A DYNAMIC AND MULTIVARIATE ANALYSIS OF TREASURY BILL BEHAVIOR IN A BANK ASSET PORTFOLIO

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Abstract

The portfolio behavior of banks in a developing financial market environment is somewhat different from that of developed markets. To explore such a situation, in this study, a dynamic and multivariate analysis of the behavior of treasury bills in the bank's asset portfolio is employed by using data from the Ethiopian banking sector. A very comprehensive econometric model that includes initial stock variable, asset portfolio variables, liability portfolio variables, and yield differentials has been developed. The study is time series and covers the period from the first quarter of 2000 to second quarter of 2010 of the Ethiopian banking sector. Except for the yield differentials other variables are found to be significant. Besides, all the explanatory variables maintain the a priori expected sign except one of the yield differentials: relative yield differential between long-term and short-term securities. This is attributed to the less attractive and more stable nature of the yield on long-term securities in the Ethiopian financial market.

Keywords: Dynamic, Multivariate Analysis, Treasury Bill Behavior

Introduction

A sound, dynamic, and competitive financial sector is essential to promote growth and reduce poverty by mobilizing savings and allocating resources efficiently. Banks and other financial institutions have tremendous effect on the economy as a whole especially in underdeveloped economies where the financial markets are weak and in most cases non-existent (Mishkin, 2004).

Banks are the most dominant players in the Ethiopian financial system holding 93 percent, 98 percent, and 92 percent of the total assets, deposits and loans of the financial sector respectively in the year 2006 while microfinance companies hold 4 percent of assets, 2

of deposits, and 8 percent of loans, insurance companies hold only 3 percent of total assets (IMF, 2007).

The Ethiopian banking sector is underdeveloped however, has been changing speeds over the years due to developments in global and domestic financial markets. The banking sector is dominated by the state owned banks. One of the major sources of short-term funding for the government is generated through treasury bills. They account for 7.8% of the total asset of the Ethiopian banking sector. The Ethiopian financial market is not a sophisticated market and still in the early stage of development. Due to rapid change taking place in the banking environment in Ethiopia, a continued analysis of bank portfolio behavior has become essential. Conventional banking theory suggests that at any point in time, the quantity of a given asset held by banks is a function of the total amount of assets available, relative yields, and liquidity considerations (Melnik, 1970). However, the use of total assets in any other case and relative yields in the Ethiopian case would not be strong in explaining the portfolio behavior of a given asset. The reason is, first, the fact that total assets have a strong correlation with every other asset and even liabilities definitely biases the estimation. Second, the Ethiopian financial market is underdeveloped and dominated by the monopoly power of the state owned Commercial Bank of Ethiopia which accounts more than 50% of the total asset of the banking sector (IMF, 2006). The fact that a monopoly exists, especially by a state owned bank, and the market is underdeveloped depresses the explanatory power of relative yields. For these reasons it is very important to exclude total assets from the model and include different portfolios of bank assets and liabilities along with the yield differentials.

In their model regarding short-run behavior of banks Bryan and Carleton (1967), Fraser and Rose (1973), and Crammer and Miller (1978) generally used the conventional method. However there were instances where Fraser and Rose (1973) admitted the failure of their model to explain short-run behavior of liquid assets such as Treasury Bills. Therefore, further investigations are warranted on liquid assets more importantly on treasury bills. As Ethiopia is still in the early stage of financial market developments, it could be worthwhile to explore such a market as there are few studies available in the literature.

This paper is organized into six parts. Part II surveys the major literature on this area of study and part III discusses the theoretical framework. In part IV, the empirical model is presented. The empirical results are presented in part V while the findings of the study are concluded in part VI.

Previous Literature

In the banking industry, assets and liabilities are managed to overcome volatilities or uncertainties arising from business activities. In other words, banks need to manage their cash flows, cost of funds and return on investments while maintaining liquidity all the time. Modern banks are very vulnerable to higher levels of volatilities in the market and need to manage their portfolios strongly. In this regard, in almost all countries, banks use treasury bills as a part of their dynamic portfolio management strategy. A few decades ago, many studies were focusing on the US banks and examined how they manage their portfolios. Notable literature is Aigner and Bryan (1971), Morrison, (1962), Silber (1966), Fraser & Rose (1972), Crammer & Miller (1978) and Menlik (1970). Depending on this, the level of cash holding or Treasury bills holding may change as banks are supposed to protect their depositors. The relationship between treasury bills and their lag indicates adjustments from the past investment decisions regarding treasury bills.

