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Sound branch cash management for less: A low-cost forecasting algorithm under uncertain demand ☆

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ABSTRACT

This paper deals with cash management for bank branches, under the assumption that branches have a role to play in the improvement of global bank institution performance. In the current scenario of unprecedented pressure amongst banks to keep costs under control, our contribution is the design of a sound and low-cost algorithm to optimize branch cash holdings using software implementation in SageMath. It is accompanied by data processing based on 60,000 real banking records. This is the first academic paper to run such an extensive database at branch level.

We find that our algorithm by and large performs well when forecasting the cash amounts that the branch might require from the central hub to satisfy all branch necessities, avoiding the generation of either surplus or shortage of cash. It is also extremely easy to implement in daily branching practice, leading to an overall reduction in operating costs. In addition, our algorithm may be easily adjusted as required and be tailor-made to the special requirements of each banking institution.

1. Introduction

The banking industry has, throughout History, constantly searched for accurate management tools to improve its performance. Additionally, in the current scenario of economic crisis, bank entities are under unprecedented pressure to keep costs under control, while improving customer service. In this situation of fierce competition, where improving efficiency seems to be a primary objective for banks, there is a body of research that argues that bank *branches* have a role to play through the assumption that *branching* efficiency significantly helps improve the performance of a global bank institution: see [8,13,30].

The importance of bank branches is increasingly recognized, in particular due to their potential in developing customer relationships as well as being one of the most effective sales channels for bank institutions. Although self-service banking (ATMs) and internet banking offer customers convenient real-time access, bank branches provide a more convenient and people-friendly service. This local customer service continues to fulfil a critical role in new customer acquisition and cross-sales, in particular for more complex financial products, while it is the preferred way of doing business of customers of different ages.[1] The increased competition amongst bank entities "has engaged in a proactive, differentiated and customer-based strategy on the retail side where the sales component of *branch* activity is emphasized" [11]. According to this philosophy, Ioannou and Mavri [22] present a decision support system in order to reconfigure and improve the bank branch network. Other evidence of the current importance of bank branches is the growing supply of proposals from financial/consulting services that are focused on bank branches. For instance, in [28], IBM addresses the introduction of banking software in new markets (Chinese banking) by boosting Chinese banking development through the improvement of the operational efficiency of Chinese bank branches.

When attempting to improve banking performance, an efficient cash management is crucial. Why? On one hand, since liquidity comes at a cost, banks might decide how much liquidity is enough while avoiding dormant liquid sources. In this sense, sound cash management reduces financing costs and optimizes the return on the cash position. On the other hand, the importance of designing methods of improving cash management relies on the increased interest of accurate liquidity management for banks in the actual context of

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[1] In the U.S., commercial banking enhances its competitiveness against non-bank financial institutions by selling financial advice products through bank branches.

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uncertainty and instability ([1] or [14]). Actually, the recent financial crisis has demonstrated the financial system's fragility *if banks do not have sufficient safety liquidity levels*. Thus, an efficient cash management is aimed at helping banks to provide a cushion of capital – available to cover losses of any kind – in order to comply with those regulatory reforms which set the *safety liquidity levels* that banks must attain. Amongst this legislation, importantly, Basel III rules, with two minimum ratios, "Liquidity Coverage Ratio" (LCR) which is a kind of stress test, and "Net Stable Funding Ratio" (NSFR) which tries to ensure that a bank's assets would be adequately supported by stable funding sources. Authors who agree on the key role that a precise cash management plays in the general health of banking institutions are [12,15,24], amongst others.

The present paper may be placed within the literature related to the design of managerial measures for improving *branch* cash management. This paper attempts to provide a new tool to upgrade cash management at daily branch level by improving their cash forecasting processes. At present, a precise liquidity management *forecasting* plays an essential role, since deciding which part of the liquid sources should be kept as ready money, as opposed to being invested in other products, is not trivial at all. On the one hand, banking institutions might have some money stock in order to face short-term obligations at the aggregate and branch level, which should prevent risking bankruptcy in long-term projections. On the other hand, when banking firms keep liquid assets in cash, they give up a part of their profitability, i.e., the opportunity costs of not investing in other alternatives which generate health. Throughout the literature, models of cash management (amongst other approaches) have attempted to solve this problem.

