SELECTIVE CREDIT CONTROLS AND THE MONEY SUPPLY PROCESS IN TRANSITIONAL ECONOMIES: THE CASE OF BULGARIA

(MASTER'S PAPER)

by Plamen K. Yossifov[1]

Ph.D. Student in Economics, University of Delaware

November, 1997

[1] I want to thank Dr. Jeffrey B. Miller and Dr. Toni Whited, both from the University of Delaware, and Dr. Simon Commander, Economic Development Institute of The World Bank, for their useful comments on earlier drafts of this paper. I also want to thank Lyobomir Dimitrov, Deputy Chairman of the Agency for Economic Co-ordination and Development, Sofia, Bulgaria for generously providing the data set used in this study.

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1. INTRODUCTION

The money supply process in developed countries is often formalized with the help of the standard model of money multiplier. This model postulates the existence of intertemporary stable, statistical relationship between the stock of high-powered money and the money supply, called the money multiplier. The stock of high-powered money consists entirely of items included in the liability side of central bank's balance sheet. According to the standard model, monetary authorities can effectively target the growth of the money supply by manipulating the size of these liabilities and using the behaviorally determined value of the multiplier to forecast the subsequent changes in the quantity of money. The key assumptions of this theory emphasize the constant nature of economic agents' portfolio preferences and their independence from the actions undertaken by the central bank in the pursuit of its policy objectives (Rasche, 1993, p.31).

While these assumptions might conform with the characteristics of the money supply process in developed countries, they were clearly refuted in most Eastern European countries, in the early stages of their transition from centrally planned to market economies. Faced by the fact that "... money multipliers were showing signs of erratic behavior due to structural breakdowns..." (Farahbaksh, 1996, p. 4) monetary authorities in these countries[2] adopted various measures of selective credit controls specifically designed to alter the structure of economic agents' portfolios.

Selective credit controls encompass all instruments used by central banks to influence directly the flows of credit in the economy (Hodgman, 1972). One of the most commonly enacted measures of selective credit controls in the former centrally planned (CPEs) is the imposition of quotas on the earning assets of commercial banks. An illustrative example of this type of selective credit controls implemented in Bulgaria between 01/1991 and 06/1994, are the periodic bank-by-bank credit ceilings that set the maximum percentage increase of bank advances in domestic currency to businesses in relation to a certain base period[3].

The implementation of such direct instruments of monetary control is often an integral part of the IMF-supported stabilization programs in the former CPEs and reflects the view expressed in publications of the International Monetary Fund that "...the advantages of direct instruments in controlling overall monetary developments during the earlier transitional stages seem to surpass their drawbacks in other areas..." (Hilbers, 1993, p.iii).

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[2] The list of transitional countries that implemented or/and still use direct instruments of monetary control include: Albania, Bulgaria, Czechoslovakia, Hungary, Lithuania, Poland, Romania (Farahbaksh, 1996, p. 4) and (Bredenkamp, 1993, p.16).

[3] The definition of credit ceilings presented above is based on the general definition of credit ceilings as stated in Farahbaksh (1996, p.5), taking into account the country-specific arrangements in Bulgaria (see Miller (1993)).

Despite the increasing importance of selective credit controls in the conduct of monetary policy in developing and transitional countries, “professional economic literature is devoid of any general theory of credit and credit controls as instruments of public policy” (Hodgman, 1972, p. 343). The state of knowledge in this field has changed little since then, partly because of the inherent incompatibility of the behavioral assumptions of the standard model of money multiplier and the non-neutral[4] nature of the direct instruments of monetary control.

The main purpose of this paper is to construct an unified framework for analyzing the influence of both direct and indirect instruments of monetary control on the money supply process. The resulting formal model is then applied in the empirical evaluation of the effectiveness of credit ceilings in limiting the growth of domestic monetary aggregates in Bulgaria.

