdrawals. Retailers' fees included transportation fees as well as withdrawal and deposit fees to financial institutions. Given the low interest rates in 2014, forgone interest on outstanding cash balances constituted a limited share of retailers' transfers. Fees made up a large part of consumers' private costs. These mainly included withdrawal fees and to a lesser extent the opportunity costs of holding cash on hand instead of in an interest-bearing account.

While the private costs help to understand the behaviour of individual stakeholders, from a social cost-efficiency perspective, the total resource costs are more informative. Subtracting the fees from the private costs (Column 5) shows that the total resources consumed by society as a whole were $6,811 million. With a total of $222 million, the Bank and the Mint contributed fewest resources. Consumers also provided relatively few resources ($790 million), which mainly included their cost of time. The majority of resources were consumed by financial institutions and infrastructures ($3,818 million), followed by retailers ($1,980 million). The resources provided by financial institutions were mainly used for providing over-the-counter and ATM-related services, whereas retailers' main costs were time spent receiving payments and performing back-office activities.

Debit cards

The total private cost incurred for debit cards was $5,963 million (see Table 8). Almost half was borne by consumers—$2,883 million—in the form of debit card transaction fees paid to

financial institutions. The remaining private costs were almost equally shared between the financial sector and retailers, amounting to $1,594 million and $1,486 million, respectively. The costs to financial institutions were mainly related to the provision and processing of payments and the management of chequing accounts. The main costs for retailers included acquiring fees and time spent on receiving payments and back-office tasks.[33]

Fees (Column 4) make up the majority of consumers' private costs and a significant share of those of retailers. In addition to acquiring fees, retailers' fees also included rental fees and depreciation costs for debit card terminals. Fees paid by financial institutions, mainly to other financial institutions, are limited.

Column 5 demonstrates that the total resource cost of debit cards was $2,777 million, which is less than half of total private costs. The contribution of consumers to total resource costs is relatively small. The resources they provided amounted to $303 million and mostly related to the time spent at the POS making payments. By contrast, financial institutions and infrastructures contributed most resources ($1,583 million) for the provision of debit card services and the underlying chequing accounts. Retailers' contributions to total resource costs amounted to $891 million, which was mainly driven by the time spent receiving payments and performing back-office activities.[34]

Credit cards

The total private cost of credit cards, including prepaid credit cards, was nearly $13,469 million (see Table 9).[35] The costs were almost equally shared between the financial sector and retailers, with $6,868 million and $6,202 million, respectively. The costs of reward programs constituted a considerable share of the costs for the financial sector, whereas acquirer fees were the main driver of the costs for the retail sector. The private costs of consumers amounted to $399 million and mainly consisted of annual credit card fees and the time needed at the POS for making a payment.

The fees in Column 4 show that they make up a significant part of stakeholders' private costs, especially those of retailers. Retailers mainly paid acquirer fees, but also incurred transfer costs for charge-backs and renting or owning card terminals. The fees paid by the financial sector mainly referred to loyalties paid out to consumers. Consumers did not pay per-transaction fees for credit cards, but paid annual fees for holding a card. Their cost of forgone interest on outstanding prepaid credit card balances was limited.

When excluding the fees, Column 5 shows that the total resources used by society for credit cards amounted to $5,705 million. With a total of $176 million, consumers contributed fewest resources, which mainly included their transaction time at the counter. The majority of resource use was incurred by the financial sector ($4,757 million).[36] Retailers accounted

[33]Due to the level of aggregation of the data received from financial institutions, a further breakdown by activity is unavailable.

[34]Because of the level of aggregation of the data received from financial institutions, a further breakdown by activity is unavailable.

[35]Given the relatively low usage of prepaid credit cards, their contribution to total credit card costs is assumed to be limited. The data set does not allow for a breakdown of prepaid credit card costs for retailers, but prepaid credit cards accounted for approximately 10 per cent and 1 per cent of consumers' and financial institutions' credit card costs, respectively.

[36]Because of the level of aggregation of the data received from financial institutions, a breakdown by

for $772 million of total resource costs, mainly in terms of time spent receiving payments and performing back-office activities.

Finding 4: *On average, debit cards are the least costly in terms of resource costs per transaction (volume) as well as resource costs per dollar transacted (value). Credit cards carry the highest resource cost per transaction, while cash is most costly in terms of resource costs per dollar transacted.*

Given that the total resource costs of payment methods are strongly affected by the number of transactions made, it is useful to look at the average resource costs per transaction when comparing different methods of payment from a social cost-efficiency perspective (see Table 10). On average, debit card transactions carry the lowest resource cost per transaction ($0.57), followed by cash ($0.84). Credit cards have the highest per-transaction cost ($1.92). The finding that credit card costs are higher than those of debit cards is consistent with the fact that the provision of credit cards involves activities that are not required for debit cards, such as credit risk analyses, management of reward programs and chargebacks and provision of credit card statements.

Other studies also demonstrate that debit cards carry the lowest resource per-transaction cost, followed by cash. The study conducted in the EU is an exception, which might be explained by the relatively high cash usage in some of the participating EU countries. Also, in Australia, some debit card schemes turned out to be more costly than cash. Looking at average costs per transaction, Canada is among the middle-ranking for each payment method.

Although credit cards are most costly in terms of average resource costs per transaction, cash payments are most expensive when comparing the costs with the value of transactions made. The last row of the upper panel of Table 10 shows the total resource costs as a percentage of the total transaction value of each payment method. Overall, for every cash transaction made, 4.7 per cent of the transaction value was spent on resources to enable, make and accept payment. For credit cards, the resource costs made up 2.2 per cent of the value of each transaction, whereas again it was lowest for debit cards (1.3 per cent).

Finding 5: *Considering variable resource costs per transaction, cash is cheapest for transactions up to $6, while debit cards are the least costly for transactions larger than $6.*

Cash and card payments are commonly known to be subject to economies of scale and scope. Therefore, it is useful to also look at the variable costs of payment instruments. Moreover, the costs of payments depend on the size of the payment. Table 11 breaks down the total resource costs by fixed and variable costs, which allows for a calculation of the variable resource costs per transaction at any possible transaction value. The composition of fixed and variable costs strongly differs across payment methods. The costs of cash include a significant fixed portion (45 per cent), which mainly consists of fixed costs incurred by the financial sector related to cash handling and the provision of ATM and counter services. The remainder of the cash costs varies with both the number and value of cash payments made

activity is unavailable.

in the economy. The total resource costs of debit cards also contain a considerable fixed component, but mainly vary with the number of transactions made (57 per cent), especially because of the time spent by consumers and retailers making and receiving payments. The resource costs of credit cards are largely affected by the size of the payments (35 per cent). Credit card costs that vary with the size of the payment include the costs of fraud prevention and losses for retailers and financial institutions. Moreover, the resource costs of credit card schemes and processors are assumed to depend on the size of the payments, as their fees charged to retailers and the financial sector are used as a proxy for these costs.

As explained in further detail in Box 3, the breakdown between transaction-linked and value-linked variable costs allows for the calculation of the variable resource costs of making one additional payment for every transaction value. These are depicted in Figure 10. The variable resource costs of debit cards hardly vary with the transaction value, while those of cash and credit cards increase with the size of the transaction. Because of these differing cost structures, the cost lines intersect at two points, which indicate the threshold values above which one payment method becomes more costly than the other when looking at the society as a whole. Threshold A suggests that cash is the least costly payment instrument for transactions up to $6. For transactions higher than $6, debit cards carry the lowest resource cost. Threshold B indicates that cash becomes more costly than credit cards for transactions higher than $80.73.

Box 3: Calculation of variable resource costs per transaction

The breakdown between transaction-linked variable costs (TVC) and value-linked variable costs (VVC) as presented in Table 11 allows for the calculation of the following indices:

- Costs related to making one additional payment with payment method j irrespective of its value: $a_j = TVC_j/N_j$, with TVC_j representing the total transaction-linked variable costs of payment method j and N_j being the total number of transactions made with it.
- Costs related to using payment method j for transacting one additional dollar in sales: $b_j = VVC_j/V_j$, with VVC_j representing the total value-linked variable costs of payment method j and V_j being the total value of transactions made with it.

See bottom of Table 11 for the a and b of each payment method.

The concept of transaction-linked variable costs and value-linked variable costs was first introduced by Brits and Winder (2005) and later used in many other cost-of-payment studies. Following the same approach, one can calculate the variable costs of making one additional transaction (VCT) for every transaction value (TV):

$$VCT = a + (b * TV) \tag{1}$$

These variable costs (VCT) reflect the costs of making one additional transaction, while assuming that all fixed costs have already been paid for. In other words, it shows how much one additional payment would cost if the underlying infrastructure is already in place. For example, assuming that the payment terminals and underlying networks are already there, one additional transaction of \$20 would cost \$0.48 if paid in cash (a, b, TV = 0.257, 0.011, 20) or \$0.34 if paid by debit card (a, b, TV = 0.321, 0.001, 20).

The exact threshold amounts are sensitive to the underlying composition of fixed and variable costs. Especially for cash, the current breakdown of variable costs into transaction-related (56 per cent) and value-related (44 per cent) components is not straightforward and requires some assumptions. For example, it is difficult to determine what share of the costs of personnel working at bank branches increases with the number of cash payments and what share is related to the value of the payments. Therefore, we perform some scenario analyses. Figure 11 and Figure 12 show how the turnaround points change when decreasing (increasing) the share of the value-related portion of cash by 10 percentage points. The threshold amount between cash and debit card decreases (increases) to \$3 (\$9). The turnaround point after which cash becomes more costly than credit cards from a society's perspective is more sensitive. Decreasing (increasing) the value-related costs of cash would increase (decrease)

the threshold amount to $201.61 ($54.23). In both cases, the conclusion that debit cards are cheapest, except for very small-value transactions, remains unchanged.[37]

Because of differences in methodology, the use of payment methods and the year of study, one should be careful when comparing the threshold values found in other countries (see Table 12). Yet all studies conclude that, from a resource cost perspective, cash is the least costly payment method for the smallest transactions. For all other transaction values, debit cards are found to be least costly.

Finding 6: *If stakeholders make their payment choices based on their private costs alone, consumers would prefer to use credit cards, while retailers and financial institutions would prefer debit card payments.*

What is least costly from a social perspective might not always be preferred by individual stakeholders, to whom private costs are often more important. Hence, a discrepancy between private and total resource costs may lead to an overuse of payment instruments that carry a higher resource cost, or an underuse of those with lower resource costs if stakeholders' decisions are driven purely by their private costs.

Figure 13 depicts, for each stakeholder, the variable private costs of each payment method by transaction size. Figure 13a and Figure 13b show that, regardless of the transaction size, credit cards are most costly for both the financial sector and retailers. Debit cards are least costly for them, except for small-value transactions, when cash is cheapest. The turnaround point lies near $5.50 for the financial sector. For retailers, debit cards are cheaper than cash for transactions over $20.13, which is in line with the results found in the Bank of Canada 2006 Survey of Merchants (see Box 4).

For consumers, the variable private costs are substantially different. Figure 13c shows that they bear the highest private costs for debit cards, except for transactions over $77.87, when cash is most expensive. Consumers' private costs of credit cards do not vary with the transaction size, as they mainly consist of the time costs of making a payment. Also, their costs for credit cards are lower than those of cash and debit cards, no matter the size of the transaction. Although other factors might also come into play, such as the benefits related to each method, the finding that credit cards and cash are least costly for consumers suggests that consumers would prefer to use these two payment methods when considering only their private costs. This is consistent with the observation that credit cards and cash constitute a major share of POS transactions in Canada.

Although debit cards carry the lowest private costs for retailers for transactions over $20, only two-thirds of small and medium-sized retailers accept them, and the acceptance of credit cards is almost the same (see Box 5). This might indicate that not only variable costs but also fixed costs are important for retailers. Since smaller retailers tend to have a lower number of transactions, their average fixed costs of, for example, card terminals, might prevent them from accepting debit card payments. Another explanation of the relatively low debit card acceptance might lie in the fact that costs are not the only driver of retailers' decisions. Debit card acceptance might also be influenced by the payment methods that consumers

[37]Further analyses showed that the value-related portion of cash will have to decrease by 14 percentage points before debit cards become cheaper than cash for every transaction size.

prefer, even if retailers incur a higher cost. To further understand consumer and retailer behaviour, further research would be useful, especially on the interaction between both sides of the market. Such work, however, would need to take into account that one's payment behaviour not only depends on costs, but also on related revenues and benefits. Consumers, for example, might receive rewards when using a credit card or desire the anonymity of using cash, whereas retailers might experience increased sales when accepting credit card payments. Therefore, further research into the benefits of payments is recommended to better understand how costs affect the use and acceptance of payment methods.

Box 4: The Bank of Canada 2006 Survey of Merchants

In 2006, the Bank of Canada conducted a survey of over 500 Canadian merchants on their accepted means of payment (see Arango and Taylor (2008)). Along with questions about perceptions of costs, they were asked to report some of their actual costs.