The branch total amount of ready cash is known as cash holdings. Such branch liquid assets are the sum of (a) the deposits made by customers and (b) the cash which might be required from the central hub in order to satisfy all of the cash needs by the branch, such as customers withdrawals. However, while controlling branch cash holdings is pressing for the banking institutions' performance, the key point in the day to day operations of a branch is to guarantee an optimum level of cash inside the branch (1) which satisfies all the needs a branch may have (2) without generating either a shortage or a surplus of money. In addition, note that avoiding generating a surplus of money allows branches to considerably decrease the risk of theft.

This paper focuses on computing the (b)-summand of branch cash holdings: the amount of cash which might be required from the central hub in order to meet all the branch cash needs. In most cases, branches do not have in practice well-functioning systems of computing such quantities of cash, apart from some intuitive routines based on branch history data. That means that branch managers require similar quantities of cash corresponding to weeks with similar features. However, during the decision-making processes, the staff in charge usually reaches a decision with only partial information. The absence of more precise and inexpensive procedures generates inconsistencies intrinsic to the operational rules, whilst non-consistent methods as well as human errors are amongst these. This paper attempts to fill this gap by proposing a method of branch-specific computation that should be valid for all of them. A sound and low-cost method.

Actually, the main contribution of this paper is an algorithm designed to be an accurate tool to improve the performance of branches with respect to its cash management. This algorithm will significantly reduce cash holdings at branches, thereby providing efficient improvements in liquidity management. More specifically, it is a monitoring program to guide short-term corrective cash management actions of the branch's staff. The theoretical fundamentals of the proposed algorithm are some notional studies on the cash requirements of branches from their central hubs developed under "the demand for cash" scope (see [6] and [33] for the deterministic model, [27] for the introduction to the stochastic model). These fundamentals were reported by the first author of this paper in [18].[2]

We find that our algorithm performs well across the forecasting of cash amounts that the branch might require from the central hub to satisfy all branch necessities, avoiding having to generate either a surplus or a shortage of cash. In this regard, two algorithms have been designed depending on the unit of time considered. The first one corresponds to a daily computation, suitable for internal branch adjustments, whereas the second one performs for weekly cash forecasts. Many other units of time could be considered as part of the algorithm setting options. Besides, the algorithm proposed is very easy to implement in daily branching practices. Hence it involves an overall reduction in operating costs since this may be implemented without extra cost either in personnel training or in the implementation of the program itself. Thus, this algorithm is a sound and low-cost method that is also appropriate for all kind of branches, not only for those that can be considered candidates for increased supervision.

The algorithm is accompanied by a complete database processing of real branch-level records (more than 60,000 excel multicolumn cells have been processed), using software implementation in SageMath [32], to prove its accuracy as well as to derive to other conclusions. The data processing corresponds to two excel files which contain all daily branch operations from June 2012 to March 2013 of some representative Spanish branches belonging to a well known Spanish banking company.[3] As mentioned in [13], branch literature is much less complete than banking literature due to the lack of easy access to branch-level data. As a matter of fact, there are only a few studies supported by real banking records *based on data transactions*, due to the existing difficulties when accessing real sufficiently detailed banking data. To the authors' knowledge, the processing of such a (huge) real banking database has not been carried out till now.

The system can also be expanded to incorporate a cost structure in such a way that the algorithm forecasted amounts which should be required from the central hub in order to comply with all branch cash needs, also minimize a given costs function. One of the advantages of this complementary cost structure is that the cost function could be modified as needed provided only that it verifies some slight requirements. As the cost specification is an important characteristic of inventory management problems, the inclusion of the cost structure allows to locate the cash management problem described in this paper within the broader context of the optimal inventory literature (see [34] for an up-to-date and complete review of such literature).

The remainder of the paper is organized as follows. While Section 2 presents a literature review, Section 3 gathers the main outcome of the theoretical framework. Section 4 presents the software algorithm. Section 5 contains the data description and data-processing of real banking records, with numerical experiments devoted to back testing the algorithm. In Section 6 a corrective coefficient is designed, aimed at explicitly incorporating local demographics to the algorithm's forecasting. Section 7 is devoted to the development of a cost structure. Section 8 concludes the paper. Finally, to facilitate the exposition, the appendix contains the algorithm (daily and weekly) in flowchart form. It should be noticed that the algorithm has been presented in the main text (Section 4) in (pseudo)code with flowcharts in an

[2] Since the theoretical method proposed in [18], pointed in the right direction, has resulted in an effective forecasting system for bank branches, a patent has been requested for the paper [18] by the University of Granada, "Method for managing liquidity in bank branches" number ES201431094, United States.

[3] Due to the existing difficulties imposed by the EU legislation, both the names of the people and the banks must be kept confidential.

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