The presentation commences in Chapter 1 with the development of a general model of money multiplier based on less stringent behavioral assumptions than the standard one. In it the intertemporal and intratemporal values of the average and marginal money multipliers[5] may differ and in order to determine the incremental effect on the money supply of changes in the monetary base, we have to explicitly consider the formula of the marginal money multiplier. The connection between the values of the two multipliers in adjacent periods is also analyzed and used to show that the standard model of money multiplier is a special case of the general one, in which the average and the marginal multipliers are equal both within and across periods and consequently can be jointly represented by the unique formula of the money multiplier. In Section 1.2 we develop statistical procedure for testing the hypothesis that the standard model of money multiplier constitutes a reasonable approximation of the processes generating the data of monetary aggregates in a given country. Section 1.3 examines the role of foreign-currency denominated assets in domestic money creation. We show that foreign-currency deposits do not participate in the process of multiple deposit creation that brings into existence the observed multiplication of the quantity of base money. Therefore, foreign-currency denominated assets should not be included in the definitions of the money supply and monetary base, used in the calculation of the marginal money multiplier. Section 1.4 focuses on the influence of credit ceilings on the formula of the marginal money multiplier within the framework of the general model. We first classify the various types of quotas on the earning assets of commercial banks in two major subcategories: regimes of total and partial credit ceilings. Total credit ceilings are in place when the central bank imposes limits on the rate of growth of all assets in commercial banks’ portfolios that participate in the process of money creation. Under a regime of partial credit ceilings, the acquisition of only selected types of banks’ assets is under regulatory control. In this Section,

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[4] Non-neutral in respect to the portfolio preferences of economic agents.

[5] The average money multiplier is the ratio between the stocks of money supply and monetary base at the end of the accounting period. The marginal money multiplier is the ratio between the changes of the money supply and monetary base in a given period. For a verbal discussion of the connection between the average and marginal money multipliers in the standard model see Rasche (1993, p.31).

we present the relevant formula of the marginal money multiplier under the regime of total credit ceilings and show how the result changes if only partial credit restrictions are enacted. An important conclusion of this analysis is that total credit ceilings enable monetary authorities to gain full control over the determination of the money supply. Whereas the effectiveness of the partial credit ceilings in limiting money creation depends crucially on the degree of substitutability between the controlled and unregulated bank assets and on the extent to which the latter facilitate the process of monetary expansion. We also develop statistical procedure for establishing the relative effectiveness[6] of the partial regimes of credit ceilings in limiting domestic money creation and for identifying the most important unregulated channels of leakages of funds from banks in the real economy.

In Chapter 2 we implement the developed formal methods and statistical procedures to analyze the influence of the partial credit ceilings on the money supply process in Bulgaria. Section 2.1 discusses the data used in the subsequent statistical analysis. Section 2.2 tests the hypothesis that the standard model of money multiplier constitutes a reasonable approximation of the processes generating the data of monetary aggregates in Bulgaria in the period 12/1990 - 01/1997. The conducted unit-root tests strongly reject this hypothesis (at 95% level of confidence) and provide empirical justification for the use of the general model of money multiplier in the analysis of the money supply process in this country. In Section 2.3, we examine the effectiveness of the partial credit ceilings, which restricted the "maximum possible increase of the total debt on the loans in local currency for the business activities of firms and other organizations owed to the banks" (BNB, 1991, p.39), in limiting domestic money creation in Bulgaria. To that end, we first calculate the benchmark values of the marginal money multiplier, that would have prevailed if the imposed credit restrictions encompassed all assets in banks' portfolios that facilitate monetary expansion. We then regress the observed values of the marginal money multiplier on its estimated values under the hypothetical regime of total credit ceilings. If the partial credit restrictions were as effective in limiting domestic money creation as the total ones, then the estimated coefficient in front of the latter should not be statistically different from unity and the regression residuals should be realizations of a white noise process. Our OLS estimate of the above coefficient equals 1.74 but the conducted Ljung-Box Q- test on regression residuals show that they are non-stationary and consequently our OLS estimates are unreliable. We then estimate the same regression in first-differences and test the coefficient restriction implied by the standard model. The latter is strongly rejected at the 99% confidence level with a standard F-test. The Ljung-Box Q-statistic, when computed using the autocorrelations of the estimated residuals up to 23 lags (out of 26 possible), has sufficiently high P-value to allow us to conclude that the residuals are realizations of a white noise process. Overall, we are able to refute the hypothesis that apart from a white noise disturbance, the values of the marginal money multiplier, under the partial credit ceilings in Bulgaria, were of the same magnitude as its values, that would have prevailed under a regime of total credit restrictions. This suggests that substantial leakages of funds from banks to the real sector occurred through channels unregulated by the partial credit ceilings and their magnitude over time was driven by some non-stochastic process. Because commercial banks' holdings of government securities is their largest domestic-