The 2006 study found that, for a transaction of $36.50, debit card payments had the lowest variable private costs ($0.19), followed by cash ($0.25) and credit cards ($0.82). Also, the study concluded that cash was cheaper than credit cards for all transaction values and that cash was less costly than debit cards for smaller transaction values only. The turnaround point at which cash became more costly than debit cards varied between $12.60 and $51.30, depending on the level of debit card fees paid (Arango and Taylor (2008-2009)).

Because of differences in methodology and scope, the estimated costs and turnaround points from the 2006 study cannot be directly compared with those found in the current study. For example, the cost calculations in 2006 were based on information from a subsample of 35 respondents, whereas the current study is based on a sample size of around 1,000 retailers. Arango and Taylor (2008) caution against a generalization of the survey findings owing to a high margin of error (see also Welte (2017) for a description of the methodological differences between the two studies). Moreover, because of the lack of data, the 2006 study did not include all costs, such as cash transportation or card-fraud-related costs, and for some costs other countries' estimates were taken as a proxy, such as tender times, which were taken from the Netherlands.

Although caution should be taken when comparing the estimates, both studies arrive at the same conclusion that the costs of accepting different payment methods vary by transaction value, and that debit cards are least costly except for small-value transactions, for which cash is cheapest. Moreover, in both studies, credit cards are found to be most expensive for retailers, irrespective of the transaction value.

The 2006 study suggested that the costs of accepting different payment methods vary by merchant. A breakdown of the costs by size of merchant is out of scope of the current study, but will become available under separate cover on the Bank's website.

Box 5: Acceptance of payment methods in 2014

The RCPM survey shows that cash is widely accepted in Canada, whereas card acceptance increases with business size; 68 per cent and 67 per cent of small and medium-sized retailers accept debit cards and credit cards, respectively,[a] as opposed to nearly 100 per cent of large retailers and chains (see Table 1).[b]

Table 1: Acceptance of payment methods in 2014, in per cent

	Cash	Debit card	Credit card
Small and medium independent retailers	94	68	67
Large independent retailers and chains	98	97	98

[a] The majority of retailers accept either both cards or no cards at all.

[b] The shares for small and medium-sized independent retailers are weighted and representative of all small and medium-sized retailers in Canada. The shares for large retailers and retail chains reflect the average sample shares, which may not be fully representative.

6 Conclusion and Discussion

This study shows that the costs of POS payments in Canada are broadly consistent with findings elsewhere that the costs of cash and card payments are non-negligible and that from a resource cost perspective, debit cards are the least costly payment instrument, except for the smallest transactions, when cash is cheapest. Although the key findings are broadly in line with the results abroad, the specificities of the retail payments market and differences in terms of methodology help to explain some of the main differences.

While total resource costs are most relevant from a social cost-efficiency perspective, private costs are more informative for understanding the behaviour of individual stakeholders. The study demonstrates that if they make their payment choices based on their private costs alone, consumers would prefer to use credit cards, while retailers and financial institutions would prefer debit card payments.

It is important to recognize that the focus of the study was solely on costs, and only those that can be measured. However, stakeholders' decisions of which payment instruments to provide, accept or use also depends on the overall revenues and benefits those instruments generate. For example, the provision of cash services may enable banks to attract and maintain clientele, which in turn allows them to generate revenues from other banking products. Similarly, despite the relatively high costs, retailers may find it beneficial to accept credit cards if this leads to higher sales. Therefore, to better understand the overall efficiency of payment methods as well as the drivers of the use and acceptance of payments, further work on the benefits and revenues is recommended. Moreover, the estimates in this study date back to 2014, and these estimates may now be different because of changes in the payments environment, such as further growth in the use of contactless debit and credit card payments and ongoing efforts by financial institutions to reduce costs, such as decreasing the number

of bank branches or promoting mobile payments among customers.

This is the first comprehensive study on the cost of payments in Canada, and it provides an objective measure of the costs of cash and card payments at the POS. The results allow for exploration of how these costs could potentially be reduced. Also, the study enables an understanding of how these costs compare with costs in other countries. The study collected a rich data set from retailers on the costs and acceptance of payment methods. This data set can be used together with the Bank's MOP survey to conduct further research to improve our understanding of the interaction between consumer and retailer payment choices.

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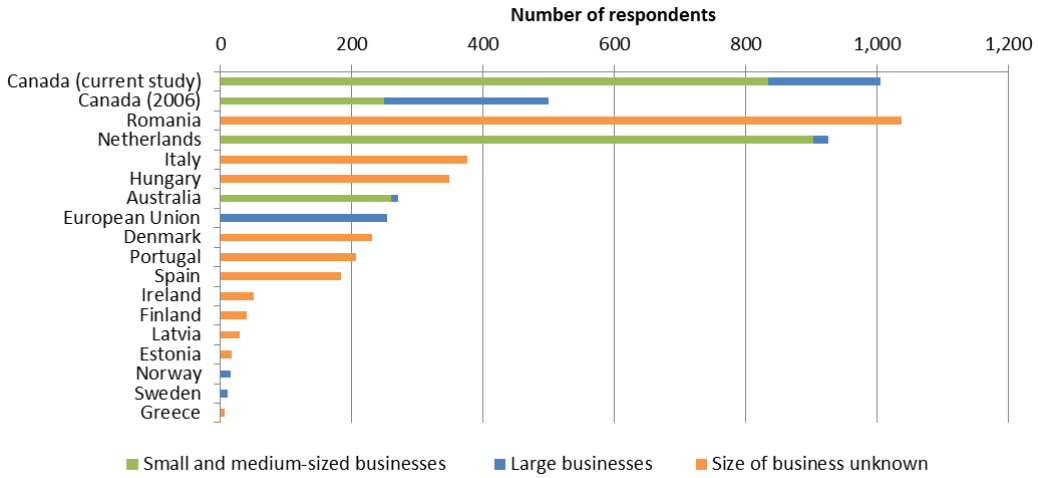
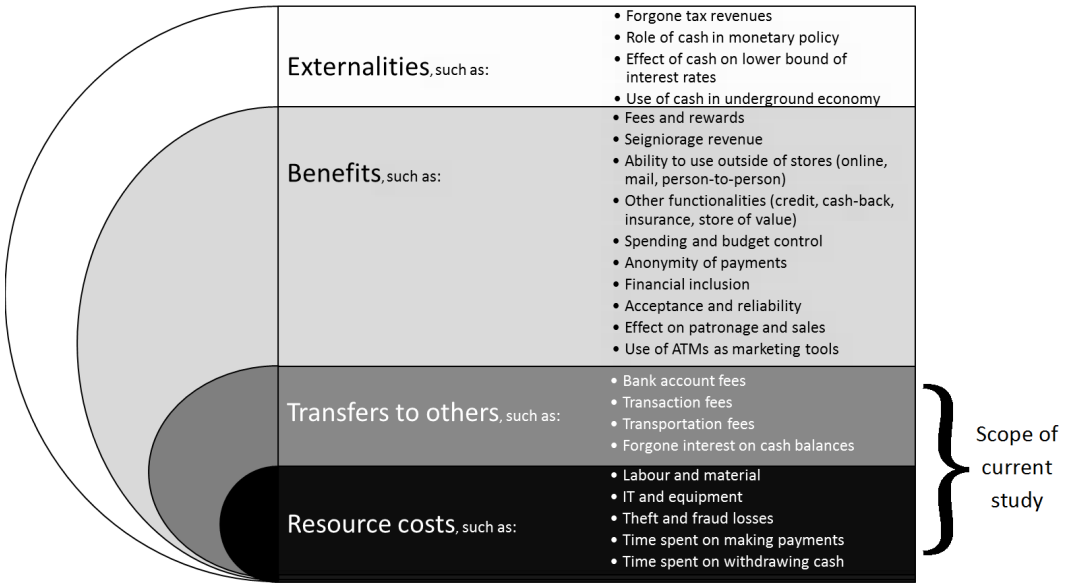
Figures

Figure 1: Comparison of number and composition of respondents to the retailer surveys



Note: The chart shows the number of respondents to the various retailer and business surveys conducted in the past 10 years. Where possible, a breakdown is presented by size of retailer/business. Numbers are based on internal calculations based on Arango and Taylor (2008), Jonker (2013), Stewart et al. (2014), Danmarks Nationalbank (2012), Schmiedel et al. (2013), European Commission (2015), Norges Bank (2014), and Segendorf and Jansson (2012).

Figure 2: Potential costs and benefits of retail payments



Note: Ideally, an all-comprehensive cost-benefit analysis would entail every item listed in this figure. Since the externalities and benefits are difficult to quantify, the current study follows the approach of other cost of payment studies (see, for example, Schmiedel et al. (2013) and references therein) by focusing on the costs that can be directly measured, i.e., resource costs and transfers paid to others.

Figure 3: Payment shares in terms of value of transactions

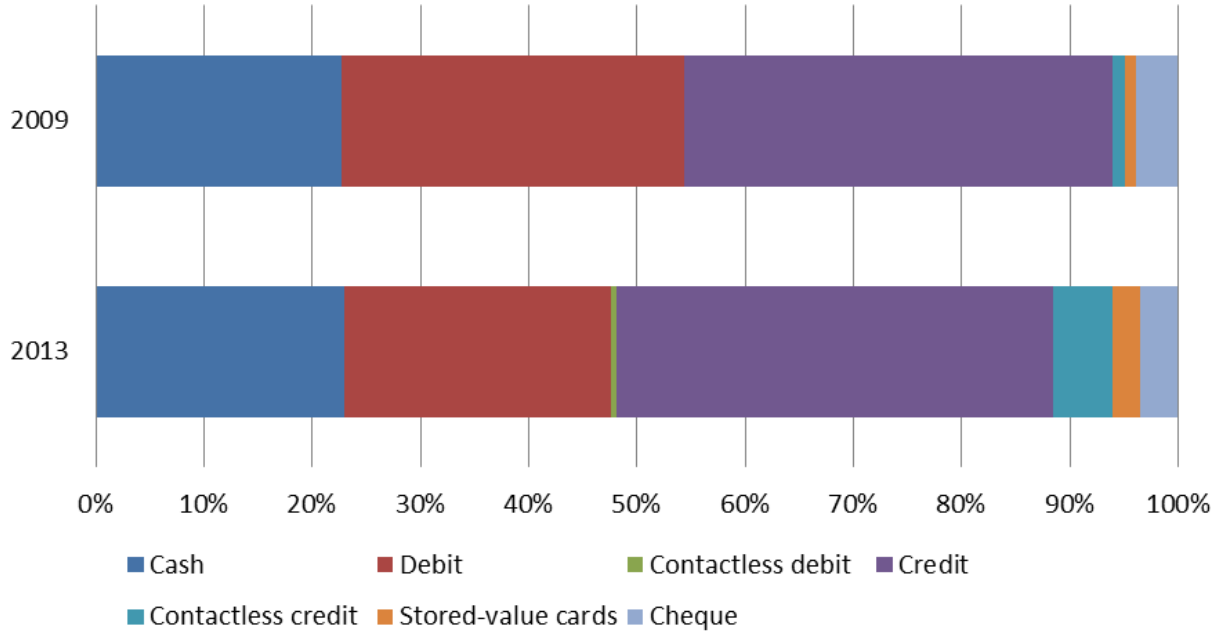
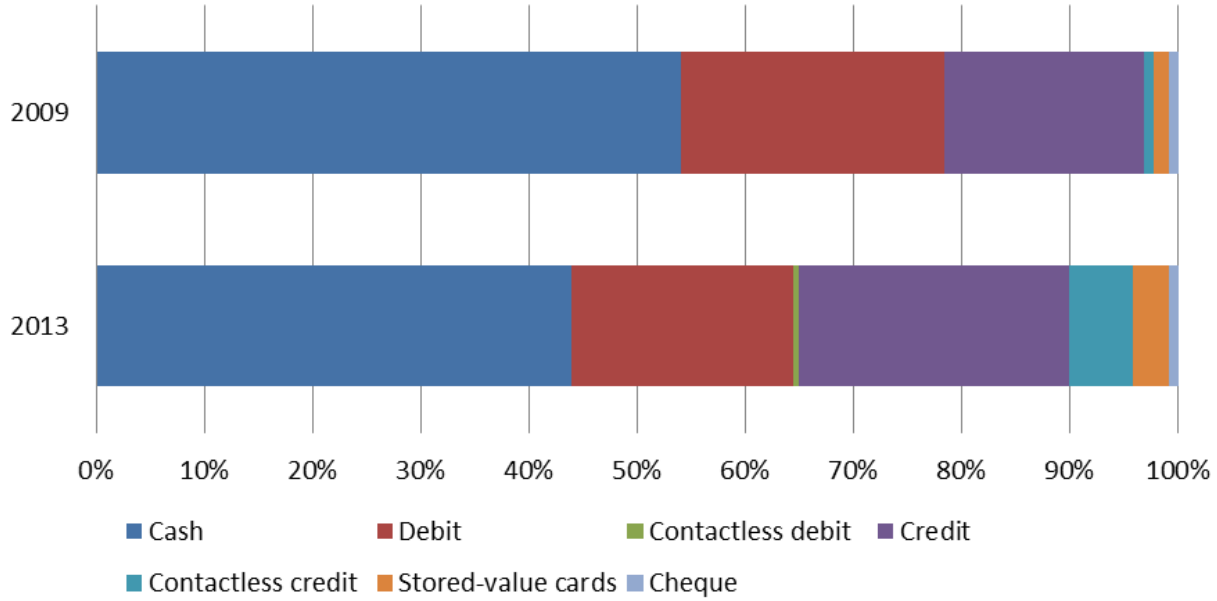
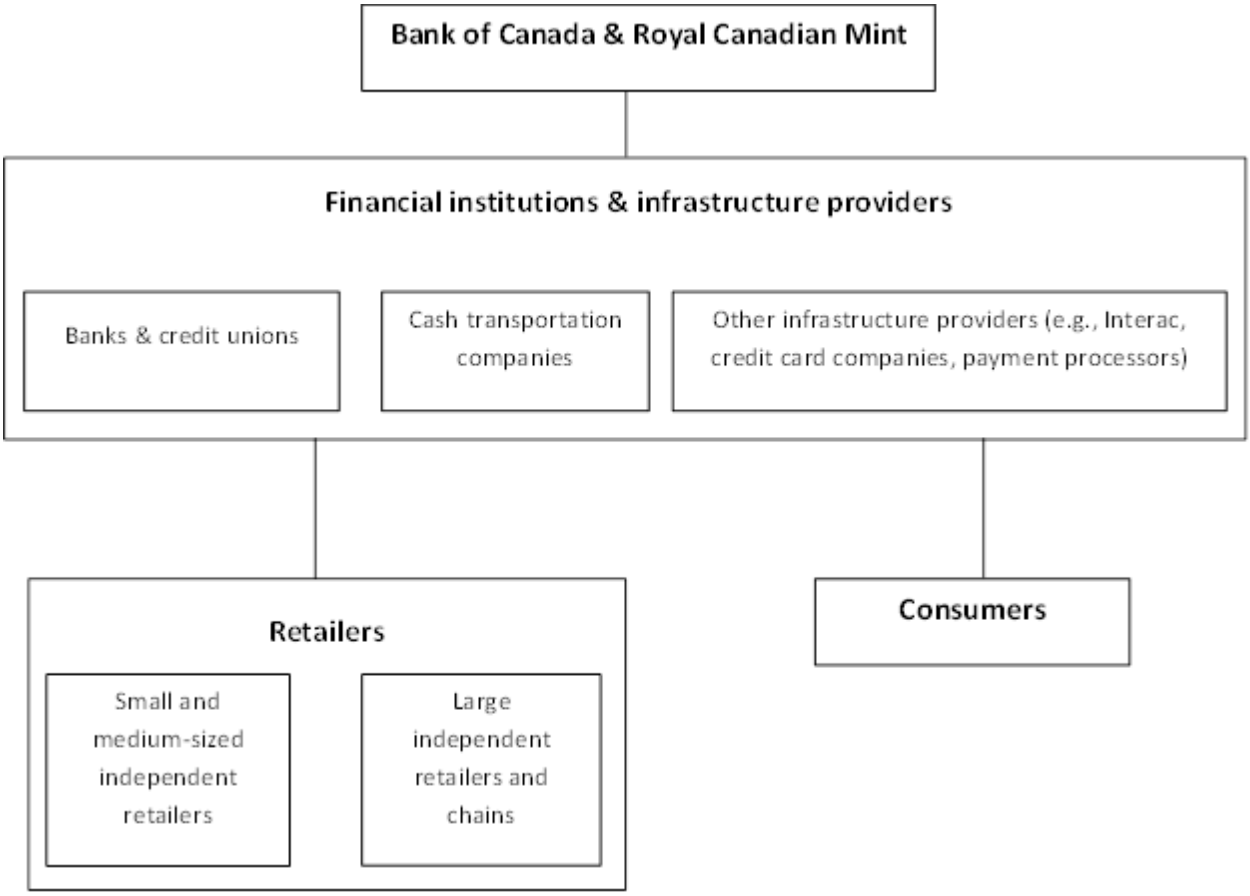