One of the reasons to use treasury bills in banks' portfolios is that treasury bills are almost similar to holding cash while receiving a reasonable return. The level of treasury bills holding in any bank will depend on the level of business activity as well as the level of other portfolios such as loan portfolio in a particular bank. Generally, business cycles are the main determinant of banking activities in any country. For example, when the market is highly competitive banks cannot charge different rates on the assets and pay for the liabilities; rather they are constrained to take the given rates of the market. In that case all the banks in a particular market should have similar profitability or rate of return on their assets. But in reality we observe a wide variation in the return among banks. An explanation of this disparity can be that, different types of assets and liabilities have different rates of return and cost, so banks can change their profitability by simply changing the composition of the portfolio of assets and liabilities.

The portfolio behavior of banks will determine the level of profitability. Hester & Zoellner (1966) employed statistical cost accounting method successfully on two sets of US banks: Kansas City District banks and Connecticut banks. They reported empirical estimates of net rates of return earned from assets and liabilities by using least-squares regression of various measures of earnings on different assets and liabilities. Their study examines whether a significant relationship exists between assets/liabilities standardized with total assets with return on assets of individual banks. They found statistically significant coefficients for most of the categories of assets and liabilities and as a result, reject the null hypothesis of no relationship between them. They also examined whether these relationships differ among

individual years and found no significant differences in the estimated rate of return existed each year during the study period. However, there were minor differences in the findings of two sets of banks which are reasonable considering market and macro level differences. Kosmidous, Pasiouras & Floropoulos (2004) examine the impact of asset and liability composition on earnings on a sample of 80 UK banks using data from 1996–2002. The authors used 457 observations during that time period arranged as unbalanced pooled data to regress operating profit of banks by their assets and liabilities. Their results show that high profit banks earn lower returns on assets than the low profit banks in general but the loss is more than covered because of the lower cost associated with their liabilities compared to their low profit competitors. These findings indicate that it is lower cost of liabilities than the higher return on assets that attribute to the higher profit among the competing banks. In case of liabilities, their analysis estimate that customer deposit and short term funding were the most costly source of fund for both domestic and foreign banks.

The study of Vasiliou (1996) investigated profitability differences in terms of portfolio of assets and liabilities between high-profit and low-profit Greek banks. The regression results suggest that it is the asset management rather than liability management that play more prominent role in explaining interbank differences in profitability for the set of banks and time period chosen in the study. These findings contrast with the findings of Kosmidous, Pasiouras & Fotopoulos (2004) who are of the opinion of their study that liability management contributes more in creating the profitability differences among banks.

The relationship between treasury bills and excess reserves could be viewed from addressing both the issues of liquidity and profitability. When treasury bills are increased and excess reserves are decreased, it means profitability has been given priority over liquidity at the given point in time. A priori, treasury bills and excess reserves are expected to maintain a negative association. The more the excess reserves of a bank, the higher the probability that they will be invested in short-term securities. The reverse is also true.

The relationship between demand deposits and treasury bills is expected to be positive. The rationale and theory behind such an assumption is that when banks have more demand deposits than other deposits they need to be more cautious about their long-term investment decisions. Generally speaking, the more demand deposits a bank have the better it invests in short-term investments such as treasury bills than long-term bank portfolios such as loans and long-term securities. Thus, it can be inferred that the expected relationship between short-term investment decisions and long-term investment decisions is negative. However, taking into account total deposits, the two variables might maintain a positive relationship,

which is an indication of their complementary relationship. This is because banks logically want to use their time deposits for long-term investments that earn them attractive profit. Yet, if there is a negative relationship between short-term and long-term investments, notwithstanding the theoretical relationships outlined above, there would be a complementary relationship.

As far as the relationship between treasury bills and loans is concerned, it is expected to remain negative. The reason is the high return and high risk characteristic of loans and the low return and low risk nature of treasury bills. Besides, when loans are liquidated, there will be a temporarily idle fund that could be invested in short-term investments of which treasury bills are only active in Ethiopia. Also, when loans are to be disbursed some treasury bills may be liquidated.

