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Convenient prices, cash payments and price rigidity ☆

Y. Bouhdaoui [a], D. Bounie [b,*], A. François [c]

[a] APEC — C2.33, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium
[b] Telecom ParisTech, Economics and Social Sciences, 46 rue Barrault, 75634 Paris Cedex 13, France
[c] EM Strasbourg Business School-Strasbourg University (LaRGE), and Telecom ParisTech, 46 rue Barrault, 75634 Paris Cedex 13, France

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ABSTRACT

Recent works suggest that convenient prices that match monetary denominations exhibit above-average price rigidity and are set up by firms that have incentives to be paid in cash. The relationship between convenient prices and cash usage has however never been explicitly examined. This paper proposes a model that relates convenient prices to cash usage and exploits to test it a unique dataset in 2011 on cash payments and prices by a representative sample of French consumers. In line with the model, estimation results bring direct evidence that individuals' shares of cash payments increase with convenient prices. This finding confirms that price rigidity can be in part explained by the use of cash to pay convenient prices.

1. Introduction

Several recent works have attempted to explain why firms have incentives to set price points or convenient prices. Convenient prices are round prices that usually match monetary denominations while price points are odd prices such as 9-ending prices (Knotek, 2008). Price points and convenient prices are of a significant importance because they are in turn accused of being one of the sources of price rigidity (Blinder et al., 1998; Kashyap, 1995; Knotek, 2011; Levy et al., 2011) which supposedly influences the monetary policy, the aggregate price level (Aoki, 2001; Carvalho, 2006) and the output (Nakamura and Steinsson, 2008).

In the economics literature, the existence of price points and convenient prices has been addressed in two main contributions.[1] In a first study, Levy et al. (2011) relate price points to consumer behaviors. They argue that consumers ignore the rightmost digits of retail prices (consumer inattention) and then may offer a plausible explanation for the existence of price points. In a second study, Knotek (2011) argues that convenient prices deal with the price-setting of firms. He reports three key factors that encourage firms to set convenient prices: transactions made with cash, items that are sold alone or with a few similar items and high-traffic transactions.

The factor that relates convenient prices to cash usage is worth focusing. Indeed, firms may set convenient prices and be paid in cash to expedite transactions at point-of-sale, avoid sales taxes or credit card fees. Conversely, it can be also profitable for a firm to set price points to avoid cash payments when the cost of handling cash is high or risky (theft, etc.) compared to the costs of other payment instruments. The same reasoning applies to consumers who also face transaction and holding costs when they use cash or other payment instruments. For instance, Whitesell (1989) has shown that consumers may prefer cash to other payment instruments for low value transactions.

However, to the best of our knowledge, the relation between cash usage and convenient prices has never received an explicit economic analysis. Indeed, based on the study of the prices of several product groups in various types of establishments, Knotek (2011) infers the existence of a relation between convenient prices and goods and services "typically" purchased in cash. Unfortunately, the author has no indication on the way convenient prices are paid in the surveyed establishments since the use of payment instruments is not observed. As a result, the impact of convenient prices on the use of payment instruments is not clearly established and could be due to other factors (high-traffic transactions, etc.). Similarly, Kim and Lee (2012) analyze in a standard search-based model of exchange how a trade-off between cash and debit card can provide one of the possible micro-foundations for price rigidity in response to monetary policy. However, the authors

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* Corresponding author.
E-mail addresses: yassine.bouhdaoui@vub.ac.be (Y. Bouhdaoui), david.bounie@telecom-paristech.fr (D. Bounie), abel.francois@unistra.fr (A. François).

[1] There is an important literature in management that analyzes how price endings affect buyer's decisions; see Stiving and Winner (1997).

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do not specifically connect cash payments to convenient prices and outline that "empirical studies with extensive data on the payment patterns should be indispensable to understand the importance of the mechanism for nominal price rigidity associated with means of payment".

The goal of this paper is precisely to examine the link between convenient prices and the use of cash in transactions. To this end, we first extend the model of Whitesell (1989) by including a cost of paying non convenient prices in cash. This model outlines that the share of cash payments should increase with convenient prices since transaction costs of cash are lower than the ones of the alternative payment instrument. Second, we exploit a unique dataset of payments reported in shopping diaries in 2011 by a representative sample of 1106 French individuals of 18 years and older. This method is standard in empirical research in payment economics and considered as promising in research on demand for cash (Alvarez and Lippi, 2009). Diary survey data have indeed the advantage to collect accurate information on individual cash (and non cash) transactions, their volume and value, the types of products purchased, the types of establishment visited, the purchases that involve single or multiple items, etc., information that are not well known by central banks. Using different econometric tests and controlling for transaction and individual characteristics, we show that individuals' shares of cash payments increase with convenient prices. This finding therefore proves the Knotek's conjecture according to which convenient prices exhibit above-average price rigidity because firms have incentives to be paid in cash.

The remainder of the paper is structured as follows. In Section 2, we refine the model of Whitesell (1989) by including a cost of paying cash non convenient prices. In Section 3, we describe the data used to explain the relation between cash usage and convenient prices and in Section 4, we present and comment on the econometric tests, the results and their robustness. Finally, in Section 5, we conclude.