Figure 4: Payment shares in terms of numbers of transactions



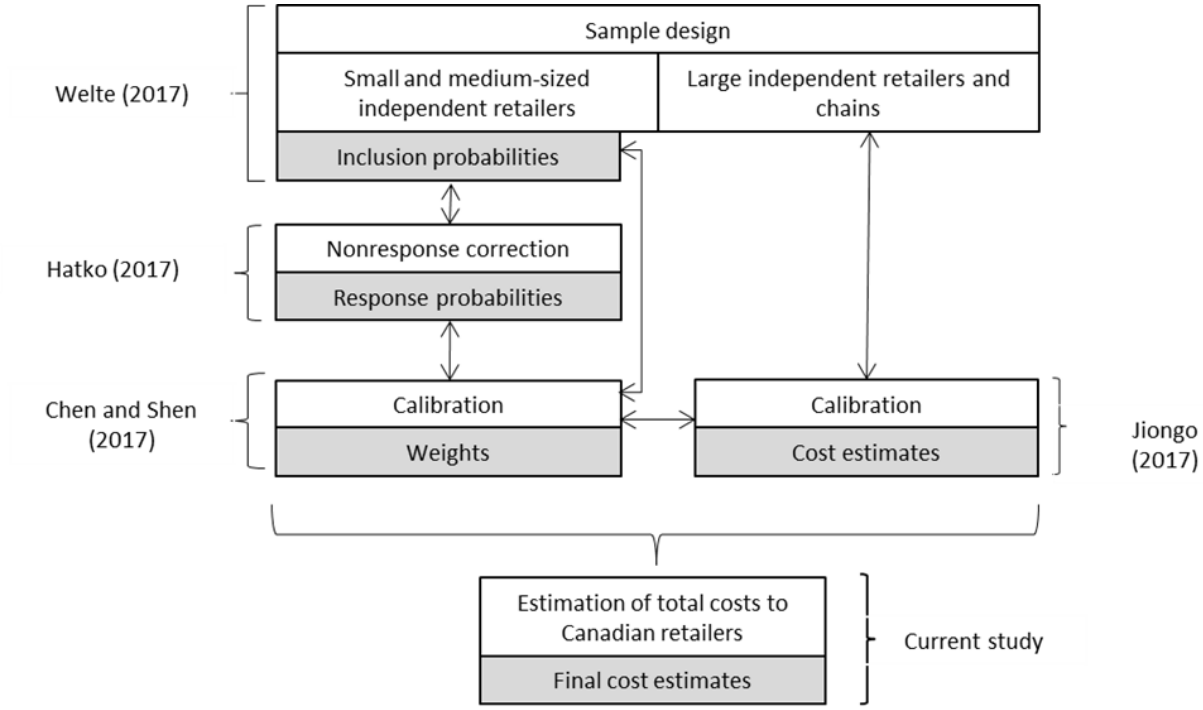
Notes: The two figures show the proportion of the total value and number of transactions by method of payment in Canada in 2009 and 2013. The scope of the data includes payments made at the point of sale, as well as person-to-person and online transactions. Transaction values include debit card cash-back values. Recurrent bill payments (i.e., mortgages or rent) are excluded. Source: Fung et al. (2015).

Figure 5: Stakeholders covered in current study



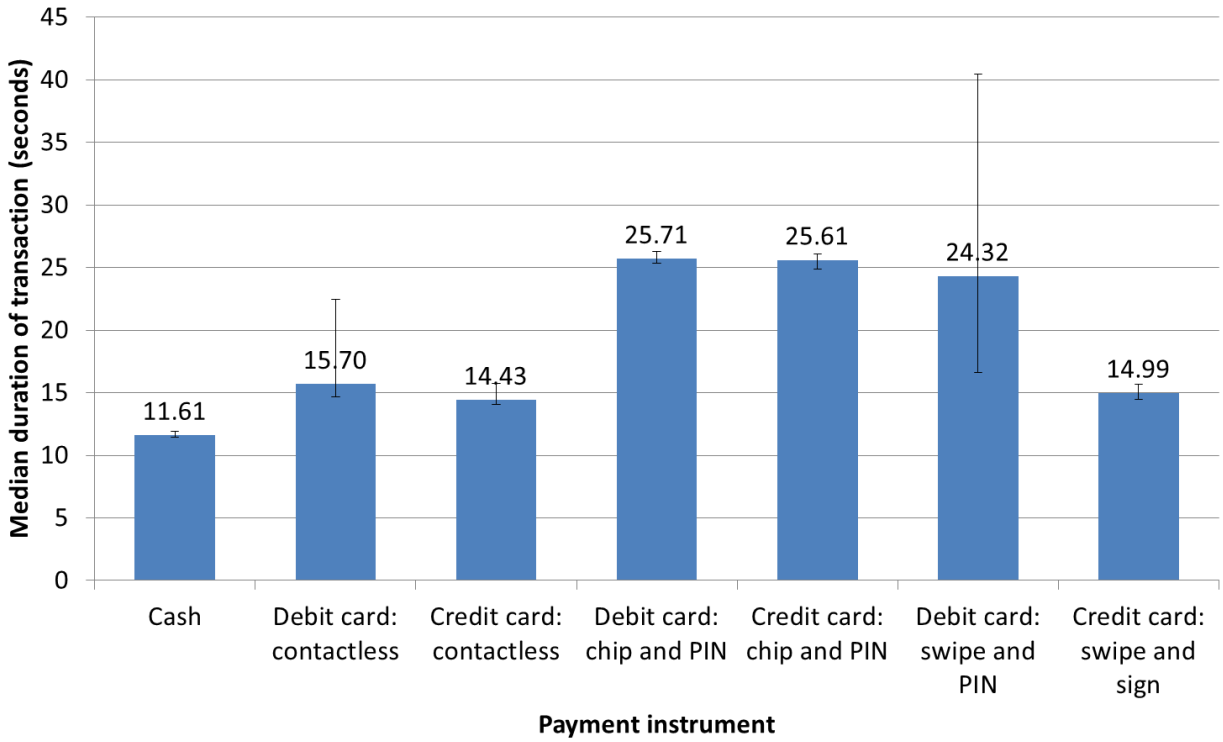
Notes: The banks and credit unions surveyed for this study cover about 96 per cent of all debit card transactions made in Canada, and approximately 78 per cent of all regular credit card payments and 94 per cent of all prepaid credit card transactions. Their costs have been scaled up to the national level based on the number and value of cash withdrawals and card payments. The final sample of small and medium-sized independent retailers provides good coverage of small and medium-sized retail stores, food and drink places and personal service providers in Canada in terms of industry and region. Survey weights are used to extrapolate the results to the national level. The large independent retailers and headquarters studied represent about 41 per cent and 18 per cent of the total turnover in the Canadian retail and restaurant sectors, respectively, and calibration methods were used for the scale-up. The consumer portion of the study uses data from the Bank's 2013 Methods-of-Payment Survey, which is representative of the Canadian population aged 18 years and older. The two cash transportation companies surveyed cover basically the entire Canadian cash transportation market. Other infrastructure providers were not directly surveyed, but captured through the information collected from the retail and financial sectors.

Figure 6: Overview of related Bank of Canada Technical Reports



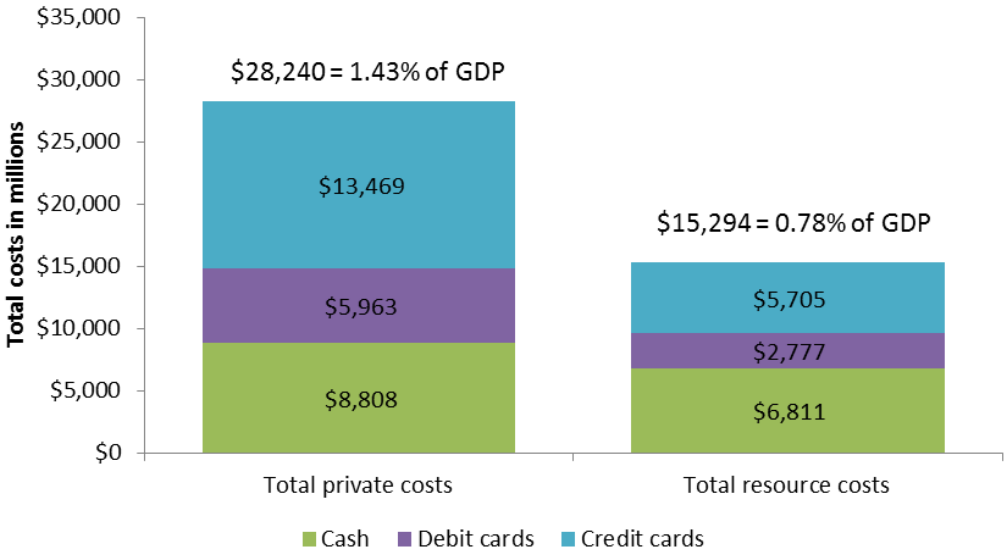
Note: This figure provides an overview of the Bank of Canada Technical Reports associated with the current study. Welte (2017) describes and discusses the sampling methodology used in the RCPM survey, including recommendations for sampling strategies in future retailer surveys. Chen and Shen (2017) describe the creation of calibrated weights for the RCPM survey in order to reduce the nonresponse bias and coverage error and to make the weighted sample estimates consistent with the target population. Hatko (2017) provides a detailed description of the analyses undertaken for nonresponse among small and medium-sized independent retailers in the RCPM survey and Jiongo (2017) describes the imputation and calibration methods used for the large retailers sample.

