



Payment choice and currency use: Insights from two billion retail transactions



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ABSTRACT

Using three years of transactions data from a discount retailer with thousands of stores, we study payment variation along three dimensions: transaction size and location; weekly and monthly frequencies; and longer time horizons. In each case, we connect empirical patterns to theories of money demand and payments. We show that cross-sectional and time-series payment patterns are consistent with a theoretical framework in which individual consumers choose between cash and non-cash payments based on a threshold transaction size, and we evaluate factors that may account for the variation in threshold distributions across locations and time.

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1. Introduction

The U.S. payments system has been undergoing fundamental changes in the past several decades, migrating from paper instruments, namely cash and check, to electronic forms such as debit and credit cards. Amidst these changes, a sizeable empirical literature has developed to study consumer payment choice, with the broader goals of understanding payments system functioning and the transaction demand for currency. For researchers and policymakers working on these issues, one major impediment is the difficulty of tracking consumers' use of cash. To gauge cash use, most studies rely on data from consumer surveys, and while this research has improved our understanding of how consumers choose to pay, consumer survey data has its limitations: Most surveys have relatively small samples (typically hundreds or thousands of participants) and lack broad coverage of locations and time.

Our paper helps to fill the gap. We report new evidence on cash use in retail transactions, as well as on credit, debit, and check use, based on a large merchant transaction dataset. The data, provided by a discount retail chain, covers every transaction in the three years starting in April 2010, in each of the chain's thousands of stores across most of the country. In total, we have about 2 billion transactions, which involve millions of consumers.¹ With this rich dataset we explore three themes: (i) payment variation across transaction sizes and locations, (ii) payment variation at weekly and monthly frequencies, and (iii) payment variation over the longer term. In each case, we link our empirical findings to theoretical work

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¹ If a consumer visits a store once a week, the data would cover more than twelve million consumers; even if we assume daily shopping, it would still cover almost two million consumers.

on money demand and payment choice, indicating which of our findings are consistent with existing theories, and which suggest directions for extending those theories.

Traditional money demand theories emphasize opportunity cost, especially foregone interest, as a factor in households' decisions of how much cash to hold. The early models have only one means of payment, but [Prescott \(1987\)](#), [Whitesell \(1989\)](#), [Freeman and Kydland \(2000\)](#), and [Lucas and Nicolini \(2015\)](#) among others, have considered multiple means of payment in models where cash payments mainly incur proportional costs while non-cash payments require a fixed per-transaction cost. Essentially, those models offer a "threshold framework," in which each consumer has a threshold transaction size below (above) which they use cash (non-cash means of payments), with the threshold determined by those costs. According to this framework, the share of cash transactions is the fraction of shoppers whose transaction sizes are below their thresholds, so the cash share decreases in transaction size as more consumers cross their thresholds.

The threshold framework guides our study of payment variation across transaction sizes, locations, and time. Motivated by the threshold framework, we include explanatory variables in our empirical model that proxy for the costs of using cash relative to other means of payment. Given that our data only identifies transactions, not customers, the demographic and economic characteristics of the zip code in which each store is located are assumed to reflect the characteristics of the store's customers and the economic environment in which they live. In addition, considering that a nontrivial fraction of the U.S. population is unbanked or underbanked, we also include zip-code-level variables in the empirical model that are likely to be correlated with consumers' adoption of non-cash payments. Finally, state and time dummies are included to control for state and time fixed effects.

We start with two sets of regression analysis. The first one includes transactions of all sizes in a single regression, where the dependent variables are shares of each payment type for each zip-code day. The explanatory variables include median transaction size in a zip-code day, which controls for the transaction size distribution, and other variables that capture the threshold distribution. In the second set of regressions, we group the data by transaction size and estimate separate models for each group. In both sets of regressions, our findings confirm the implications of the threshold framework: The share of cash transactions decreases in transaction size, and conditional on transaction size, zip-code-level variables reflecting a higher opportunity cost of holding cash are negatively associated with the cash share, as are variables proxying for access to, or adoption of non-cash payments.

The estimation results provide the basis for exploring the three aforementioned themes of payment patterns. The first theme is payment variation across transaction sizes and locations. In addition to finding that the fraction of cash (non-cash) payments decreases (increases) in transaction size in a given zip code, we also find that the cross-location dispersion of the payment mix increases with transaction size, which indicates that the threshold distributions across locations exhibit more variation for larger transaction sizes. A quantitative decomposition reveals that the estimated threshold distributions cannot be explained by transaction-size fixed effects. They are instead primarily determined by location-specific characteristics, which in part proxy for the degree of access to non-cash payments.

The second theme is the day-of-week and day-of-month patterns. According to the threshold framework, these patterns could be driven by factors that affect the threshold distributions at weekly and monthly frequencies. Over the course of the week, the cash and debit fractions are nearly mirror images of each other, whereas over the month, credit comes closer to mirroring cash. In addition, the *number* of transactions shows time patterns similar to those for the cash share. We interpret the high correlation between the number of transactions and the cash share of transactions as indicating that consumers are subject to time-varying financial or cash constraints through the week and month (likely related to their frequency of pay), which then affect their shopping patterns and payment choices.

The last theme involves the seasonal cycles and longer-run trends in the payment mix identified by the month-of-sample dummies in our regressions. Over the longer term, the shares of cash and check transactions decline steadily, while debit and credit's shares rise. The overall cash fraction of transactions is estimated to have declined by 2.46 percentage points per year in our three-year sample period, largely replaced by debit. We argue that the decline in cash (in other words, the leftward shift of the threshold distribution) at this particular retailer was likely not driven by transitory factors, and if the decline were to continue, only a relatively small fraction could be explained by forecasted changes in the zip-code-level variables, including age-cohort composition. This leaves a large fraction of the time trend to be explained, with prime candidates being technological progress in debit and changing consumer perceptions of debit relative to cash.

Besides the theoretical works mentioned above, our paper is closely related to the growing empirical literature on payment choice. [Klee \(2008\)](#) also used merchant transaction records to study consumer payment choices. However, with a different empirical strategy and a much broader dataset, we are able to investigate cross-sectional and time-series payment variation that was not addressed in Klee's study. Unlike prior work, our analysis is also explicit about the threshold framework and its implications. Our findings on the negative relationship between cash use and transaction size are consistent with some recent papers that study payment choice using consumer survey data (e.g., [Arango et al., 2011](#); [Cohen and Rysman, 2012](#); [Wakamori and Welte, 2016](#)). Nevertheless, those studies typically focus on the effects of consumer-specific characteristics on payment choice, but ignore the effects of locationwide factors and time. Our work also complements recent research on how consumer payment choice is affected by attributes of payment instruments such as pricing, speed, security, and access to credit (e.g., [Borzekowski et al., 2008](#); [Borzekowski and Kiser, 2008](#); [Zinman, 2009](#); [Ching and Hayashi, 2010](#); [Schuh and Stavins, 2012](#); [Stavins, 2013](#); [Koulayev et al., 2016](#)). While our data does not contain direct information on payment attributes, we point out that they could be factors driving the longer-run payment trends observed in our data. Finally, it is worth mentioning that compared with many existing studies, our data is especially informative about cash use.

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