The Research Model

In their model regarding treasury bills, Fraser and Rose (1973) used the Treasury bill rates, the yield differences between the treasury bills and other earning assets (i.e. opportunity cost of holding treasury bills than other earning assets), size of bank portfolio (i.e. total assets), a vector of various measures of deposit composition, and a stochastic disturbance term (E_i). However, while some of the variables included by Fraser and Rose (1973) are also included in this study some are removed and some new are added. The adjustment is made for two reasons: (i) reflect the condition of the Ethiopian financial system and (ii) correct some of the mistakes.

Due to unavailability of separate data on the yield of long-term securities, the average yield on long-term securities is used as a proxy. It is also believed that the inclusion of total assets as it was used by Fraser and Rose distorts the estimation of the parameters. This is because of the obvious association of total assets with every balance sheet item. Thus, total assets are excluded. Another point that needs to be mentioned here is, different deposit portfolios should be entered individually rather than as a ratio of one another, as done by Fraser and Rose. This approach helps to capture the individual influence of deposit portfolios on the holdings of treasury bills.

It is worth noting here that state and local government securities and enterprise securities are excluded from being explanatory variables for treasury bills. Given the fact that state and local government securities account for less than 1% of the total long-term securities and the introduction of corporate securities only after the third quarter of 2004 the decision is strongly justified. This helps in better estimating the association between other explanatory variables and treasury bills. Finally, taking into account the critics made in this

section and the relationships outlined in the theoretical framework section, a mathematical relationship is developed.

The Data: Nature and Source

The data used in this study has been collected from quarterly balance sheet and income statement reports submitted by commercial banks to the National bank of Ethiopia; both public and private. The nature of the data is level data. It is not seasonally adjusted. The study covers the period from the first quarter of 2000 to the second quarter of 2010. Before the data on treasury bills was used for estimation, it was tested for unit root problem. The test results showed a unit root problem with the level data. To correct the unit root problem, the level data were first differenced, and found to be significant at 1% when checked with Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) test statistics. Similar result was secured with Kwiatkowski-Phillips-Schmidt-Shin test statistics (KPSS) though the alternate hypothesis for ADF & PP is the null hypothesis for KPSS.

The Model

Although Aigner (1973), Aigner and Bryan (1971), Anderson and Burger (1969), Bryan and Carleton (1967), Fraser and Rose (1973), Hester and Pierce (1975), and Melnik (1970) have dealt with the multivariate aspect of the process, their work lacks the dynamic properties. The research works of Cramer and Miller (1976) and (1978) though addresses both the multivariate and dynamic properties, they didn't include impact of portfolio composition. In this research work these deficiencies are removed.

The explanatory variables of treasury bills constitute four important components: (1) the initial stock variable, (2) asset portfolio variables, (3) liability portfolio variables, and (4) the relative yield differential variables. Besides, in developing this model some very important assumptions are made. These assumptions though modified were used by Cramer and Miller (1978).

(1) All the explanatory variables are exogenous - the explanatory variables do not depend on the dependent variable.

(2) There is a time series relationship between the explanatory and explained variable.

(3) The explanatory variable lag or contemporaneous the explained variables, and

(4) The independent variables have no lead or lag relationship.

Explain briefly the rationale of setting the assumption that there is a time series relationship between the explanatory and explained variable is the strong belief that the Ethiopian banking system will follow the pattern suggested by most theories of bank financial behavior. With respect to the assumption that the explanatory variables should lag

or contemporaneous the explained variable, the rationale for such an assumption to make is for an explanatory variable to cause the explained variable it shall exist before the explained variable. Finally, regarding the last assumption, for the explanatory variables to claim independent causality, they shall not co-integrate each other.

The general model that captures the different asset and the liability portfolio behavior of commercial banks could be presented as follows:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^{n} \alpha_2 A_{it} + \sum_{j=1}^{m} \alpha_3 L_{jt} + \sum_{k=1}^{p} \sum_{l=1}^{q} \alpha_4 R_{klt} + e_t \quad \text{----------Eq----------} \textbf{Eq. 1}$$

Where,

Y_t= amount of treasury bills at time t

Y_{t-1}= the lag of treasury bills

A_{it}= size of ith asset portfolio at time t

L_{jt}= size of jth liability portfolio at time t

R_{klt}= the relative yield differential of the kth and lth asset portfolios at time t

e_t= stochastic term

The lag variable helps to capture the speed of adjustment. Asset portfolio variables have been included to measure the substitution/complementary effects of other competing/complementing asset portfolio variables and also to measure the relationship between asset and liability portfolios. Liability portfolio elements are also included to measure what sources of funds fund what uses of funds and how much they cost in their funding. Besides, the inclusion of yield differential of different assets helps to capture a possible shift in the allocation of bank funds.

