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## Economic Modelling

journal homepage: [www.elsevier.com/locate/econmod](http://www.elsevier.com/locate/econmod)Cash remains top-of-wallet! International evidence from payment diaries<sup>☆</sup>Carlos A. Arango-Arango<sup>a</sup>, Yassine Bouhdaoui<sup>b</sup>, David Bounie<sup>c,\*</sup>, Martina Eschelbach<sup>d</sup>,  
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## ABSTRACT

In recent years, many studies have emphasized the cost-saving potential of electronic payments. Yet, cash is still heavily used to pay for point-of-sale transactions in many developed economies. We introduce a model of optimal cash holdings and payments that exploits survey payment diaries from Austria, Canada, France, Germany, the Netherlands and the United States. Our results provide evidence that differences in incentives, such as the relative cost of cards compared with cash, and differences in ATM withdrawal costs, are key factors explaining why cash remains top-of-wallet across many developed economies. Indeed, we show that once obtained, cash goes first because it "burns" in consumers' wallets.

## 1. Introduction

Increasing the efficiency of retail payment systems is high on the agenda of every central bank (Bouhdaoui and Bounie, 2012a). With advances in the field of financial innovation, payments have migrated to secure digital platforms, achieving economies of scale and increasing the relative costs of paper-based payment instruments (Beijnen and Bolt, 2009; Bolt and Humphrey, 2007; Hromcová et al., 2014). However, despite substantial investment in technological innovations like debit cards (Bounie et al., 2016), prepaid cards (Shy and Tarkka, 2002), contactless cards (Fung et al., 2015), and mobile payments (Liu et al., 2015), cash is still the main payment instrument used to pay at point-of-sale in most developed economies.

Just recently the President of the European Central Bank declared that over three-quarters of all payments at points-of-sale in the euro area are made in cash.<sup>1</sup> In fact, various surveys show that cash payment shares account for 44% of total payment volumes in Canada and more than 80% in Germany and Austria.<sup>2</sup> Furthermore, despite the many payment innovations introduced over the past decade, the ratios of cash to GDP and cash per-capita have either remained constant or increased in recent years in many developed economies (Fig. 1).

Many countries are looking for ways to reduce the rates of cash usage. Numerous regulations focus on wider and affordable access to electronic payment systems, but others have targeted cash directly. Many countries in Europe, such as Italy, Spain, France, Greece and Portugal, have put caps on payments made in cash.<sup>3</sup> The Reserve Bank

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<sup>1</sup> Reuters, "Three-quarters of euro zone payments made in cash: ECB," April 4, 2017.

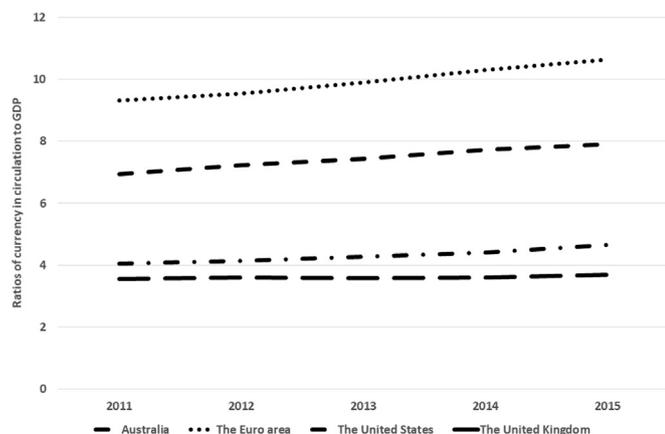
<sup>2</sup> See Jonker et al. (2012) for the Netherlands, Bundesbank (2013) for Germany, Mooslechner et al. (2012) for Austria, Bouhdaoui and Bounie (2012b) for France, Arango and Welte (2012) and Fung et al. (2015) for Canada, and Schmiedel et al. (2012) for various European countries.

<sup>3</sup> LiveMINT, "Is capping cash transactions feasible?," July 25, 2016.

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**Fig. 1.** Ratios of currency in circulation to GDP in selected monetary areas from 2011 to 2015. Source: BIS payments statistics, various issues, ([https://www.bis.org/list/cpmi/tid\\_57/index.htm](https://www.bis.org/list/cpmi/tid_57/index.htm)).

of India decided in 2016 to withdraw the highest-denomination banknotes from circulation to curtail cash usage in the shadow economy.<sup>4</sup> And the central bank of South Korea announced recently its intention to remove small change from circulation by 2020.<sup>5</sup> Many authors go even beyond this and invoke the total abolition of cash in order to allow central banks to set negative interest rates and combat crime (Rogoff, 2015).

