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MODELING OF THE DEMAND DEPOSITS FROM MOROCCAN COMMERCIAL BANKS

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Abstract
According to the recent recommendations of the Basel committee, the modeling of the flow of the demand deposits is a major issue in the Asset Liability Management. In the present work, we propose a modeling of the flow of the demand deposits (unpaid accounts) of the Moroccan commercial banks. The data have been extracted from the Bank Al-Maghrib (BAM) in order to liquidate the stable portion of these deposits according to the time that the bank can use to grant loans while minimizing the risk of the transition and liquidity. It is found that the deposits of the clients show no apparent behavior in relation to their demand deposits. This results will permit the bank do not take into account the factor of the short-term interest rate as affecting the available volume of a current accounts.
Keywords: Asset liability management; Demand deposits; Modeling; Selvaggio model; ARCH test.

1. Introduction

To invest in the markets and lends to the customers, the bank collects the deposits. This temporary financial role makes them more vulnerable to various financial risks. ALM, Asset and Liability Management intends to deal with all monetary dangers of banking organiza- tions. Historically, it focused on the interest rate risk; but the crises of the years 2007 and 2011 highlighted the importance of improving the management of the liquidity risk (gener- ally) and of the daily liquidity (particularly) [1]. The liquidity risk reflects the institution deficit to fulfill its obligations, and therefore its inability to rebalance the sheet [2-5]. The origin of this risk comes from the fact that the demand deposits which are the main resource of the banks have no contractually defined maturities. Thus, a massive withdrawal of the demand deposits can lead to a shortage of cash flow and force the bank to borrow again from the market. To manage this risk, the bank internally offers conventional flow laws on the deposits at maturity uncertain in order to be ready to better adjust its balance sheet in the event of an imbalance. This required

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modeling of their outstandings since their evolution depends on the behavior of the clientele which can be financial, economic or seasonal. By applying the deposit assessment model which will make it possible to establish a stability threshold for demand deposits which constitutes the part of those which the bank will have for its different positions and without extraordinary danger of being responsible. In fact, the demand deposits (DDs) are already a very important source of the liquidity risk. It is the largest debt of the bank and does not have a contractual flow as it does for the majority of the other items on the balance sheet. Therefore, they are no maturity. This means that these amounts may vary in both directions and without delay. Statistically, a significant fraction of DDs is stable. Faced with this opportunity represented by the bank excess liquidity and the important place that the demand deposits occupy in the resources of banks, the main concern of this study is to determine the flow model of demand deposits for Moroccan banks. Thus the part of these deposits stable as a function of the time that the banks could us

to grant loans while minimizing the risk of the transformation and the liquidity. Especially relevant concern if we take into account that the bank as a rational economic agent with the aim of improving its profitability.

To achieve these objectives, we will highlight the following hypothesis: the evolution of interest rates in Morocco does not have a significant effect on the level of the outstanding demand deposits. For this, in this paper, we present precisely the first demand repository model that was designed by selvaggio as well as the logic behind it. We estimate its parameters and belong to analyzes on Moroccan commercial banks.

2. Conceptual frame

Liquidity risk

For a credit institution, the liquidity risk represents the possibility of not being able to meet at a given moment on its commitments or its deadlines even through the mobilization of its assets [6]. The liquidity risk depends on its own situation or on the external factors such as the supply of the financial markets. The materialization of the liquidity risk may occur on the occasion:

- A massive withdrawal of the deposits or the customer savings;
- A crisis of the market confidence in the institution concerned;
- A general liquidity crisis in the market.

Currently, the measurement of the liquidity risk first involves by calculating the liquidity gap. It is calculated by subtracting the temporary timing of the uses on the resources including the hidden options. The development of the provisional schedule consists of an assessment of the liquidity depreciation of the resources or uses. For the banking Book, it is necessary to take into account the hidden options included in the various products like the early repayment option "shortens" the liquidity schedule of the associated credit. In particular, the liquidity schedule is a priori random in the sense that there is uncertainty over the exercise or not of a future options. The liquidity risk does not only relate to the maturity of the available liquidity; also it relates to the evolution of the cost of the liquidity. Nowadays, the banks have a little apprehension of the sensitivity of their margins and the value of their balance sheet items to this cost. Indeed,