Generally, the explanatory variables were entered into the multivariate model according to the theoretical model of bank portfolio behavior as it was suggested by Crammer and Miller (1978). In view of the general model and theoretical framework laid down in the previous section, the relationship between defensive assets and the explanatory variables is mathematically represented as shown below.

$$\Delta T = f(\Delta T_{-1}, \Delta ER, \Delta DD, \Delta G, \Delta L, RLRB, RGRB)$$

Where,

T is treasury bills

T_{-1} is lag of treasury bills

ER is excess reserve

DD is demand deposits

G is long-term Ethiopian government security

L is loan

RGRB is relative yield differential between long-term and short-term securities

RLRB is relative yield differential between loans and treasury bills

In view of above, except that of the demand deposits the rest of the right hand side variables are expected to maintain a negative association with treasury bills. The analytical model that took its root from the theoretical and mathematical models discussed and presented above is given below.

$$\Delta T = \alpha_0 + \alpha_1 \Delta T_{-1} + \alpha_2 \Delta ER + \alpha_3 \Delta DD + \alpha_4 \Delta G + \alpha_5 \Delta L + \alpha_6 \Delta RB + \alpha_7 \Delta RG + e_t \text{ ---------- Eq. 2}$$

Where, e_t is a stochastic term

Estimation and Results

We found that all of the explanatory variables except the yield differentials are significant (Table 2). Besides, all the explanatory variables maintain the a priori expected sign except one of the yield differentials: relative yield differential between long-term and short-term securities. This is attributed to the less attractive and more stable nature of the yield on long-term securities in the Ethiopian financial market.

The residuals of treasury bills are checked for unit root. All the three tests: ADF, PP and KPSS indicate that there is no unit root problem (Table 1). This means the residuals are stationary.

Table 1: Unit root test of residuals of treasury bills using Augmented Dickey-Fuller, Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin test statistics

Variable	Level data	ADF test statistic (t-statistics)	PP test statistic (t-statics)	KPSS test statistic (LM-Stat)
Residual of treasury bills	residtb	-6.73*	-6.74*	0.07ɤ

* Significant at 1% for ADF and PP test statistics

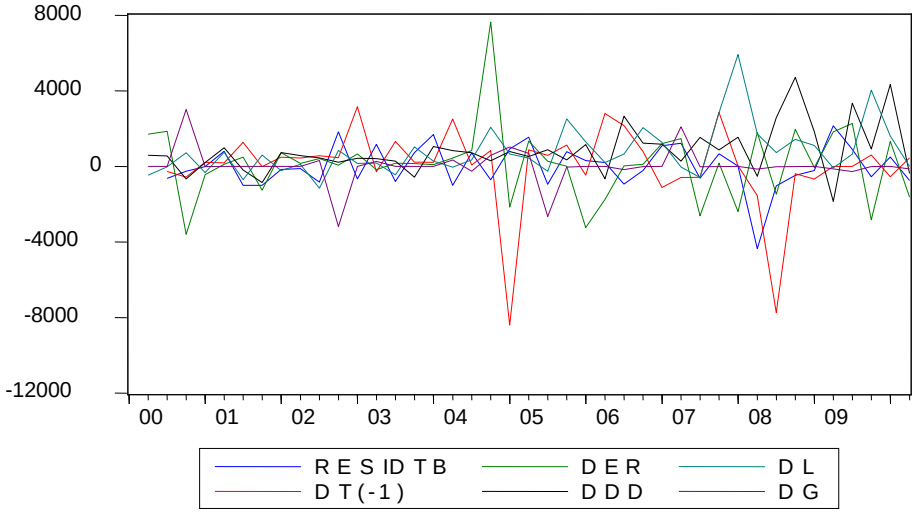
ɤ the null hypothesis, i.e. the decision variable is stationary could not be rejected even at 10% level of significance

The graph for the residual of treasury bills indicates that investment in treasury bills were in their lowest position in the first quarter of 2008 though it was declining since the second quarter of 2007 (see Figure 1). This means the lag of treasury bills were also in declining situation.