[6] In comparison to the results obtained under a regime of total credit restrictions.

currency denominated asset, which is not subject to any regulatory restrictions, we next test the hypothesis that the rapid growth of commercial banks' holdings of government securities substantially undermined the effectiveness of the partial credit ceilings in Bulgaria. In the performed econometric analysis, we regress the difference between the observed and the theoretical values of the marginal money multiplier on an index of the size of the net claims to general government in Bulgaria, which approximates the amount of government securities accumulated by commercial banks[7]. The OLS estimate of the coefficient in front of the index of the net claims to general government (0,007) is positive and statistically significant at 99% level of confidence. Furthermore, the conducted Q-tests on regression residuals support the hypothesis that they are realizations of a white noise process and hence re-affirm the statistical robustness of our OLS estimates. An one hundred basis points increase in the quantity of outstanding government debt widens the gap between the observed and the benchmark value of the marginal money multiplier in a given period by 0.7. Thus, this paper provides theoretical justification and strong empirical support for the argument put forth by Miller (1994) and appearing in Yossifov (1994), that the gradual development of the market for government securities in Bulgaria de-emphasized the role of credit ceilings in controlling money creation and enhanced their importance in redistributing credit flows into the hands of state bureaucrats.

2. A General Model of Money Multiplier

In this Chapter we develop a model of money multiplier, that does not rely on the assumption that the portfolio preferences of economic agents remain constant over time and are set independently of central bank's actions. Instead, we assume that within each time period the portfolio preferences of economic agents remain constant on the margin but that across periods they can be adjusted, in response to the non-neutral interventions of monetary authorities. Within such analytical framework, one can analyze the influence of both indirect and direct instruments of monetary control on the money supply process. The model presented below is in part inspired by the verbal discussion of the possible discrepancies between the values of the average and marginal money multipliers in the standard model found in Rasche (1993, p.30-33). Section 1.1 presents the basic definitions and assumption of the general model and introduces the formulas of the average and the marginal money multipliers. In Section 1.2 we analyze the connection between the values of the marginal and average money multipliers in adjacent periods and show that the standard model of money multiplier is a special case of the general one, in which the average and the marginal multipliers are equal both within and across periods and consequently can be jointly represented by the unique formula of the money multiplier. Here, we also develop statistical procedure for testing the hypothesis that the standard model of money multiplier constitutes a reasonable approximation of the processes generating the data of monetary aggregates in a given country. In Section 1.3 we show that foreign-currency denominated assets do not participate in the process of multiple deposit creation and therefore should not be included in the definitions of the money supply and monetary base used in the derivation of the marginal money multiplier.

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[7] In the early stages of transition, commercial banks in Bulgaria were the sole buyer of government debt instruments, which were usually held until maturity.

Section 1.4 focuses on the influence of credit ceilings on the formula of the marginal money multiplier within the framework of the general model.

2.1 DEFINITIONS AND ASSUMPTIONS

For the purposes of the forgoing analysis, we use the broad definition of the money supply [M2]:

$$M_t \equiv Cp_t + D_t \quad \text{, where} \qquad [1.1.1]$$

M_t - the money supply at the end of period (t)

Cp_t - currency outside banks at the end of period (t)

D_t - demand and time deposits in domestic currency

Two points in the construction of equation [1.1.1] deserve further explanation. First, demand and time deposits are pooled in one common term. From one hand, this simplifies the presentation and from the other the distinction between the two types of deposits, based on their use for transaction purposes is blurred in transitional economies because of the limited use of check-writing against demand deposit balances. Second, our working definition of the money supply excludes foreign-currency denominated assets for reasons discussed in Section 1.3.