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currently, they are trying to remedy it following to the recent liquidity crisis. Thus, the hedge liquidity risk or illiquidity involves, first and foremost, the support of the resource liquidity for the uses. Then, it consists of raising (or placing) the necessary funds in order to insensitive the margins / the value to the cost of the liquidity. In general, the cost of the liquidity increases with the maturity of the commitments which indicates the existence of a risk premium. Right now, for the banks, the large and global increase in this cost pushes to take a closer interest to the identification, the modeling for the spreads and the measurement of the liquidity risk. From a regulatory point of view, the used indicators at the bank level concern a liquidity ratios such as the 1-month liquidity ratios, the observation ratios at 3, 6 and 12 months, the capital and the permanent resources at 5 years [7].

General on asset-liability management

The asset-liability management (ALM) refers to the techniques for controlling liquidity, interest rate and exchange risk on the scope of the commercial activities of a banking net- work. It is an approach of identification, measurement and control of the risks. Also, it is an assessment management tool [8, 9, 10, 11]. According to more detailed definition given by the Society of Canadian Actuaries The asset and liability management refers to a busi- ness management style that aims to coordinate decisions regarding the assets and liabilities. Therefore, it is a contained process, involving the formulation, implementation, monitoring and review of strategies relating to the assets and liabilities. Thus, it is an ongoing process, involving the formulation, implementation, monitoring and revision of strategies relating to the assets and liabilities in order to meet financial objectives, taking into account a certain tolerance for the risk and certain constraints. The active passive management is crucial for any organization that needs capital investment to meet its obligations and wants to ensure a balanced financial management. . This means that the banks have become aware of the link between the quality and structure of assets and liabilities, and the series of future results that the bank will be able to generate.

The risks are varied in nature. To be assessed, they require information systems and some- times very sophisticated theories, their management is of interest to the bank and the whole financial system. For these reasons, a good management is extremely complex; ALM is the leak of the experience of successes but above all of banking "accidents" [12]. It is first and foremost a tool for preventing bankruptcies and a way to always aim for a high profitability. This is why ALM aims to optimize risk and performance and to plan the development and its financing accordingly. Thus, estimating and managing the balance between resources and functions in relation to the risks to which the organization is exposed under the constraints of the level of profitability and a precise and changing regulatory framework by the coun- tries. It systematically analyze liquidity and interest rate risks, and ensures compliance with the ratios imposed by local and international regulators. For this, she needs to understand the customer behavior in order to model them and assess their impacts through simulations which then allow him to decide to set up hedging operations against the identified risks.

Presentation of the Selvaggio model

Selvaggio has proposed in 1996 one of the first models of the development of the outstand- ing

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demand deposits [13, 14]. The basic idea comes from defining the target amount of the deposits that have dynamics according to the macroeconomic variables Yk and the interest rate Rk. This model is given in Eq.1

$$logD_k^* = \alpha_1 + \alpha_2 logR_k + \alpha_3 logY_k \quad (1)$$

With:

Yk represents the macroeconomic variables other than the interest rates. It is an indi- cator that can be represented by wages, the unemployment rate...;

- α1, α2 and α3 are a variables.

Then he assumes that, outstandings have a tendency to adjust around the target outstandings at a rate λ according to Eq.2:

$$logD_k = logD_{k-1} + (logD_k^* - logD_{k-1}) \quad (2)$$

Finally, we obtain the model given in Eq.3

$$logD_k = (1 - \lambda)logD_{k-1} + \lambda(\alpha_1 + \alpha_2 logR_k + \alpha_3 logY_k) \quad (3)$$

Selvaggio's model was based on monthly data. So, it had to add a variable that takes into account the seasonality of the demand deposits. Thus, we assume an exponential time trend of the macroeconomic variables. The model will have the form of Eq.4:

$$logD_k = \alpha_0 + \alpha_1 logD_{k-1} + \alpha_2 logR_k + \alpha_3 t + \sum_{i=4}^{15} \alpha_i month_{i-3} \quad (4)$$

With monthi−3 represents a monthly test variables. This model is mainly based on the following assumptions:

- The existence of a target value for DDs;
- The adjustment speed around the target value is assumed to be constant;
- The target value is not stable;
- We model the logarithm of the outstandings not the outstandings;
- logYk has a linear trend of the time.