The objective of this article is to propose a dynamic shopping model to study the factors that still make people hold and use cash in daily transactions, even though they have alternative payment instruments, such as cards. Our model incorporates three main features of cash management and payment choices discussed in the literature. First, it exploits the heterogeneity in the distribution of cash withdrawal values across different economies. These differences in withdrawal distributions explain many aspects that vary across payment systems in the economies studied, such as the density and access costs of ATM networks<sup>6</sup> and the level of merchant acceptance and fees involved in digital payments.<sup>7</sup>

Second, following Eppen and Fama (1969), Milbourne (1983), and Alvarez and Lippi (2009), our model recognizes that, faced with the uncertainty of cards not being accepted, incurring high charges for card use, or having to make costly cash withdrawals, consumers would tend to hold cash as a precaution. We have incorporated this by assuming consumers tend to follow a “minimum cash holdings” policy.

The third feature of our model is that consumers prefer to use cash whenever they have enough cash on hand; otherwise, consumers pay by card. Alvarez and Lippi (2017) have formally derived this feature of cash, which they term as “burning”, as an optimal policy, and in the context of this study it is referred to as “cash first.” The intuition is simple: because people have paid the fixed cost of obtaining cash, they find holding cash at the margin less costly than cards, especially at low transaction values.

We contrast the predictions of our model about cash payment shares at different transaction values with data from consumer payments recorded in diaries in six countries, namely Austria, Canada, France, Germany, the Netherlands, and the United States. Our results

<sup>4</sup> BBC New online, “India scraps 500 and 1,000 rupee bank notes overnight,” November 9, 2016.

<sup>5</sup> Financial Times, “South Korea to kill the coin in path towards cashless society,” December 1, 2016.

<sup>6</sup> See for instance Attanasio et al. (2002) and Lippi and Secchi (2009).

<sup>7</sup> See Arango et al. (2015b); Borzekowski et al. (2008); Ching and Hayashi (2010); Carbó and Linares-Zegarra (2011), and Simon et al. (2010), for detail empirical evidence on how incentives and fees affect consumer payment choices in Canada, the US, and Australia.

highlight the potential that policy measures have in achieving a shift in payment behavior. Although cash has traditionally been used for small payments, our paper shows that this is not necessarily the case.

Interestingly, we find that the model operates in Austria, Canada, France, Germany, and the United States, but to a lesser extent in the Netherlands. Indeed, in the Netherlands, a significant fraction of low-value transactions is paid by card even though the public has enough cash on hand (which contradicts the cash first policy). In addition, the Dutch have the lowest minimum cash holdings compared to the rest of countries in the sample.

We discuss policy implications for the banking industry. In particular, we document how the Netherlands has succeeded in reducing the use of cash for low-value transactions by implementing a set of strategies to reduce the costs of the retail payment system as a whole. These strategies imply making changes to the payment infrastructure for retailers and promoting card acceptance (reductions in retailer’s fees, etc.) and usage among retailers and consumers (e.g. advertising campaigns). These efforts may account for cards actually becoming less costly than cash in terms of speed and increasing satisfaction among users unwilling to deal with coins and change. The Netherlands’ experience shows that retail payment systems can switch from a “cash first” policy to a “card first” policy as a result of appropriate incentives and information campaigns.

Our contributions to the payments literature are twofold. First, we develop an original simulation model of cash management and payment choices. Departing from standard inventory models that are based on a continuous flow of consumption (Alvarez and Lippi, 2017), our model allows for the discrete arrival of payments of different size. This novel feature allows us to predict the use of payment instruments at different transaction values, a key feature of consumer payments behavior. Furthermore, it makes our model a useful policy tool, as the issuing of cash by central banks depends crucially on the distribution of cash usage across transaction values.

Second, we assess the validity of the model across different economies, exploiting six detailed microdata sets based on surveys and payment diaries commissioned by central banks and card payment networks. This effort is significant in the field of payment economics, where detailed public data are scarce and hardly homogeneous for this type of comparisons. Our results show that the Netherlands has been able to ensure that using debit cards for low-value transactions is the cheapest and most convenient payment instrument for many consumers. Increasing merchant acceptance alone results in a significant increase in the benefits to consumers of carrying and using a debit card.<sup>8</sup> Our results also suggest that high ATM withdrawal fees may induce higher average cash holdings, which may explain why Austrians and Germans, for example, use cash for high transaction value purchases more often than consumers in other economies.

The paper is structured as follows. In Section 2, we present the related literature. Section 3 describes the simulation model and the methodology of the simulations. Section 4 presents the data and Section 5 the results of the simulations. Section 6 concludes.

## 2. Optimal cash holdings and payment choices: a review of the literature

Recent research in monetary and payments economics provides strong predictions about household cash holdings (and withdrawals) and payments. Firstly, it is optimal for people to hold a positive stock of cash for transactions and, secondly, they prefer to use cash instead of cards whenever they have enough cash on hand. We review these predictions in detail and use them as a benchmark in our simulation model.

<sup>8</sup> Between 2005 and 2011, the number of active point-of-sale terminals in the Netherlands increased by 35%, which in combination with a set of promotion strategies translated into a 71% increase in debit card transactions (See the following statistics ([http://www.pin.nl/wp-uploads/2012/08/p\\_uk\\_key\\_figures\\_pinnen.pdf](http://www.pin.nl/wp-uploads/2012/08/p_uk_key_figures_pinnen.pdf))).

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