The monetary base is defined as the sum of the domestic currency outside banks and commercial banks' reserves at the central bank:

$$B_t \equiv Cp_t + RR_t + ER_t \quad \text{, where} \qquad [1.1.2]$$

B_t - value of monetary base at the end of period (t)

RR_t - required reserves of commercial banks

ER_t - excess reserves of commercial banks

The required reserves are amassed by commercial banks in fulfillment of the legal reserve regulations, whereas the excess reserves are maintained voluntarily in the form of vault cash and deposits at the central bank.

To facilitate the following derivation of the formula of the average money multiplier we define the following ratios:

- Currency to deposits ratio at the end of period (t):

$$cr_t = \frac{Cp_t}{D_t} \qquad [1.1.3]$$

- Excess reserves to deposits ratio at the end of period (t):

$$er_t = \frac{ER_t}{D_t} \qquad [1.1.4]$$

- Reserve requirement ratio in period (t):

$$rr_t = \frac{RR_t}{D_t} \qquad [1.1.5]$$

In addition to the basic definitions presented above, the analysis of the money supply process is based on certain behavioral assumptions about the way in which economic agents distribute the additions to their monetary holdings among the existing investment alternatives. The general model of money multiplier is built around the assumption that within each time period the public, commercial banks and the central bank distribute their newly acquired monetary balances among the investment alternatives in fixed proportions. These proportions can be adjusted in the beginning of each new period in response to the non-neutral interventions of the central bank or to shifts in tastes:

The Public - out of every new dollar received in period (t) people deposit a fixed part in the banks (using the rest to acquire cash balances). If the public follows the investment strategy assumed above, at the end of period (t) the ratio between the total change in its cash balances during that period and the corresponding change in the total sum of its monetary holdings will be just equal to the marginal rate of acquisition of bank deposits:

$$\frac{\Delta D_t}{\Delta M_t} = \frac{1}{1+\tilde{cr}_t} \qquad [1.1.6]$$

$\Delta D_t = D_t - D_{t-1}$- total change in bank deposits in period (t)

$\Delta M_t = M_t - M_{t-1}$ - total change in the money supply in period (t)

Where,

$$\tilde{cr}_t = \frac{\Delta Cp_t}{\Delta D_t} \qquad [1.1.7]$$

$\Delta Cp_t = Cp_t - Cp_{t-1}$ - total change in cash balances in period (t)

$\tilde{cr}_t = const.$ - desired proportion between the newly accumulated cash balances and bank deposits

The time subscripts in the above expressions indicate that across periods people can change the rate, at which they accumulate assets out of their new monetary holdings.

<u>Commercial Banks</u> - out of every new dollar received as deposits in period (t), banks keep a fixed part in the form of excess reserves. If banks follow the investment strategy assumed above, at the end of period (t) the ratio between the total change of their excess reserves and the amount of newly attracted deposits will be equal to the marginal rate of excess reserves accumulation:

$$\tilde{er}_t = \frac{\Delta ER_t}{\Delta D_t} \qquad [1.1.8]$$

$\tilde{er}_t = const.$ - desired proportion between the newly accumulated excess reserves and bank deposits in period (t)

$\Delta ER_t = ER_t - ER_{t-1}$ - total change in the excess reserves in period (t)

Parallel to the discussion of the investment behavior of the public, we assume that banks can adjust the rate of accumulation of excess reserves over time.