Due to the non-seasonality of the monthly data, we remove the monthly test variables from the formula. Then, we find a new form which is written in Eq.5:

$$logD_k = \alpha_0 + \alpha_1 logD_{k-1} + \alpha_2 logR_k + \alpha_3 t \quad (5)$$

Flow convention of the demand deposit

Demand deposits (DDs): contractually payable after 1 day...

Actually, the amount can vary in either direction, statistically exhibits a fairly stable behavior;

but it can withdrawn at any time,

• Various solutions are possible to treat the flow of DDs:

– Adopt a prudent vision: consider them as a volatile resource. Does not favor a realistic vision and ignores the stability of DDs which reduces long resources;

– Adopt a simple approach, but not convincing: set a deadline conventional, arbi- trary and distant;

– Adopt a fairly simple approach: make a distinction between the stable deposits base (over a period) and the volatile base. The volatile part is considered as CT resources and the stable kernel is considered as LT resources;

– Report the number of closed accounts during a year to the number of accounts existing at the start of the year. For example, if this rate is 10%, the DDs should be amortized by 10% or 0.83% per month;

– Generally, these solutions are based on conventions that may stray from the reality;

– DDs depend on macroeconomic variables: interest rates, GDP, other factors that affect on DD levels. This multitude of factors explains the complexity of DD estimates;

– Only a statistical study can measure the volatility over the period. It is the observation of customer behavior that will provide a flow profile.

• Presentation of stock flow functions.

In this part, our article is mainly concerned with the flow of existing assets in the balance sheet entitled "the flow of stock";

The flow occurs assuming that there are no new productions in the future. The production flow function is given in Eq.6:

$$S(t,T) = \exp(-\int_t^c \lambda(u)du) \qquad (6)$$

With λ do not depend on the date of the generation. It is the only one which leads to the equality between the stock flow function and the production flow function.

Thus, we obtain Eq.7

$$S_{Stock}(t,T) = S(T,T) \Rightarrow \lambda(t,T) = \frac{\partial ln(S(t,T))}{\partial T} = \lambda(T) \qquad (7)$$

So, the outstanding VAD is written in Eq.8

$$D_t = \int_{-inf}^{T} PN(s)exp(-\int_s^t \lambda(u)du)ds \qquad (8)$$

Consider a dynamic expressed in Eq.9:

$$dD_t = (PN(t) - \lambda D_t)dt \qquad (9)$$

Which is interpreted as follows: The changes in outstanding amounts are equal to the credit flows minus debit flows, expressed as a percentage of available outstandings. To simplify, we

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consider that the adjustment speed λ and the credit flows PN are constant. Then, we obtain the flow dynamics in Eq.10:

$$D_t = D^* + (D_0 - D^*) * e^{-\lambda t} \qquad (10)$$

- Presentation of the flow functions of the new production:

The flow function gives the probability that a new production dirham entering the balance sheet at a date t will still exist at a later date t. PN (t) denotes the new production appearing at the date t. PN(t,T) is the amount of this production which still present at the date T. Therefore, we define the flow function of the new production by the relation of Eq.11:

$$PN(t, T) = PN(t).S(t, T) \qquad (11)$$

This flow function defines the liquidity convention of the product and it has the following properties:

S(t, T) = 1, a dirham entering the balance sheet at the date t, is always found in the balance sheet at the date t;

- S(t, +∞) = 1, sooner or later, the production disappears from the balance sheet.

3. Application of the Selvaggio model for the evolution of outstanding demand deposits Description of the data

In the present article, in all Moroccan commercial banks, the data that we will use concern the outstanding unpaid demand deposits (CC current accounts and CCH check accounts). For our modeling, we propose the series of monthly CC and CCH outstanding amounts and the interest rate as a variable extracted from BAM. The series which taken into account is a series of monthly rates which runs from December 2001 until October 2020 (Fig. 1). The