Figure 7: Median transaction duration by payment method (in seconds)



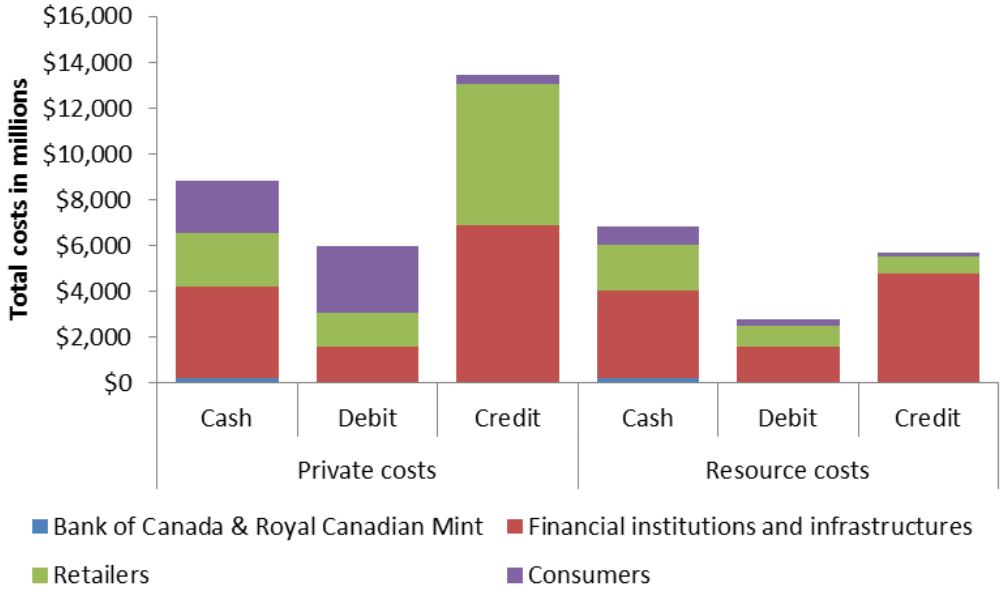
Note: Data taken from the Bank of Canada 2014 Time Duration Study. The chart presents the median transaction durations and the 95 per cent confidence intervals by payment method as estimated using a quantile regression model. The swipe technology, which is hardly used anymore, requires customers to swipe the magnetic stripe of their card through the terminal. Debit card swipe transactions require a PIN, whereas a signature is requested for credit card swipe transactions.

Figure 8: Total private and resource costs (in millions)



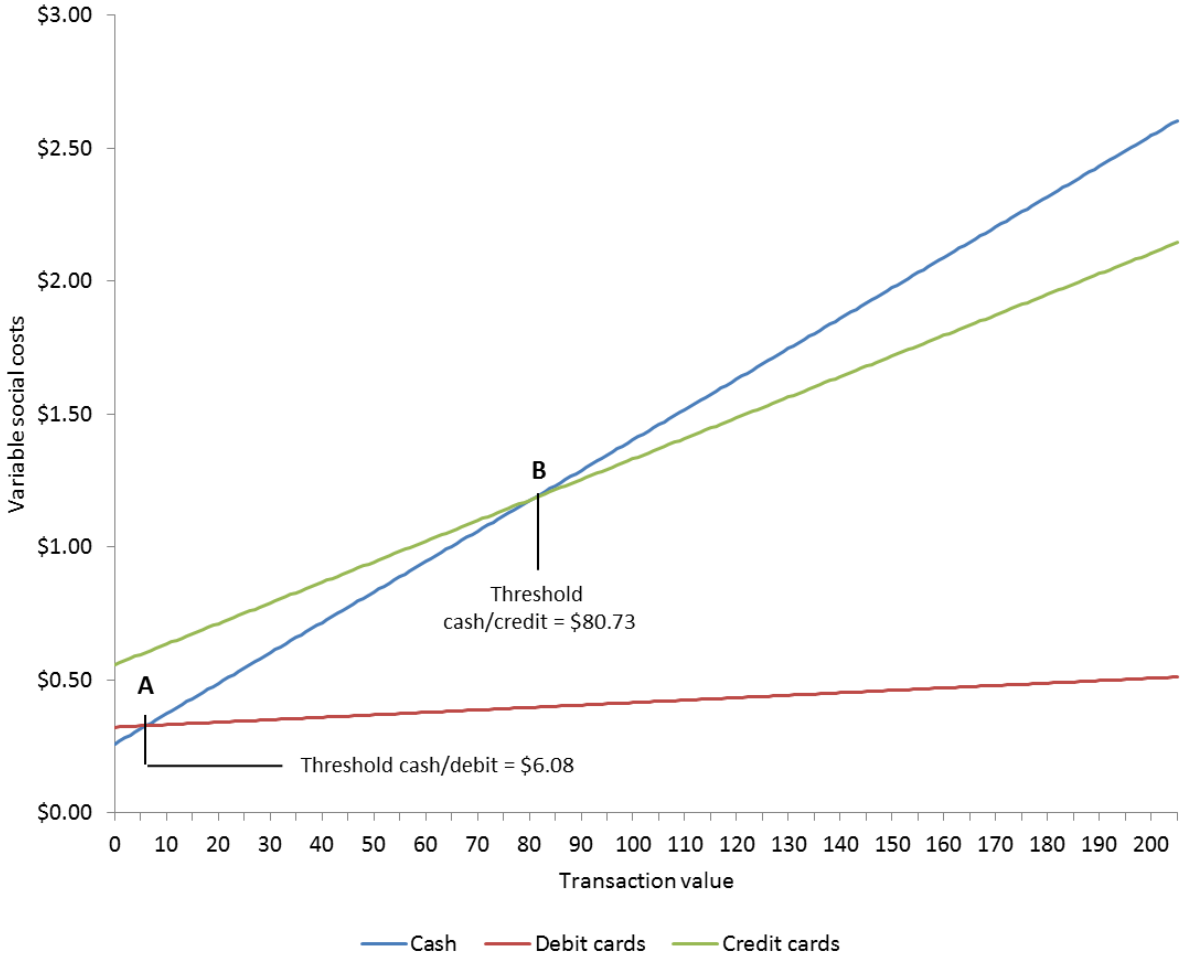
Note: This figure presents the total private and resource costs incurred in 2014 by the stakeholders covered in the study. Private costs include both resource costs and transfers paid to others. Percentage of GDP is based on gross domestic product at market prices in 2014 as reported by Statistics Canada on http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/econ04-eng.htm. Credit card costs include the costs of prepaid credit cards.

Figure 9: Total costs by stakeholder (in millions)



Note: This figure presents a breakdown of the total private and resource costs by stakeholder. Private costs include both resource costs and transfers paid to others. Credit card costs include the costs of prepaid credit cards.

Figure 10: Variable resource costs per transaction by transaction value (Can$)



Note: This figure presents the variable resource costs of cash, debit card and credit card payments (VCT) for various transaction values (TV). They are calculated based on the costs of one additional transaction *(a)* and the costs for Can$1 in additional sales *(b)* as listed in Table 11 using the following formula: $(VCT) = (a) + (b)*(TV)$. Hence, they are based on the assumption that 44 per cent of the variable resource costs of cash are related to the transaction value, while 56 per cent vary with the number of transactions. Threshold A demonstrates that cash is more expensive than debit cards for transactions higher than $6.08 and Threshold B shows that cash is more expensive than credit cards for payments higher than $80.73.

Figure 11: Scenario 1—Decrease of share of value-related variable costs of cash (Can$)

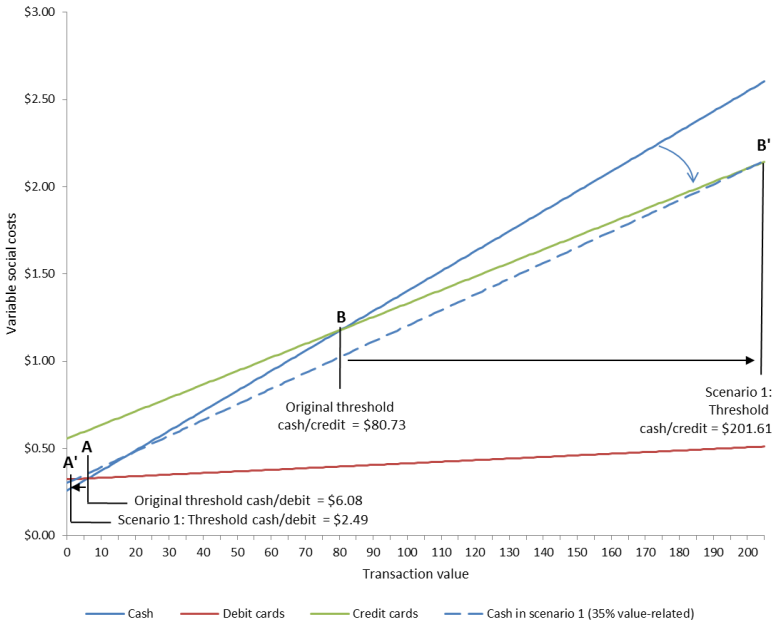
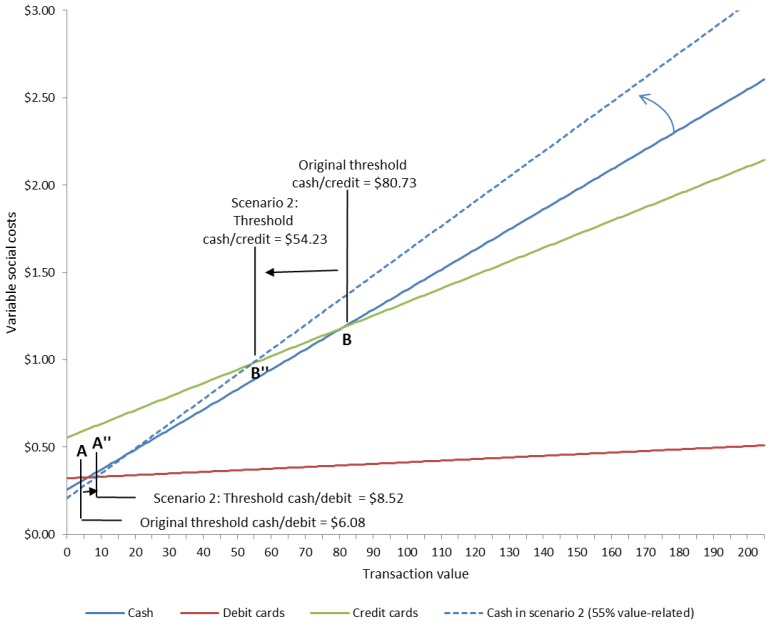


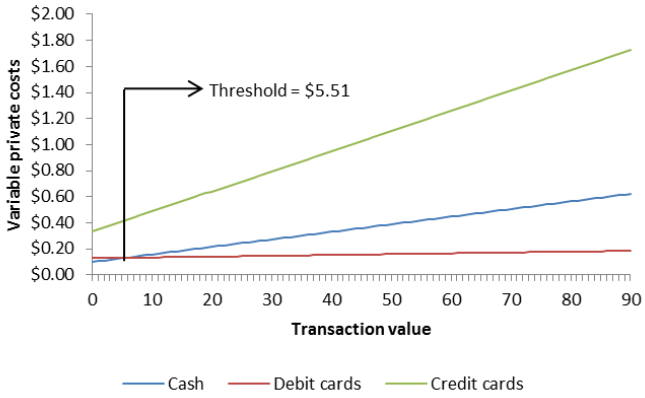
Figure 12: Scenario 2—Increase of share of value-related variable costs of cash (Can$)



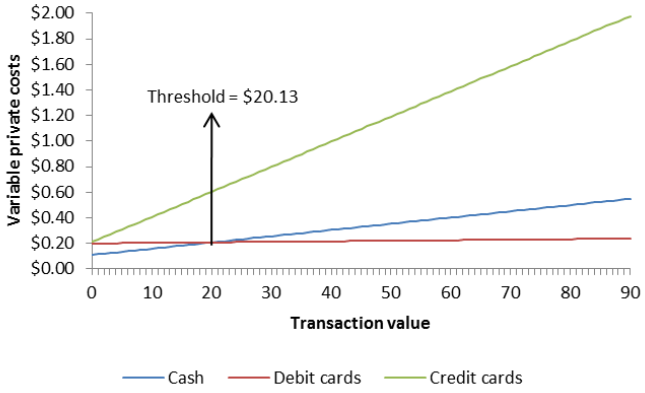
Note: The above graphs present the variable resource costs of cash, debit card and credit card payments (VCT) for various transaction values (TV). The solid lines equal the benchmark situation as depicted in Figure 10. These are based on the assumption that 44 per cent of the variable resource costs of cash vary with the value of transactions. The dashed lines depict the costs of cash assuming that 35 per cent (Figure 11) and 55 per cent (Figure 12) of its variable resource costs are related to the transaction value. In Figure 11, the slope of the cash cost curve decreases compared with the benchmark situation. As a result, the threshold after which cash becomes more costly than debit cards decreases from A to A', while the threshold after which cash becomes more expensive than credit cards rises from B to B'. In Figure 12, the slope of the cash curve increases, which causes the cash/debit threshold to increase to A", while the cash/credit threshold falls to B".