2. A model of convenient prices and cash usage

In developed countries, most consumers hold several payment instruments such as cash, credit and debit cards, etc. Each time they face a price, consumers have then to decide which payment instrument to use. Whitesell (1989) has proposed a framework to model the choices between payment instruments. In this model, consumers face a predetermined set of transaction $\mathcal{D}$ payable either with cash or with an alternative payment instrument. When using cash, consumers are supposed to incur a withdrawal fee, b, and an opportunity cost for holding cash that equals the interest rate, i, times the average cash holding over the purchasing period. Regarding the alternative payment instrument, consumers incur a fixed cost per transaction, u_F, and a variable cost, u_V.

Formally, a consumer making n withdrawals incurs a cost of cash that can be written as:

$$C_{(1)} = nb + \frac{i}{2n}\sum_{t\in\mathcal{D}_{(1)}} t, \tag{1}$$

where $\mathcal{D}_{(1)}$ is a subset of $\mathcal{D}$ that refers to the transactions paid in cash over the period.[2] The complementary set $\mathcal{D}\backslash\mathcal{D}_{(1)}$, payable with an alternative payment instrument, induces the cost:

$$C_{(2)} = \sum_{t\in\mathcal{D}\backslash\mathcal{D}_{(1)}} (u_F + u_V t). \tag{2}$$

The consumer problem is then to minimize $C_{(1)} + C_{(2)}$ by making the optimal choices of payment instruments. Whitesell (1989) shows in this case that the optimal domain of cash is compact and located in low value transactions.[3]

Now, we extend the initial framework to account for convenient prices. As outlined in Knotek (2011), price points are indeed not easy to process for consumers and require to carry more tokens during shopping trips. Therefore, these factors affect the consumer's trade-off between payment instruments. In the following, computational and carrying costs of cash are referred to as "transaction costs of cash". We associate them, in practice, to the number of tokens exchanged in transactions.[4] Formally, we consider a currency system s composed of J denominations of face values $v_s(j)$ with $j \in \{1, \ldots, J\}$, and assume, as in standard theoretical and empirical works, that agents pay cash following the "principle of least effort".[5] This principle states that consumers and merchants exchange a minimum number of coins and notes to pay a given amount of cash. Namely, a transaction of size t is paid by exchanging $r_s(t, j)$ token(s) for each denomination $v_s(j)$:

$$t = \sum_j r_s(t, j) v_s(j), \tag{3}$$

such that the number of monetary units exchanged $r_s(t) = \sum_j |r_s(t, j)|$ is minimum.[6] The parameter $r_s(t)$ is a direct measure of the convenience of a price.[7] As argued previously, we define the transaction cost of cash, based on $r_s(t)$, as $w \cdot r_s(t)$, where w is the unit cost of exchanging a token. The cost of cash defined in Eq. (1) can then be extended as follows:

$$C'_{(1)} = nb + \frac{i}{2n}\sum_{t\in\mathcal{D}_{(1)}} t + w\sum_{t\in\mathcal{D}_{(1)}} r_s(t). \tag{4}$$

By adding up $C'_{(1)}$ and $C_{(2)}$, the consumer's problem can be written as:

$$\min_{\mathcal{D}_{(1)}\in\wp(\mathcal{D})}\left\{ nb + \frac{i}{2n}\sum_{t\in\mathcal{D}_{(1)}} t + w\sum_{t\in\mathcal{D}_{(1)}} r_s(t) + \sum_{t\in\mathcal{D}\backslash\mathcal{D}_{(1)}} (u_F + u_V t)\right\}, \tag{5}$$

with $\wp(\mathcal{D})$, the powerset of $\mathcal{D}$.

According to Eq. (5), the consumer's problem consists in minimizing the costs of transactions by determining the optimal set of cash payments $\mathcal{D}_{(1)}$, given that the complementary set of transactions is carried out using the alternative payment instrument.

The first order condition related to the number of cash withdrawals, n, is written as follows:

$$b - \frac{i}{2n^2}\sum_{t\in\mathcal{D}_{(1)}} t = 0. \tag{6}$$

Therefore, the optimal number of withdrawals is:

$$n^* = \sqrt{\frac{i}{2b}\sum_{t\in\mathcal{D}_{(1)}} t}. \tag{7}$$

[2] The term $\frac{i}{2n}\sum_{t\in\mathcal{D}_{(1)}} t$ refers to the interest earnings foregone over the period.

[3] As shown in Whitesell (1989), the alternative payment instrument will not be used for low-value transactions because of the fixed cost of transaction.

[4] Beside the processing cost of transactions, there is a wide agreement in the economics literature according to which the carrying cost of money is an essential element in studying cash payment patterns (Lee, 2009; Van Hove and Heyndels, 1996).

[5] The principle of least effort was introduced by Caianiello et al. (1982) and subsequently refined by Cramer (1983). More recently, Franses and Kippers (2007) have shown that the principle of least effort constitutes a reasonable approximation of the Dutch public payment behavior.

[6] Absolute values indicate that overpayment and return of change are allowed.

[7] $r_s(t)$ takes low values for convenient prices as they require to exchange fewer tokens, and vice versa.