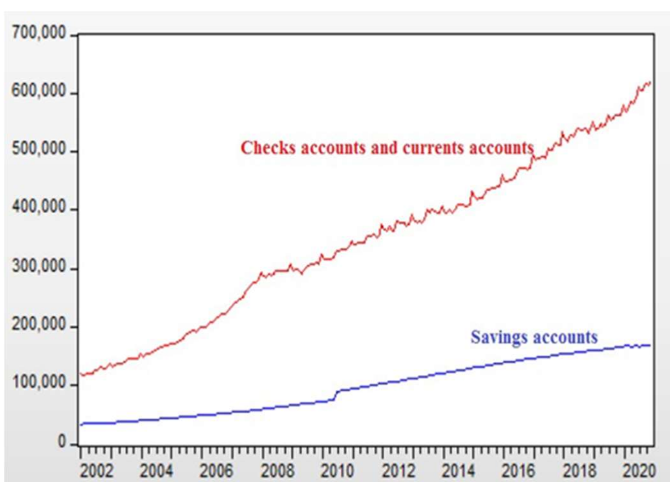

Figure 1: Evolution of the demand deposits of Moroccan banks

drop in the consumption is due to the lockdown and the constraints on unemployment which have prompted households to leave more money in their accounts and to enhance prudential

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savings. This explains the dynamics of the deposits since the beginning of 2020. This contrasts with the trend for the last ones which have noticeably slowed down. We haven't seen such dynamic bank deposits for a long time. Demand deposits with banks are increased by 8.8% over one year at the end of June 2020. The outstanding savings accounts increased by 2.5%. The reasons for this strength are strongly linked to the exceptional situation linked to the coronavirus. Lower consumption and household concerns about the economic outlook, especially unemployment, lead to less use of their deposits and to a boost in precautionary savings (account on notebook). The current situation contrasts with the behavior of the bank deposits during the recent years.

Estimation of the model parameters

The selvaggio model proposes to explain the variation in the outstanding demand deposits of the commercial banks by a linear trend of time, the amounts outstanding at the previous date (i.e. the delayed amount) and the interest rate. Except the time, these variables are considered after a logarithmic transformation. This will permit us to have a parameters that should be interpreted in terms of the relative variations of the explanatory variables compared to the dependent variable. So, in terms of interpretation, the parameters will represent the percentage changes in the explained variable caused by the 1% increase in the explanatory variable. All other things being equal.

Here, the Selvaggio model of which we estimate the parameters takes the form of Eq.12:

$$logD_k = \alpha_0 + \alpha_1 logD_{k-1} + \alpha_2 logR_k + \alpha_3 t \qquad (12)$$

For the empirical estimation, we have used E-views software where the model variables were introduced. The obtained results are given in table 1:

Table 1: Estimation of the coefficients of the Selvaggio model

Dependent Variable : LOG(CPTS_CHQ_ET_CRT_SA)				
Variable	Coefficient	td. Error	t-Statistic	Prob.
C	1.252668	0.564286	2.219916	0.0284
@TREND	0.000489	0.000247	1.984924	0.0495
LOG(CPTS_CHQ_ET_CRT_SA(-1))	0.895344	0.045469	19.69114	0.0000
LOG(TAUX_D_INTERET)	-0.008884	0.010717	-0.828917	0.4089
R-squared	0.998479		Mean dependent var	11.64622
Adjusted	R-squared	0.998439	S.D. dependent var	0.258484
S.E. of regression	0.006919		Akaike info criterion	-5.351408
Sum squared resid	0.005554		Schwarz criterion	-5.258492
Log likelihood	428.5747		Hannan-Quinn criter.	-5.313674
F-statistic	25374.96		Durbin-Watson stat	2.193569
Prob(F-statistic)	0.000000			

After the estimation of the parameters, the Selvaggio model will therefore be written as Eq.13 :

$$Dlogk = 1.2526 + 0.00048tk + 0.08953logk-1 - 0.0088LogRk \qquad (13)$$

Before interpreting these results, we will analyze the model residuals to ensure their normality. For this, we perform the following tests:

- Jarque-Bera residue normality test (Fig. 2)