Figure 13: Variable private costs per transaction by transaction value (Can$)

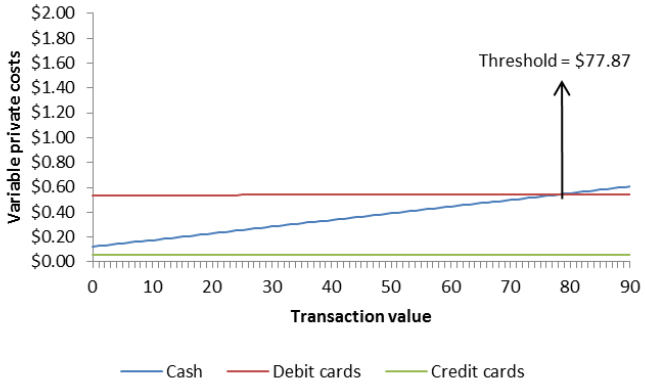
(a) Financial institutions and infrastructures



(b) Retailers



(c) Consumers



Note: The figures present the variable private costs of cash, debit card and credit card payments for financial institutions, retailers and consumers. Private costs include all variable resource costs plus all variable fees paid to others. Note that the exact threshold values strongly depend on the underlying composition of fixed and variable costs. The presented turnaround points are therefore only indicative.

Tables

Table 2: RCPM survey responses by size of retailer

	Number of invitations	Number of responses	Response rate
Small and medium independent retailers	28,695	1,014	3.5%
Large independent retailers and chains	830	55	6.6%
Total	29,525	1,069	3.6%

Notes: Number of responses includes all responses. Of the 1,014 questionnaires received from small and medium-sized independent retailers, 940 were useful for analyses. Small independent retailers include independent retailers with fewer than 5 employees, medium-sized independent retailers have 5 to 49 employees and large independent retailers are defined as those having more than 49 employees.

Table 3: Breakdown of responses from independent retailers

	Number of employees							
	0 to 4		5 to 49		50+		Total	
By region	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Atlantic provinces	68	17.8%	63	14.2%	6	5.3%	137	14.6%
Quebec	74	19.4%	128	28.8%	31	27.2%	233	24.8%
Ontario	95	24.9%	94	21.2%	42	36.8%	231	24.6%
Prairie provinces	69	18.1%	88	19.8%	28	24.6%	185	19.7%
British Columbia	76	19.9%	71	16.0%	7	6.1%	154	16.4%
Total	**382**	**100%**	**444**	**100%**	**114**	**100%**	**940**	**100%**
	0 to 4		5 to 49		50+		Total	
By industry	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Specialized retail stores	99	25.9%	158	35.6%	74	64.9%	331	35.2%
General retail stores	95	24.9%	58	13.1%	3	2.6%	156	16.6%
Accommodation and food places	64	16.8%	159	35.8%	29	25.4%	252	26.8%
Personal service providers	124	32.5%	69	15.5%	8	7.0%	201	21.4%
Total	**382**	**100%**	**444**	**100%**	**114**	**100%**	**940**	**100%**

Notes: This table presents a breakdown of the total number of responses received from independent retailers by retailer size. Number of responses includes only valid responses that were used in the final analyses. The industry groups are defined using the North American Industry Classification System (NAICS), with specialized retail stores being NAICS 44, general retail stores being NAICS 45, accommodation and food places being NAICS 72 and personal service providers belonging to NAICS 81.

TABLE 4: Number and value of POS payments made in Canada in 2014

	Cash	Debit cards	Credit cards
Total no. of POS transactions (in millions)	8,104	4,900	2,978
Total value of POS transactions (in Can$ millions)	$145,951	$211,000	$259,672
Average transaction amount (in Can$)	$18.01	$43.06	$87.19

Notes: Numbers and values include only domestic POS transactions. Cash estimates are based on information from the RCPM survey, the Bank's 2013 MOP survey and Statistics Canada. Debit and (prepaid) credit card statistics are based on information from Interac, the Canadian Bankers Association, Nilson and individual market participants.

TABLE 5: Private costs of cash, debit card and credit card payments (in Can$ millions)

	Cash	Debit cards	Credit cards	Total
Bank of Canada and Royal Canadian Mint	$ 239	$ -	$ -	$ 239
Financial institutions and infrastructures	$ 3,944	$ 1,594	$ 6,868	$ 12,406
Retailers	$ 2,384	$ 1,486	$ 6,202	$ 10,073
Consumers	$ 2,240	$ 2,883	$ 399	$ 5,522
Total	**$ 8,808**	**$ 5,963**	**$ 13,469**	**$ 28,240**
% Share in total costs	**31%**	**21%**	**48%**	**100%**
% GDP	**0.446%**	**0.302%**	**0.683%**	**1.431%**

Notes: This table presents the total private costs of each payment method. It is generated by adding together the private costs from Table 7, Table 8 and Table 9. Percentage of GDP is based on gross domestic product at market prices in 2014 as reported by Statistics Canada on http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/econ04-eng.htm. Credit card costs include the costs of prepaid credit cards.

TABLE 6: Resource costs of cash, debit card and credit card payments (in Can$ millions)

	Cash	Debit cards	Credit cards	Total
Bank of Canada and Royal Canadian Mint	$ 222	$ -	$ -	$ 222
Financial institutions and infrastructures	$ 3,818	$ 1,583	$ 4,757	$ 10,158
Retailers	$ 1,980	$ 891	$ 772	$ 3,643
Consumers	$ 790	$ 303	$ 176	$ 1,270
Total	**$ 6,811**	**$ 2,777**	**$ 5,705**	**$ 15,293**
% Share in total costs	**45%**	**18%**	**37%**	**100%**
% GDP	**0.345%**	**0.141%**	**0.289%**	**0.775%**

Notes: This table presents the total resource costs of each payment method. It is generated by adding together the resource costs from Table 7, Table 8 and Table 9. Percentage of GDP is based on gross domestic product at market prices in 2014 as reported by Statistics Canada on http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/econ04-eng.htm. Credit card costs include the costs of prepaid credit cards.

TABLE 7: The private and resource costs of cash (in Can$ millions)

	Private costs	Share in total private costs	Fees paid	Resource costs	Share in total resource costs
The Bank and the Mint	$ 239	3%	$ 17	$ 222	3%
Financial inst. and infr.	$ 3,944	45%	$ 125	$ 3,818	56%
Retailers	$ 2,384	27%	$ 404	$ 1,980	29%
Consumers	$ 2,240	25%	$ 1,450	$ 790	12%
Total	$ 8,808	100%	$ 1,997	$ 6,811	100%

Notes: This table presents the private and resource costs of cash incurred by each stakeholder in 2014. The sum of the resource costs constitutes the total use of resources by society as a whole. The costs for the Bank of Canada, Royal Canadian Mint and financial sector include all costs related to the issuance and provision of cash, irrespective of how the cash was finally used by the public. Part of this cash may have been used for purposes other than POS payments, so the total costs may overstate the costs of POS payments only. The cash costs for consumers and merchants are calculated using POS cost information only, so are not subject to such an overestimation.

TABLE 8: The private and resource costs of debit cards (in Can$ millions)

	Private costs	Share in total private costs	Fees paid	Resource costs	Share in total resource costs
Financial inst. and infr.	$ 1,594	27%	$ 12	$ 1,583	57%
Retailers	$ 1,486	25%	$ 595	$ 891	32%
Consumers	$ 2,883	48%	$ 2,579	$ 303	11%
Total	$ 5,963	100%	$ 3,186	$ 2,777	100%

Notes: This table presents the private and resource costs incurred for debit cards by each stakeholder in 2014. The sum of the resource costs constitutes the total use of resources by society as a whole. Costs refer only to card transactions made at the POS in Canada and are calculated assuming that the per-transaction costs for the financial sector are the same for domestic and international debit card payments, as well as for POS and online debit card payments.

TABLE 9: The private and resource costs of credit cards (in Can$ millions)

	Private costs	Share in total private costs	Fees paid	Resource costs	Share in total resource costs
Financial inst. and infr.	$ 6,868	51%	$ 2,111	$ 4,757	83%
Retailers	$ 6,202	46%	$ 5,431	$ 772	14%
Consumers	$ 399	3%	$ 222	$ 176	3%
Total	$ 13,469	100%	$ 7,764	$ 5,705	100%

Notes: This table presents the private and resource costs incurred for credit cards by each stakeholder in 2014. The sum of the resource costs constitutes the total use of resources by society as a whole. Costs include the costs of prepaid credit cards and refer only to card transactions made at the POS in Canada. They are calculated assuming that the per-transaction costs for the financial sector are the same for domestic and international credit card payments, as well as for POS and online credit card payments.

TABLE 10: Average resource costs per transaction (Can$)

	Cash	Debit cards	Credit cards
Average resource costs per transaction	**$ 0.840**	**$ 0.567**	**$ 1.916**
Bank of Canada and Royal Canadian Mint	$ 0.027	$ -	$ -
Financial institutions and infrastructures	$ 0.471	$ 0.323	$ 1.597
Retailers	$ 0.244	$ 0.182	$ 0.259
Consumers	$ 0.098	$ 0.062	$ 0.059
Resource costs as a percentage of transaction value	**4.7%**	**1.3%**	**2.2%**
Average private costs per transaction			
Bank of Canada and Royal Canadian Mint	$ 0.029	$ -	$ -
Financial institutions and infrastructures	$ 0.487	$ 0.325	$ 2.306
Retailers	$ 0.294	$ 0.303	$ 2.083
Consumers	$ 0.276	$ 0.588	$ 0.134

Notes: The average resource (private) costs per transaction for each payment method are calculated by dividing its total resource (private) costs as presented in Table 6 (Table 5) by its number of transactions, as laid out in Table 4. The resource costs as a percentage of transaction value are generated by dividing the resource costs of each payment method by the total value of transactions made with it, as listed in Table 4. It reflects how much of each transaction, irrespective of its size, was spent by society for enabling, making and accepting this payment.

TABLE 11: Breakdown of resource costs by fixed and variable costs (in Can$ millions)

	Cash	Debit cards	Credit cards
Bank of Canada and Royal Canadian Mint			
Fixed costs	$ 109	$ -	$ -
Transaction-linked variable costs	$ 67	$ -	$ -
Value-linked variable costs	$ 46	$ -	$ -
Financial institutions and infrastructures			
Fixed costs	$ 2,293	$ 827	$ 1,833
Transaction-linked variable costs	$ 684	$ 622	$ 966
Value-linked variable costs	$ 841	$ 134	$ 1,959
Retailers			
Fixed costs	$ 544	$ 181	$ 205
Transaction-linked variable costs	$ 875	$ 650	$ 515
Value-linked variable costs	$ 561	$ 61	$ 52
Consumers			
Fixed costs	$ 108	$ -	$ -
Transaction-linked variable costs	$ 461	$ 303	$ 176
Value-linked variable costs	$ 222	$ -	$ -
Total			
Fixed costs	$ 3,054	$ 1,008	$ 2,037
Transaction-linked variable costs (TVC)	$ 2,086	$ 1,575	$ 1,657
Value-linked variable costs (VVC)	$ 1,671	$ 194	$ 2,011
Costs of 1 additional transaction (a)	$ 0.257	$ 0.321	$ 0.556
Costs for CAN 1 in additional sales (b)	$ 0.011	$ 0.001	$ 0.008

Notes: This table breaks down the total resource costs by fixed and variable costs, assuming a medium-term horizon of three to five years. Any discrepancies between the sum of the fixed and variable costs presented in this table and the total costs listed in earlier tables are caused by rounding errors. The costs of one additional transaction (a) are calculated by dividing its total transaction-related variable costs (TVC) by the number of transactions from Table 4. The costs for Can$1 in additional sales ($b$) are generated by dividing the value-linked variable costs (VVC) by the total value of transactions from Table 4.

