On the socially optimal density of coin and banknote series: Do production costs really matter?☆

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ABSTRACT

By adding denominations to their coin and banknote series central banks can increase the efficiency of cash payments. In practice, however, they opt for a denominational structure with a relatively low density. The literature holds that this is because of the production costs involved. To test this proposition, we introduce a per-denomination fixed cost into the matching model of Lee et al. (2005) and parameterize the model with data on the production of US dollar banknotes. Our simulations demonstrate that central banks could increase the density of their currency systems beyond the observed level without the efficiency gains for transactors being dwarfed by the additional production costs for the central bank itself. This suggests that the explanation for the low density rather lies with costs incurred by consumers and merchants - and anticipated by central banks - that are not yet in any of the extant models.

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1. Introduction

Ensuring a sound and efficient cash payment system is one of the prime missions of a central bank. This mission is all the more important given that several studies indicate that the social cost 2 of the retail payment system is substantial and that cash is the most costly payment instrument for society (Garcia Swartz et al., 2006; Schmiedel et al., 2012).

Policies that lower this social cost are therefore welcome. The most straightforward option would consist in reducing the overall level of cash usage by promoting more cost-efficient electronic payment instruments. However, in view of the resilience of cash usage in many countries, measures that lower the social cost of cash in a status quo situation - that this, for the prevailing volume of currency in circulation - also make sense.

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Central banks can contribute to this by lowering their own private costs (obviously without undue externalities) and/or by positively influencing the costs incurred by other stakeholders. Central banks can, for example, improve the durability-cost ratio of their banknotes by switching from cotton-based paper to polymer (Menzies, 2004; Bouhdaoui et al., 2013; Van Hove, 2015). They can replace low-value banknotes by cheaper coins (Lambert et al., 2013). Or they can optimize their cash cycle, by, for example, altering the note order size and order frequency (Massoud, 2005).

The present paper examines yet another possible central bank measure, namely the modification of their coin and banknote series - the so-called denominational structure of a currency - with an eye on increasing the efficiency of cash payments. This is especially an option for central banks with a denominational structure that has a low ‘density’, which we define as the number of denominations per ‘decade’; i.e., each interval [10^x, 10^{x+1}]. Central banks in such a position could add one or more denominations to their series and, in this way, make cash payments more convenient by making it possible for transactors to compose a range of amounts with, on average, a lower number of tokens.

At first sight, such a move would seem to be a win-win for multiple stakeholders. Indeed, up to and including Van Hove (2001) the prevailing thinking in the literature was that a denominational structure that allows transactors to economize on the number of tokens exchanged in payments would lower the number of coins and notes in circulation, and would thus also keep down the handling and production costs incurred by the central bank itself.

However, recent papers have cast doubts on this claim. Bouhdaoui et al. (2011) in particular show that, under certain conditions, the lower variable production costs that come with a more efficient currency system can be overwhelmed by the fixed costs caused by the addition of new denominations. They therefore argue that central banks face an efficiency-cost trade-off. However, Bouhdaoui et al. do not explicitly model the private costs of transactors. More broadly, to the best of our knowledge, there is as yet no denominational-structure model that takes a welfare point of view and also takes into account the interactions between, for example, the denominational structure and the distribution of cash transactions. This is where our paper tries to contribute to the literature.

To that end we build on the matching model of Lee et al. (2005), which has the benefit that it endogenizes both the distribution of transactions and the portfolios held by transactors. A drawback of the model, however, is that it yields currency systems with “too many” denominations (Lee et al., 2005, p. 955) - because their number can be increased at no cost. Following the suggestion of Lee et al. themselves, we therefore introduce the per-denomination fixed cost that is at heart of the model of Bouhdaoui et al. (2011) - as well as two other production cost components - and in this way try to marry a model that focuses mainly on the transactors side (Lee et al.) with a model that concentrates on the central bank side (Bouhdaoui et al.).

We parameterize our model based on statistics concerning the US economy and data on the production of USD banknotes. With the parameterized version of our model, we examine how discounted welfare evolves when we increase the density of the denominational structure. We find that as the density goes up, the efficiency gains for transactors continue to outweigh the additional production costs for the central bank up to and including four denominations per decade.

We show that this result also holds for real-life denominational structures. This raises the question why in real life central banks cap the density of their series to three or, in some cases, even to two. Our finding refutes the widespread idea that this is because of the production costs involved. Rather, our results show that the explanation should be sought on the side of the public. In particular, we suggest two costs incurred by consumers and merchants that are not yet in the model.

The remainder of the paper is structured as follows. In the next section we first explain in more detail, by means of real-life examples, why an increase in the density of a denominational structure lowers the volume of tokens in circulation and thus has the potential to lower the production costs of the central bank. We also explain how the existing models compare to one another. In Section 3, we introduce the model equilibrium, the different components of the production cost of cash, and the overall ex ante welfare function. In Section 4, we parameterize our model and present the results of our simulations. In Section 5, we generalize our results to real-life denominational structures and discuss the implications. Section 6 concludes.

2. Background and motivation

As mentioned in the Introduction, until recently the consensus in the literature was that an efficient denominational structure would also limit the private costs of the central bank itself. The intuition behind this thinking can be illustrated by analyzing how specific currency systems perform in reality. Today, most central banks have settled on so-called binary-decimal triplets: that is, a denominational structure of the form 1–2–5, etc. As an example of a central bank with such a series we have taken the European Central Bank (ECB). The ECB series has no less than 15 denominations, ranging from a 1 cent coin all the way to a EUR 500 banknote.

There are, however, also central banks that have opted for a 1–5 structure. In order to identify such banks and compile the necessary data, we have relied on the ‘Red Book’ of the Bank for International Settlements (CPMI, 2016). In the Red Book, Table 4 of the country tables provides data on the composition of the currency circulation. Of the countries covered in the Red Book, only South Korea has a complete 1–5 structure. However, the cases of Japan and Russia are also interesting.

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3 The introduction of polymer notes is also motivated by the fight against counterfeiting (Kim and Turton, 2014).

4 See footnote 2 in Bouhdaoui et al. (2011) for a list of authors who (implicitly) supported this view.
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