In this particular period there was no problem of excess liquidity. Excess liquidity was very high at this point in time. Regarding investments in long-term Ethiopian government securities, they were the same as they were before: no major change in the investment of long-term Ethiopian government securities. However, there were two major factors that caused the historic decline in treasury bills: loan disbursement was very high and demand

deposit holdings had declined. These factors together explain the major decline in the investment history of treasury bills by Ethiopian banks.

Figure 1. Explaining outliers in the Treasury Bill holdings of the Ethiopian banking sector from 2000Q1-2010Q2



The holding of treasury bills exhibited a tremendous increase in the beginning of 2009. The two major factors responsible for such a big jump in the investment of treasury bills are major decline in loan disbursement and a surge in the holding of excess reserves. Generally speaking the lag of treasury bills, demand deposits, excess reserves, long-term Ethiopian government securities and the amount of loan disbursed are what explain the behavior of treasury bills in the Ethiopian banking sector.

Table 2: Regression of Treasury Bills against its lag, excess reserves, demand deposits, long-term Ethiopian government securities, loan disbursed, relative yield difference between loans and Treasury bills as well as long-term securities and Treasury Bills

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	324.8095	264.5458	1.227801	0.2285
ΔT_{-1}	0.234895	0.100575	2.335516	0.0259**
ΔER	-0.841495	0.110439	-7.619557	0.0000*
ΔDD	0.515256	0.168658	3.055026	0.0045*
ΔG	-0.443268	0.228395	-1.940801	0.0611***
ΔL	-0.802181	0.159001	-5.045121	0.0000*
ΔRLRB	958.3882	755.7725	1.268091	0.2139
ΔRGRB	-164.1169	524.9104	-0.312657	0.7566

$R^2 = 0.72$ $Adj.R^2 = 0.66$ $S.E = 1263$ $DW = 2.05$

* Denotes significance at 1% level ** Denotes significance at 5% level

*** Denotes significance at 10% level

The relationship between treasury bills and its lag is negative. The negative sign of their association indicates that the holding of treasury bills in the Ethiopian banking sector is generally lower that what it ought to be. On the average, it takes twelve to thirteen months to adjust treasury bills to a desired level. With other variables while the relationship between excess reserves and Treasury bills is negative, demand deposits maintained a positive relationship. Both have met the a priori expectations.

One Ethiopian Birr[38] increase in excess reserves results in 0.84 Ethiopian Birr decrease in the investment made in treasury bills. Similarly, a decrease of one Ethiopian Birr excess reserve is used for purchasing a 0.84 Ethiopian Birr treasury bill. In relation to demand deposits one Ethiopian Birr increase in demand deposits is used to acquire a 0.52 Ethiopian Birr treasury bill. Similarly, a decrease of one Ethiopian Birr in demand deposits requires liquidation of 0.52 Ethiopian Birr treasury bills among others.

In their relationship with long-term Ethiopian government securities, treasury bills maintained a negative relationship noting that they are substituting to each other. One Ethiopian Birr increase in the investment of long-term Ethiopian government security can be covered by a 0.44 Ethiopian Birr liquidation of treasury bills. Similarly, a sale or liquidation of one Ethiopian Birr long-term Ethiopian government securities is required to cover 0.44 Ethiopian Birr treasury bills among others.

The best explanation for the substitute relationship than a complementary relationship of long term Ethiopian government securities and treasury bills shall be their similarity in their riskiness and difference in their liquidity and return. Had their riskiness been significantly different they could have assumed a complementary relationship than a substitute one.

The relationship between treasury bills and loans is negative. As it was the case with long term Ethiopian government securities, the relationship between loans and treasury bills is substituted. Increasing loan disbursements by one Ethiopian Birr requires liquidation of treasury bills amounting 0.75 Ethiopian Birr. In a nutshell, while treasury bills assume a negative relationship with excess reserves, loans and long term Ethiopian government securities, they show a positive association with demand deposits.

Conclusion

The amount excess reserves, supply of demand deposits, size of loan and long-term Ethiopian Government securities are the factors that explain the behavior of treasury bills in the Ethiopian banking sector. The change in the above mentioned explanatory variables

[38] Birr is Ethiopian currency and 1 Ethiopian Birr=US$ 0.05

together explain 72% of the change in treasury bills. Finally the speed of adjustment for treasury bills takes from 12 to 13 months. This long period is a testimony to the underdeveloped nature of the Ethiopian financial system and the prevailing poor management of financial assets. Therefore, the banking sector needs to do more work to become a more profitable and efficient system that could help the country to achieve higher economic growth.

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