TABLE 12: Results of recent cost-of-payment studies

	Canada	EU	Australia*	Austria**	Netherlands***	Denmark****	Norway	Sweden
Cash								
Share of cash in total no. of cash and card payments	**51%**	**83%**	**55%**	**82%**	**52%**	**49%**	**24%**	**40%**
Total resource costs (% of GDP) excl. consumer costs	0.31%	0.49%	0.19%	0.36%	0.28%	0.27%	0.07%	0.28%
Total resource costs (% of GDP)	0.35%	0.49%	0.19%	0.36%	0.28%	0.35%	0.10%	0.28%
Share borne by central bank and minting authority	*3%*	*4%*	*0%*	*4%*	*4%*	*2%*	*3%*	*2%*
Share borne by financial institutions and infrastructure	*56%*	*39%*	*45%*	*48%*	*48%*	*37%*	*59%*	*48%*
Share borne by retailers	*29%*	*55%*	*55%*	*48%*	*48%*	*37%*	*11%*	*50%*
Share borne by consumers	*12%*	*n/a*	*n/a*	*n/a*	*n/a*	*23%*	*26%*	*0%*
Resource cost per average cash transaction	$ 0.84	$ 0.64	$ 0.43	$ 0.65	$ 0.67	$ 1.15	$ 0.96	$ 1.12
Resource cost per average cash transaction, excl. consumer costs	$ 0.74	$ 0.64	$ 0.43	$ 0.65	$ 0.67	$ 0.88	$ 0.71	$ 1.12
Debit card								
Share of debit in total no. of cash and card payments	**31%**	**14%**	**30%**	**14%**	**41%**	**50%**	**67%**	**51%**
Total resource costs (% of GDP) excl. consumer costs	0.13%	0.10%	0.16%	0.05%	0.12%	0.11%	0.10%	0.19%
Total resource costs (% of GDP)	0.14%	0.10%	0.16%	0.05%	0.12%	0.15%	0.13%	0.19%
Share borne by central bank and minting authority	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Share borne by financial institutions and infrastructure	*57%*	*80%*	*72%*	*75%*	*52%*	*27%*	*34%*	*58%*
Share borne by retailers	*32%*	*20%*	*28%*	*25%*	*48%*	*47%*	*40%*	*42%*
Share borne by consumers	*11%*	*n/a*	*n/a*	*n/a*	*n/a*	*26%*	*26%*	*0%*
Resource cost per average debit card transaction	$ 0.57	$ 1.06	$ 0.64	$ 0.63	$ 0.45	$ 0.49	$ 0.40	$ 0.61
Resource cost per average debit transaction, excl. consumer costs	$ 0.51	$ 1.06	$ 0.64	$ 0.63	$ 0.45	$ 0.36	$ 0.29	$ 0.60
Credit card								
Share of credit in total no. of cash and card payments	**19%**	**4%**	**15%**	**2%**	**1%**	**1%**	**10%**	**9%**
Total resource costs (% of GDP) excl. consumer costs	0.28%	0.09%	0.14%	n/a	n/a	0.02%	0.07%	0.09%
Total resource costs (% of GDP)	0.29%	0.09%	0.14%	n/a	n/a	0.02%	0.08%	0.09%
Share borne by central bank and minting authority	*0%*	*0%*	*0%*	*n/a*	*n/a*	*0%*	*0%*	*0%*
Share borne by financial institutions and infrastructure	*83%*	*89%*	*84%*	*n/a*	*n/a*	*88%*	*73%*	*84%*
Share borne by retailers	*13%*	*11%*	*16%*	*n/a*	*n/a*	*8%*	*16%*	*16%*
Share borne by consumers	*3%*	*n/a*	*n/a*	*n/a*	*n/a*	*4%*	*11%*	*0%*
Resource cost per average credit card transaction	$ 1.92	$ 3.62	$ 1.13	*n/a*	*n/a*	$ 3.29	$ 1.71	$ 1.58
Resource cost per average credit transaction, excl. consumer costs	$ 1.86	$ 3.62	$ 1.13	*n/a*	*n/a*	$ 3.17	$ 1.53	$ 1.58
Total resource costs of cash and cards (% of GDP)	0.78%	0.68%	0.49%	0.41%	0.40%	0.52%	0.31%	0.56%
Excl. consumer costs	0.72%	0.68%	0.49%	0.41%	0.40%	0.40%	0.24%	0.56%
Year of study	2014	2009	2013	2013	2009	2009	2013	2009
Threshold amount cash/debit (Can$)	$6.08	*n/a*	$16.78	($17.82 – $19.44)	$4.63	n/a	n/a	$ 2.70

Notes: Costs per transaction and the threshold amounts are expressed in PPP-adjusted Canadian dollars. PPP exchange rates taken from https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm. The threshold amount cash/debit represents the transaction amount above which debit cards are cheaper than cash in terms of variable costs per transaction.

* Costs for small retailers are excluded. Cost per debit card transaction based on weighted average for electronic funds transfer at point of sale (eftpos) and MasterCard and Visa debit cards. Credit card costs do not include costs associated with the interest-free period or rewards.

** Payment shares are taken from Bagnall et al. (2016).

*** Breakdown by stakeholder based on 2009 results and payment shares taken from Bagnall et al. (2016).

**** Debit card results refer only to domestic debit card scheme.

Sources: Schmiedel et al. (2013), Stewart et al. (2014), Abele and Schaefer (2016), Jonker (2013), Danmarks Nationalbank (2012), Norges Bank (2014), and Segendorf and Jansson (2012).

Appendices

A Characteristics of recent cost-of-payment studies

The following table presents the key characteristics of cost-of-payment studies done elsewhere over the past 10 years. Noticeable differences can be observed in terms of year of study, stakeholders covered and payment methods considered. Also, some studies examined only the resource costs of payments, whereas others looked solely at private costs or both. Moreover, not every study analyzed the breakdown of the costs by fixed and variable costs. Hence, caution should be taken when comparing their results.

TABLE 13: Key characteristics of recent cost of payment studies

	Year of study	Type of costs covered			Stakeholders		Instruments covered
		Resource	Private	Fixed/variable breakdown	Included in reported results	Directly surveyed	
Canada (current study)	2014	✓	✓	✓	Central bank & mint Financial institutions Cash transportation companies Other financial infrastructures Retailers Consumers	* ✓ ✓ ✓ 	Cash Debit Credit (incl. prepaid)
Australia Stewart et al. (2014)	2013	✓	✓	✓	Central bank & mint Financial institutions Cash transportation companies Other financial infrastructures Retailers Consumers **	✓ ✓ ✓ 	Cash Debit Credit Cheques Direct debit Credit transfers
Austria Abele and Schaefer (2016)	2013	✓		✓	Central bank & mint Financial institutions Cash transportation companies Other financial infrastructures Retailers	✓ ✓ ✓ 	Cash Debit
Canada Arango and Taylor (2008)	2006		✓	✓	Retailers	✓	Cash Debit Credit
Denmark Danmarks Nationalbank (2012)	2009	✓	✓		Central bank (incl. mint) Financial institutions Cash transportation companies Other financial infrastructures Retailers Consumers	✓ ✓ ✓ ✓ ✓	Cash Debit Credit Direct debit Credit transfers

Notes: *The central bank was directly surveyed, whereas the costs of the mint were estimated based on external data.
** Results not included in reported estimates of total resource costs for the economy.

TABLE 14: Key characteristics of cost of payment studies: contintued

	Year of study	Type of costs covered			Stakeholders		Instruments covered
		Resource	Private	Fixed/variable breakdown	Included in reported results	Directly surveyed	
European Central Bank Schmiedel et al. (2013)	2009	✓	✓		Central bank & mint Financial institutions Cash transportation companies Other financial infrastructures Retailers	✓ ✓ *** *** ✓	Cash Cheques Debit Credit Direct debit Credit transfers
European Commission European Commission (2015)	2013	✓	✓	✓	Retailers	✓	Cash Debit Credit
Netherlands Jonker (2013)	2009	✓	✓	✓	Central bank & mint Financial institutions Cash transportation companies Other financial infrastructures Retailers	✓ ✓ ✓	Cash Debit
Norway Norges Bank (2014)	2013	✓	✓		Central bank (incl. mint) Financial institutions Cash transportation companies Other financial infrastructures Retailers Consumers	✓ ✓ ✓ ✓	Cash Cards Giro payments
Sweden Segendorf and Jansson (2012)	2009	✓	✓	✓	Central bank (incl. mint) Financial institutions Cash transportation companies Retailers Consumers	✓ ✓ ✓ ✓ ✓	Cash Debit Credit Direct debit Credit transfers

Note: ***In some countries, cash transportation companies and other interbank infrastructures were directly surveyed, in other countries they were not.

B Key assumptions used in this study

Figure 14 summarizes the major assumptions made in this study and how these might potentially have affected the results. Overall, the total estimated costs of cash are likely to be overestimated as they include all cash-related costs incurred by the Bank, Mint and financial sector, irrespective of how the public finally used the cash. Since cash can be used for other purposes than POS payments, such as person-to-person payments or maintaining a supply of cash on-hand, the total cash costs may overstate the costs of cash used for POS payments only.

When approximating the costs of other entities not directly surveyed for the study, such as credit card companies, Payments Canada or white-label ATM providers, their profit margins are assumed to be zero. As a result, the true resource costs of cash, debit cards and credit cards might be overestimated if these entities are generating profits. As such, the total costs of debit cards and credit cards are likely to be an upper bound. Moreover, all costs and transactions are assumed to be made for consumer payments. Hence, business-to-business transactions are ignored and assumed to be zero. As a result, the results might overstate the true costs of consumer payments only. This holds for cash, debit card and credit card payments.

The other key assumptions listed below might have impacted the results in either an upward or downward direction.

Figure 14: Main assumptions and potential associated bias

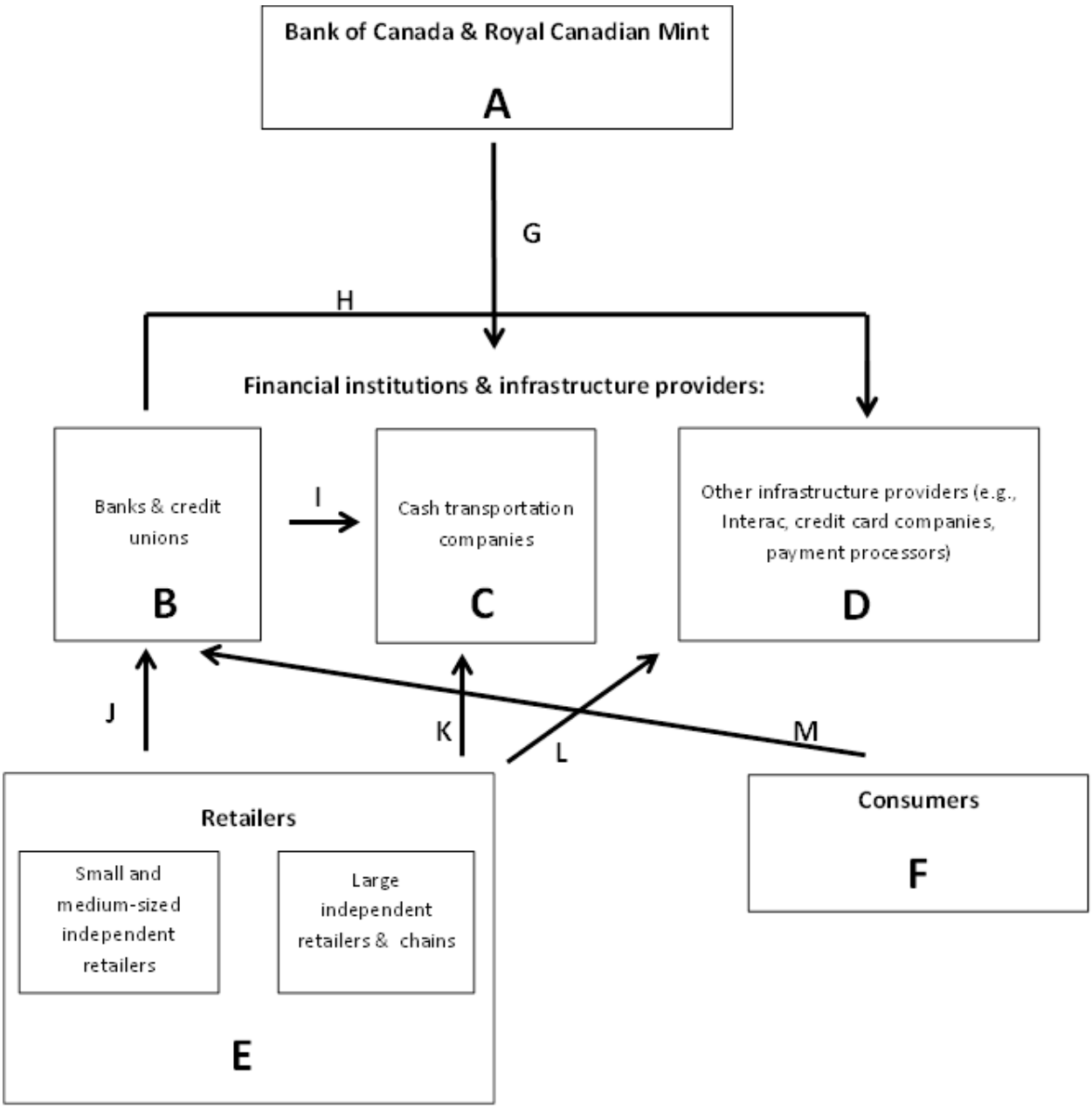
	Cash	Debit	Credit	Turnaround points
• All cash-related costs incurred by the Bank, Mint and financial sector are assumed to be entirely associated with POS cash transactions made.	+			
• All POS payments are assumed to be made by consumers. As such, business-to-business POS payments are assumed to be zero.	+	+	+	
• The fees paid to entitities not directly studied in the study are assumed to equal the resource costs of these entities and to not include a profit margin.	+	+	+	
• Allocation of indirect costs across payment methods based on authors' estimations is based on information from the respondents, other similar studies and external sources.	+ / -	+ / -	+ / -	
• The costs incurred by large retailer sample are assumed to be representative of the large retail population in Canada.	+ / -	+ / -	+ / -	
• The sample of financial institutions is assumed to be representative of all credit card issuers in Canada.			+ / -	
• The breakdown of fixed and variable costs is based on authors' estimations based on information from the respondents, other similar studies and external sources.				+ / -

Note: This figure provides an overview of the key assumptions underlying the study. A "+" indicates whether the assumption is likely to have resulted in an overestimation of the costs, whereas a "+/-" indicates that it could have affected the results in either an upward or downward direction.