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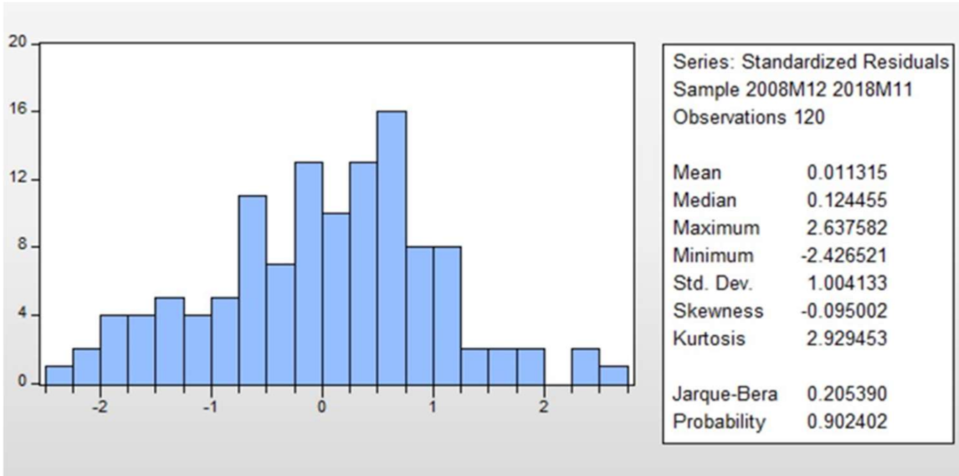

Figure 2: Jarque-Bera residue normality test

The p-value of our test is greater than 5%. So, our residues follow a normal law. Then, we will test homoscedasticity using ARCH test to detect a possible ARCH effect in our residues. But first, let's start with the correlogram of squared residuals (table 2).

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.230	0.230	6.5339	0.011
		2	0.066	0.014	7.0800	0.029
		3	-0.010	-0.030	7.0932	0.069
		4	0.023	0.033	7.1614	0.128
		5	0.019	0.010	7.2090	0.206
		6	0.010	0.000	7.2212	0.301
		7	-0.175	-0.187	11.186	0.131
		8	-0.115	-0.038	12.923	0.115
		9	-0.079	-0.032	13.757	0.131
		10	-0.004	0.018	13.759	0.184
		11	-0.114	-0.121	15.519	0.160
		12	-0.037	0.019	15.709	0.205
		13	-0.084	-0.063	16.668	0.215
		14	0.065	0.076	17.257	0.243
		15	0.088	0.046	18.328	0.246
		16	-0.060	-0.132	18.839	0.277
		17	0.000	0.054	18.839	0.338
		18	0.112	0.088	20.651	0.297
		19	-0.061	-0.147	21.192	0.326
		20	-0.029	-0.039	21.313	0.379

Table 2: Correlogram of the residue square

The squared residual correlogram permit us to include a single lag in our ARCH test.

- ARCH test on the residues (Table 3)

Table 3: ARCH test on the residues

Heteroskedasticity			
F-statistic	6.608725	Prob.F(1,117)	0.0114
Obs*R-squared	6.362320	Prob.Chi-Square(a)	0.0117

Our ARCH test effectively confirms the heteroskedasticity of our errors because the probability corresponding to our obs R-squared statistic is 0.0114 <5%. Thus, to correct the heteroskedasticity, we need to estimate our model with ARCH effect (1).

The estimation results of our model with ARCH error are given in table 4: The results are

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Table 4: Results of the estimation of the Selvaggio model with ARCH error

Dependent Variable : LOG(CPTS_CHQ_ET_CRT_SA)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.734128	0.443397	1.655688	0.0978
@TREND	0.000272	0.000191	1.421459	0.1552
LOG(CPTS_CHQ_ET_CRT_SA(-1))	0.937483	0.035717	26.24785	0.0000
LOG(TAUX_D_INTERET)	-0.010635	0.010525	-1.010426	0.3123
Variance equation				
C	3.38E-05	5.78E-06	5.840059	0.0000
RESID(-1)²	0.266871	0.176713	1.510194	0.1310
R-squared	0.998467		Mean dependent var	12.90090
Adjusted	R-squared	0.998427	S.D. dependent var	0.175138
S.E. of regression	0.006946		Akaike info criterion	-7.092265
Sum squared resid	0.005596		Schwarz criterion	-6.952891
Log likelihood	431.5359		Hannan-Quinn criter.	-7.035665
F-statistic	2.778366		Durbin-Watson stat	2.90090
Prob(F-statistic)	0.998467			

almost identical to the model parameters after estimation (Eq.14):

$$Dlogk = 0.7341 + 0.00027tk + 0.9374logDk{-}1 - 0.0106LogRk \quad (14)$$

- ARCH heteroskedasticity test (table 5).