C The concept of private and resource costs

Figure 15 provides an illustration of the concept of private and resource costs.

Figure 15: Overview of stakeholders and transfers made



As explained below in Table 15, the capital letters A to F represent the total resource costs consumed by each stakeholder. These include the fees paid for products or services bought from parties that are not included in this study. For example, "A" includes all resource costs incurred by the Bank, such as the costs of labour, IT and its premises, but also the fees paid

to the bank note printer or the substrate supplier. The arrows between the stakeholders (i.e., letters G to M) reflect the transfers made between the stakeholders covered in this study. In the Bank's example, "G" includes the fees paid to cash transportation companies for transporting bank notes across the country.

Table 15: Explanation and examples of resource costs and transfers paid

	Explanation	**Examples**
A	Own resource costs, incl. fees to others outside study	Labour, IT, premises, charges for printing, substrate
B	Own resource costs, incl. fees to others outside study	Labour, IT, premises, charges for outsourcing cash handling
C	Own resource costs, incl. fees to others outside study	Labour, premises, depreciation of vehicles, fuel
D	Own resource costs, incl. fees to others outside study	Labour, IT, premises, charges for electricity
E	Own resource costs, incl. fees to others outside study	Time costs, depreciation of safes and cash registers
F	Own resource costs	Time costs
G	Fees paid to others considered in study	Transportation fees
H	Fees paid to others considered in study	Card processing fees
I	Fees paid to others considered in study	Transportation fees
J	Fees paid to others considered in study	Chequing account fees, forgone interest on cash on hand
K	Fees paid to others considered in study	Transportation fees
L	Fees paid to others considered in study	Card acquiring fees
M	Fees paid to others considered in study	Transaction fees, forgone interest on cash on hand

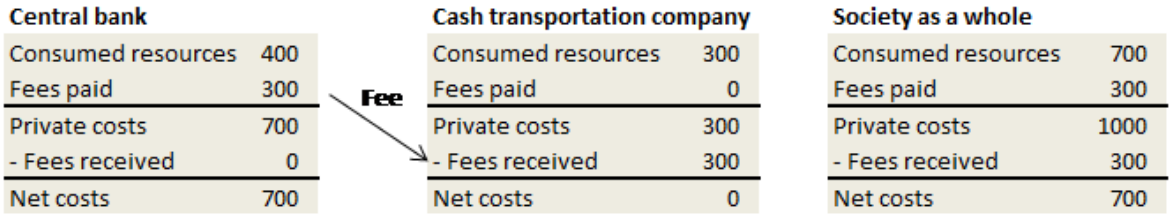
The total resource costs to society can be calculated by adding up all resource costs (see Table 16). Adding up the total private costs of all stakeholders would generate a total cost of A+G+B+C +D+H+I+D+J+K+L+F+M. This, however, would double-count the resource costs that stakeholders pass on to each other through fees. For example, the transportation fees paid by the Bank (G) are likely to (partly) reflect the resource costs incurred by the cash transportation companies (C).

Table 16: Calculation of resource costs

	Resource costs	**Fees paid**	**Private costs**
Bank of Canada & Royal Canadian Mint	A	G	A+G
Financial institutions & infrastructure providers	B+C+D	H+I	B+C+D+H+I
Retailers	E	J+K+L	E+J+K+L
Consumers	F	M	F+M
Total resource costs	**A+B+C+D+E+F**		

Figure 16 provides a further illustration of why the total society's resource costs cannot be generated by adding together all private costs. In this fictitious example, the central bank uses $400 of resources in the form of labour, machinery and premises for the processing of bank notes. The central bank then outsources the transportation to a cash transportation company at a cost of $300. The cash transportation company incurs a total resource cost of $300, which includes the costs of fuel, personnel and depreciation of vehicles. At the same time, it receives revenue from the central bank of $300. The total private costs in this case would be $700 plus $300, hence $1,000. From a society's perspective, this would overstate the total net resource costs, as it includes the $300 income received by the cash transportation. The net resource costs can therefore be generated by subtracting these fees, which would give $700. This is exactly the same as the sum of the resources consumed by the central bank ($400) and cash transportation company ($300).

Figure 16: Fictitious example of private versus resource costs



Note: This figure illustrates a fictitious example of the difference between resource costs and private costs and demonstrates that the total costs to society can be calculated by adding together the resources consumed by all stakeholders.

D RCPM Survey: Sampling, survey, incentives and modes

D.1 Survey, sampling and incentives

The Bank conducted an extensive survey to collect data from Canadian retailers, the Retailer Survey on the Cost of Payment Methods (RCPM survey). The survey asked for all costs tied to accepting cash and card payments at the POS in Canada in 2014. The survey instruments were tailored to the business structure, which resulted in two different questionnaires being used: one for retailers who independently own and operate a business and one for headquarters that operate a chain. Both questionnaires asked for the same information, but the headquarters' survey was divided into two sections. The first section had to be completed by someone at the head office, whereas the second one had to be forwarded to and filled out by individual sales locations. For example, information about the total number and value of payments received was expected to be available at the head office and therefore was part of the first section. By contrast, the individual sales locations were expected to be more capable of providing information about the time needed for back-office activities, such as time spent counting coins and bank notes. Hence, these questions were part of the second section.[38] Before being sent into the field, the survey was tested and discussed with various individual retailers and trade organizations.

The retailers were selected from different frames. The largest headquarters in Canada were sampled with a probability of one based on information on the largest chains in the Canadian retail and restaurant industry. Smaller chains and independent retailers were sampled from the Dun & Bradstreet (D&B) database using stratified random sampling. The stratification levels were region (Atlantic provinces, Quebec, Ontario, Prairie provinces and British Columbia), industry group defined by the NAICS, and business size based on employee count. For a detailed description on the sampling methodology, see Welte (2017).

To promote participation, the survey allowed respondents to select different incentives. Overall, a chance to win an iPad was most popular,[39] followed by receiving the final research report and a more detailed report by region, industry and business size. A considerable number of retailers also chose to receive a certificate of appreciation or an invitation to a webinar.

D.2 Survey modes

The survey followed Dillman et al. (2008) and approached retailers with a mixed-mode methodology to maximize responses. Moreover, independent retailers were contacted differently than headquarters operating a chain.

The independent retailers were first sent an invitation letter signed by the Governor of the Bank of Canada. One week later, a paper questionnaire was sent followed by a reminder postcard several days after that. The packages went out in multiple waves in order to learn and, if needed, to modify the approach based on returns. At the same time, an online survey

[38] Copies of the questionnaires are available upon request.

[39] This option was offered to independent retailers only.

provided invitees an alternative way to complete the survey. The Bank's website also served as a separate channel where all retailers in Canada were given an opportunity to download the questionnaire or to complete the survey online. The paper questionnaire was available in different languages, such as English, French and Cantonese/Mandarin, to accommodate different preferences. Additionally, telephone interviews served as a complementary data collection method among nonresponders and to boost response in certain strata.[40] Telephone interviews were also used to retrieve missing information from those who had completed the survey on paper. Finally, Bank staff made personal visits to recruit retailers from industries with low response rates. In the end, 81 per cent of the responses from independent retailers were received on paper, 8 per cent through the online tool and 12 per cent through telephone interviews.

Like the independent retailers, headquarters were sent an invitation letter signed by the Governor of the Bank of Canada, followed by a paper questionnaire and a reminder postcard. They were also offered the opportunity to complete the survey online. However, lower than expected response rates motivated a more personalized outreach. The low response rate was likely caused by the impersonal nature of the paper mailouts. The invitations were sent to the chief financial officer in the absence of actual names. As a result, many invitations were likely intercepted by gate-keepers or lost within the company. Hence, Bank employees personally reached out to retailer headquarters through email and telephone to contact the appropriate individuals and seek their participation. Moreover, a further boost in responses was achieved as a result of intermediation from retailer organizations. By far, the majority of headquarters responses were through paper.

[40]The initial response rate was particularly low among small and medium-sized food places.

E Survey among financial institutions

After careful consideration of other potential methods, such as using the fees charged to consumers and retailers (see Krüger and Seitz (2014)) or estimating a structural supply and demand model, the most suitable approach to measure financial institutions costs was to directly gather their cost information. A major limitation of using the fees charged to consumers and retailers is that these may not properly reflect the financial sector's costs if the market is not perfectly competitive or characterized by cross-subsidization.[41] Also, a rigorous modelling approach would be needed to account for this, since prices faced by consumers and retailers are often not directly measurable when services are offered in packages and when banks apply implicit pricing through low or zero interest on deposits (see Krüger and Seitz (2014)).

To assist the financial institutions to collect the information, the Bank developed an automated data collection tool based on the activity-based costing (ABC) framework. Respondents were free to use this tool or their own accounting methods. The ABC framework has proven useful for measuring the costs of payment methods (see Stewart et al. (2014), Norges Bank (2014) and Schmiedel et al. (2013)). According to this framework, the costs of individual payment methods are calculated as the sum of the costs of all activities performed for offering these methods of payment. Examples of activities in the provision of payment instruments by financial institutions include "issuing a credit card" or "processing a cash withdrawal." Table 17 provides an overview of all activities considered in the study.

[41] Carbo-Valverde and Perez-Saiz (Forthcoming) study the competition in Canadian retail banking and find that competition has a significant downward effect on monthly fees paid for bank accounts and credit cards.

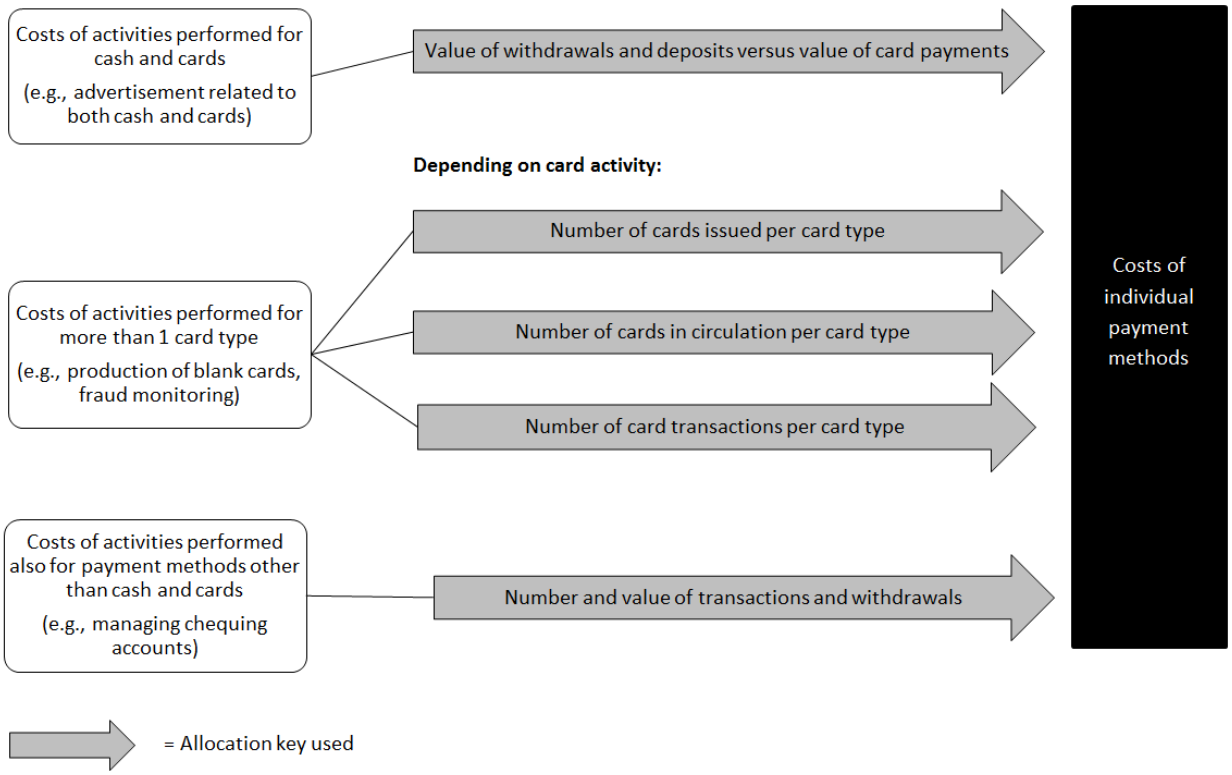
TABLE 17: Activities and cost items covered in survey of financial institutions

Activities	Examples of cost items and activities covered	A potential cost of:			
		Cash	Debit cards	Credit cards	Prepaid credit cards
Over-the-counter (OTC) services:					
Processing OTC cash deposits	Receiving, counting and registering deposits, etc.*	✓			
Processing OTC cash withdrawals	Checking account balances, paying and recording withdrawals, etc.*	✓			
Other in-branch cash or card activities	Providing in-branch customer support associated with cash or cards, etc.*	✓	✓	✓	✓
ATM services:					
Servicing ATMs	Filling and maintaining ATMs, depreciation or rent of ATMs, etc.*	✓			
Processing ATM cash withdrawals	Fees paid to network or financial institutions for other banks' ATM usage, etc.	✓			
Processing ATM cash deposits	Fees paid and other related costs.	✓			
Servicing other deposit facilities	Operating and maintaining night safes, etc.*	✓			
Cash handling services:					
Cash handling and storage	Sorting and packing cash, vault maintenance, cash centre facility costs, etc.*	✓			
Cash transportation	Collecting and transporting cash, fees paid to cash transportation companies, etc.*	✓			
Cash fraud	Investigating and processing fraud, training costs, fraud or theft losses, etc.*	✓			
Providing customer support for cash	Responding to customer questions, online or by phone.*	✓			
Card services:					
Producing, procuring and issuing cards	Producing cards, card manufacturer fees, license fees to credit card companies, etc.*		✓	✓	✓
Maintaining cards	Suspending and activating cards, renewing agreements, etc.*		✓	✓	✓
(Prepaid) credit card account management	Creating, maintaining and closing (prepaid) credit card accounts.*			✓	✓
Issuing (prepaid) credit card statements	Issuing (prepaid) card statements and other related costs.*			✓	✓
Processing card transactions	Authorizing and settling transactions, interchange and processing fees, etc.*		✓	✓	✓
Processing charge-backs	Processing charge-backs and other related costs.*		✓	✓	✓
Card fraud	Transaction monitoring, fraud investigation and losses, risk management programs, etc.*		✓	✓	✓
Insurance and loyalty programs	Loyalty programs, such as insurance and other benefits.*			✓	✓
Other payments-related credit card costs	Performing credit checks, costs associated with providing a 21-day grace period, etc.*			✓	
Advertisement related to cards	Advertising and marketing that is directly associated with cards.*		✓	✓	✓
Providing customer support for cards	Responding to customer questions, online or by phone.*		✓	✓	✓
Chequing account services:					
Chequing account management	Creating, maintaining and closing chequing accounts.*	✓	✓		
Issuing chequing account statements	Issuing chequing account statements to customers.*	✓	✓		
Providing customer support	Responding to questions about the chequing account in general.*	✓	✓		
Overhead costs:					
Branch facility costs	Rent, depreciation, utilities and security associated with institution branches.*	✓	✓	✓	✓
Overhead costs	Head office costs, acquiring and training of employees, etc.*	✓	✓	✓	✓
General advertising and marketing	Expenses tied to general advertisements not specifically associated with cash or cards.	✓	✓	✓	✓
Other:	Other costs not covered.	✓	✓	✓	✓

* Including staff, information technology, communication and equipment costs.

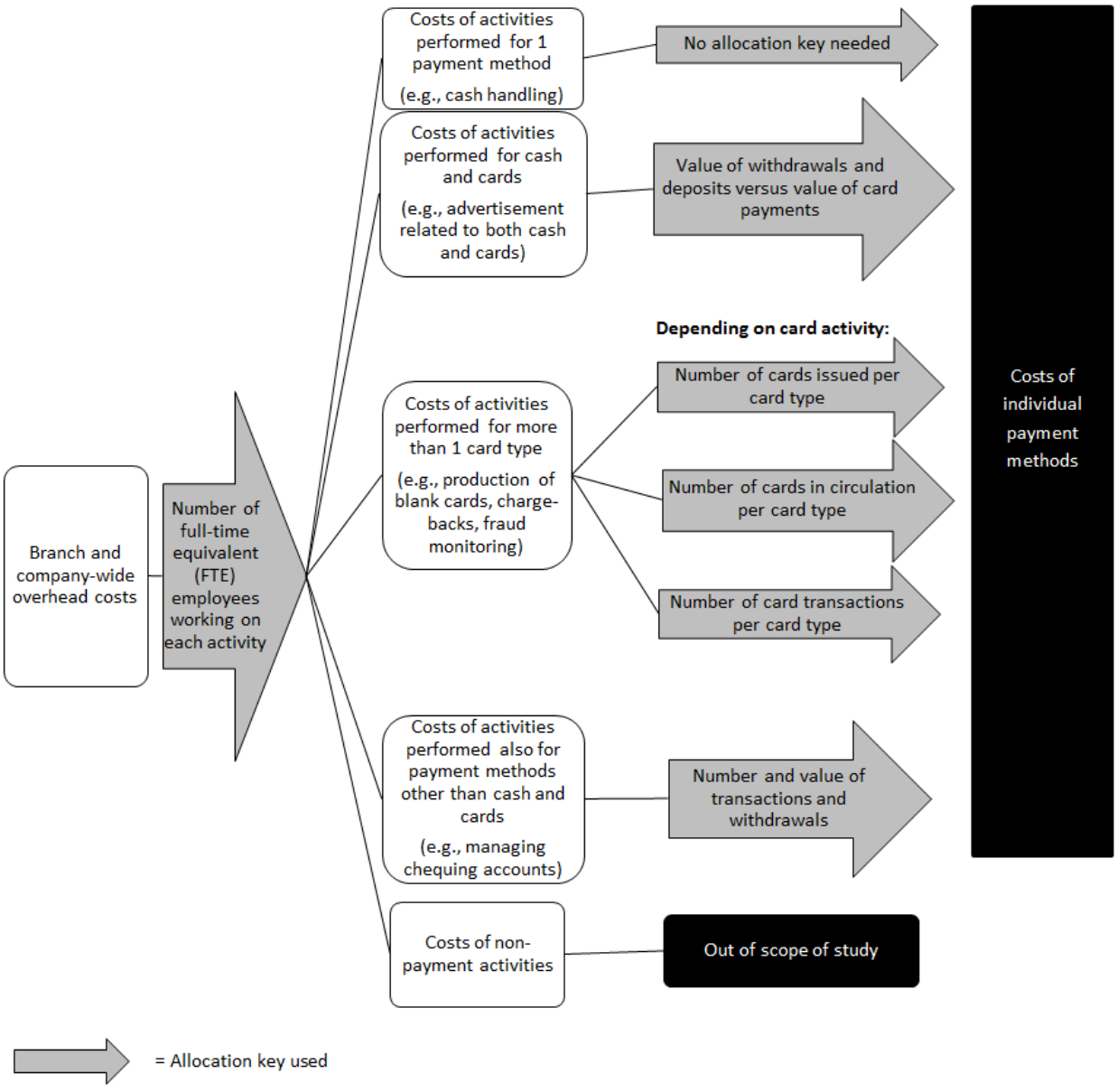
An important element of the automated data collection tool was the allocation of indirect costs. Indirect costs resulting from activities related to payments but not directly to one payment method in particular (hereafter called payments-related indirect costs) were allocated using various allocation keys, depending on the main cost driver (see Figure 17). For example, costs related to the production of blank cards were allocated across debit and credit cards based on the number of cards issued per card type, whereas the costs of managing a chequing account were allocated based on the number and value of transactions made from these accounts.

Figure 17: Allocation of payments-related indirect costs in survey of financial institutions



The branch and company-wide overhead costs were allocated in two steps (see Figure 18). In the first step, given their labour-intensive nature, the costs were allotted across the various activities based on the number of full-time equivalent (FTE) employees working on each activity. In the second step, the costs of each activity were traced to each individual payment method. If the same activities were performed for various payment methods, a second round of allocation was needed, in which case the same allocation keys were used as for the allocation of the payments-related indirect costs as illustrated in Figure 17.

Figure 18: Allocation of branch and company-wide costs in survey of financial institutions



F Time duration study

F.1 Methodology and sample

Tender time analyses conducted abroad show that the transaction times of payment methods vary considerably across countries (see Schmiedel et al. (2013)). Given the impact of transaction times on total costs of payments, the Bank undertook an extensive study in the fall of 2014 to properly estimate the tender times in Canada. Time data were gathered by observers who visited stores to take note of the duration of payments made by customers.

The field work was conducted by an external research company. The main field work was preceded by a pilot study that intended to determine the desired sample size, methodology and requirements. Observers visited 6 stores in Montreal to observe all transactions over a one-hour period. Per store, an average of 37 transactions were logged. The results pointed at considerable variances in transaction times. Therefore, it was decided to increase the number of stores and the length of the observation time for the main field work, to ensure enough transactions could be observed for cash, debit cards and credit cards. As a result, the main study covered 29 stores and transactions were recorded for six hours. The sample was split among Montreal, Toronto and Ottawa to avoid potential store-fixed effects. Furthermore, visits were made on all seven days of the week and spread over a whole day (morning, afternoon and evening) to account for any day- or time-related effects. To account for variation across different sizes and types of stores, the sample consisted of a large variety of retailers, such as grocery stores, general merchandise stores, gasoline stations, and food and drink places.

F.2 Definition and scope

The transaction duration was defined as the number of seconds between the moment that the total sum to be paid is made known to the customer and the moment that the receipt and billing slips are printed and taken out of the register. The transaction duration explicitly ended before any receipts and billing slips are handed over, since they are not always given to or accepted by the customer. Time used for social or productive activities that were not directly related to payment, such as scanning purchases, packaging or socializing with clients, was included only when these activities occurred while the customer was waiting for the transaction to be authorized and approved. If not, any such time was subtracted from the total time to measure only the payment activity.

All payments were logged, regardless of the payment instrument used. These included, but were not limited to, cash, debit card, credit card, store gift card and cheque payments. Transactions settled with more than one payment method were ignored. Similarly, payments made at self-checkout tills, registers with a trainee and counters belonging to other companies were out of scope.

F.3 Obtaining permission from retailers

The Bank was responsible to contact the stores to obtain their permission to participate in the study. This was especially challenging for larger retailers, which required permission

from both the head office as well the store owner in question. In general, it was pivotal that the observations not affect regular business activities and the customer experience. Retailers with whom the Bank already had a relationship proved to be most willing to participate. All retailers were offered the outcomes of the observations made in their stores as well as the final research report.

F.4 Instructions

Observers were selected based on their profile and experience. They were sent detailed guidelines, and an online certification program was put in place to validate their knowledge and understanding of the instructions. Highly accurate timers, such as those found on smart phones or similar devices, were used to record the transaction time. The observers stood near the cash registers, close enough to observe the payment instrument used by the customer and the transaction amount on the screen, but far enough for the customer to feel at ease. Since it may have been difficult for an observer to distinguish between debit and credit cards, cashiers were asked to confirm the payment instrument used.

Observers received clear instructions on how to select a cash register if a store had several registers in operation. To avoid potential selection biases, a random number generator was used. However, if after 10 minutes the chosen cash register turned out to attract a minimum number of customers, the observer could select a new one from among the busier registers. Similarly, the observers were instructed to proceed to another register if the cash register closed or in the event of technical problems with the payment card terminal.

Besides the duration, observers recorded the payment method used and transaction amount of each single transaction. Other factors that could affect the tender time were also logged, such as the day and time, type of payment methods accepted in store, gender and estimated age of the client and cashier, the number of cash registers in the store and those in operation, and type of cash register chosen. The observers also logged any irregularities, such as cashiers requesting help from colleagues, technical problems with card terminals, or customers cancelling their transactions.

F.5 Data analysis

A total of 5,891 transactions were recorded. The reported durations presented some extreme values for all payment methods. Therefore, the median transaction times are assumed to be a better measure of the tender times in Canada than the means. The medians are estimated using regression analysis instead of being taken directly from the data set. This makes it possible to account for the fact that the durations might have been affected by factors such as the type of store, the time of the day, the transaction amount and the number of cash registers in operation. A quantile regression model was used to account for potential skewness in the distribution of the transaction durations. For more information about quantile regression, see, for example Koenker and Bassett (1978) and Koenker (2005).

F.6 Lessons learned

The time duration study generated a rich set of data, which enabled the Bank to estimate the median transaction times of cash and card payments in Canada. The total observation time per store was determined at six hours to ensure that a large enough number of transactions could be observed. When evaluating the methodology with the observers at the end of the fieldwork period, the length of the observation period was raised as an issue to be reconsidered in potential future studies. Since observer fatigue might affect the precision of the records, it may be better to reduce the time to, for example, three hours. Moreover, by reducing the observation period, the study would have a lower impact on the usual business of the store, which might increase the willingness of retailers to participate.