Table 5: ARCH heteroskedasticity test

Heteroskedasticity test ARCH			
F-statistic	0.000821	Prob.F(1,117)	0.9772
Obs*R-squared	0.000835	Prob.Chi-Square(a)	0.9769

The value of our chi-square probability corresponding to obs R-squared statistic is 0.9769 <5%; so the errors are homoscedastic.

From Eq. 14, contrary to the expectations, the interest rate which seemed, a priori, the most important for the explanation of the evolution of outstanding demand deposits is not significant. That is, the behavior of the customers in terms of the demand deposits in their current (unpaid) accounts is independent of the changes in interest rates. This may be due to the fact that the interest rates do not increase significantly in a way for the interest holders of the demand deposit accounts. Also, We can justify this by the fact that the bulk of the demand deposits consist of a precautionary balances. In addition, It is evidence that in Morocco, the absence of an active financial market has made it difficult to diversify into attractive financial products capable of collecting the personal savings and the surplus of the corporate treasury.

Determination of the portion of the stable demand deposits as a function of the time

- Disposal of DDs from an unpaid account

The parameters of the adjusted model beforehand allow us to calculate the speed of the

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adjustment λ = 6.26%. Using the flow dynamics equation (Eq. 15):

$$D_t = D^* + (D_0 - D^*)exp(-\lambda_t) \quad (15)$$

The coefficient of the calculated variation on the data series is 17.71%. This means that 17.71% of the current account liabilities deposits are volatile and drain very quickly. The stable part which represents 82.29% of the deposits available to the bank will be marketed linearly over an horizon H.

The table 6 lets the bank know how much it can lend without the risk of the transforma- tion. In this sense, the examination of the provided results permits us to say for a maturity of 12 months: for example, to grant the requested loans, the bank can lend 51% of its stock of the demand deposits to its best customers.

Table 6: Outstandings flow agreement on a date t as a function of the time

Date in months	Outstandings	Elapsed percentage	
0	621574,26	-	
1	571274,27	7,31	
2	525829,18	6,61	
3	484770,40	16,23	
6	383878,64	20,80	
12	254597,30	6,51	75,75 Instable part
15	214127,82	3,36	
17	193239,52	3,92	
20	168876,94	1,06	
21	162270,77	0,96	
22	156302,21	0,87	
23	150909,74	2,13	
26	137659,06	5,99	24,25 Stable part
182	**100432,52**	0,00	
190	100432,52	0,00	
195	100432,52	0,00	
200	100432,52	0,00	
210	100432,52	0,00	
220	100432,52	0,00	
230	100432,52	-	

4. Conclusion

We conclude that the demand deposits (unpaid) with the commercial banks are not sig- nificantly sensitive to the interest rates. This result confirms the validity of our hypothesis that, the behavior of the clients in Morocco in terms of deposits in their current (unpaid) accounts is independent of the interest rate variance.

Several important recommendations can be made. On the one hand, commercial banks will need to improve their ALM information system, in order to take into account customer- specific

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variables that are useful for bringing customer rationality into the analyzes. They should become more involved in the financing of the economy by valuing the stable parts of demand deposits.It should take into account the stable part of these deposits in the con- struction of liquidity impasses in order to determine their real liquidity needs or surpluses at future dates. On the other hand, the dynamism of the financial sector is becoming a major issue, because an active financial sector would allow the holders of demand deposit accounts to buy more attractive financial assets and this by mobilizing their deposits which remain idle in banks. This will prevent this kind of the hoarding. Finally, if commercial banks cannot value these deposits, The central bank can use the stability of these demand deposits to adjust the reserve requirement factor related to this type of the deposit.

The existence of a dynamic financial sector with stimulating interest rates would make it possible to study the effect of these rates on the stability of demand deposits. Finally, another perspective for the continuation of this study is to incorporate variables for the commercial policy of the bank and variables related to customer behavior such as attrition rates (number of the closed accounts per month) and acquisition rate (number of the open accounts per month).

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