<u>The Central Bank</u> - in the beginning of each period the central bank sets the value of the reserve requirement ratio effective throughout the whole period:

$$\tilde{rr}_t = \frac{\Delta RR_t}{\Delta D_t} \qquad [1.1.9]$$

$\tilde{rr}_t = const.$ - reserve requirement ratio

$\Delta RR_t = RR_t - RR_{t-1}$ - total change in the required reserves during period (t)

Within the framework presented above, the average money multiplier is defined as the ratio between the end-of-period values of the money supply and monetary base. To arrive at its formula, we divide [1.1.1] by [1.1.2] and express[8] the right-hand side variables in terms of ratios [1.1.3] through [1.1.5]:

$$m_t^{av} \equiv \frac{M_t}{B_t} \qquad [1.1.10]$$

$$m_t^{av} \equiv \frac{1+cr_t}{cr_t + rr_t + er_t} \text{ , where} \qquad [1.1.11]$$

m_t^{av} - the average money multiplier in period t

The economic interpretation of the average money multiplier is that it measures on average how many units of the money supply are supported by one unit of base money. The formula of the average money multiplier is a tautology, constructed from the definitions of monetary aggregates. As such, it can not provide any additional insights on the process, that brings into existence the observed multiplication of the quantity of base money in the economy.

The marginal money multiplier is defined as the ratio between the observed change in the money supply and the corresponding change in the monetary base:

$$m_t^{mg} \equiv \frac{\Delta M}{\Delta B} \qquad [1.1.12]$$

m_t^{mg} - the marginal money multiplier in period (t)

$\Delta M \equiv M_t - M_{t-1}$

$\Delta B \equiv B_t - B_{t-1}$

Where,

ΔM - observed change in the money supply in period (t)

M_{t-1} - the value of the money supply at the end of period (t-1)

ΔB - observed change in the monetary base in period (t)

B_{t-1} - the value of the monetary base at the end of period (t-1)

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8 $m_t^{av} = \frac{Cp_t + D_t}{Cp_t + RR_t + ER_t} \cdot \frac{D_t}{D_t} = \frac{\frac{Cp_t}{D_t} + 1}{\frac{Cp_t}{D_t} + \frac{RR_t}{D_t} + \frac{ER_t}{D_t}} = \frac{1 + cr_t}{cr_t + rr_t + er_t}$

To express the formula of marginal money multiplier in terms of the constant marginal proportions [1.1.7] through [1.1.9], we first decompose the changes in the money supply and monetary base into changes of their components and then simplify[9]:

$$m_t^{mg} = \frac{1 + \tilde{cr}_t}{\tilde{cr}_t + \tilde{rr}_t + \tilde{er}_t} \qquad [1.1.13]$$

The marginal money multiplier measures the number of units of the money supply, created by increments to the quantity of base money. Its value remains constant within a given period (all ratios entering the right hand side of equation [1.1.13] are constant) but can vary across periods, as economic agents adjust their portfolio preferences. The importance of the marginal money multiplier stems from the fact, that for the purposes of monetary targeting, it is the correct prediction of its value, that determines the success of the monetary policies pursued by the central bank.

In contrast to the average money multiplier, the marginal money multiplier is not simply a tautological expression. It is a quantitative measure of the impact of the process of multiple deposit creation[10] on the quantity of money in the economy (for a formal proof of this statement see Appendix 1). The term "multiple deposit creation" refers to the following well-known facts "...(1) that with fractional reserve banking cash deposits produce excess reserves, (2) that such excess reserves lead to loans, and (3) that the proceeds of the loans when redeposited in the system augment the volume of deposits per dollar of cash base" (Humphrey, 1987, p.5). Therefore, whenever the central bank increases the quantity of banknotes in circulation or replenishes commercial banks' reserves, the quantity of money in the economy expands by the multiple [1.1.13] of this intervention.

An alternative representation of the formula of the marginal money multiplier can be constructed by taking into account the fact that money can only be created by the central and commercial banks. Hence, each addition to the quantity of money in the economy can be attributed to a corresponding increase in commercial bank lending or central bank lending or both (see Appendix 1):

$$\Delta M_t = \Delta B_t + \Delta L_t \text{ , where} \qquad [A.4]$$

ΔL_t - net change in the stock of bank credit in period (t)

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[9] $m_t^{mg} \equiv \frac{\Delta Cp + \Delta D}{\Delta Cp + \Delta RR + \Delta ER} \cdot \frac{\Delta D}{\Delta D} = \frac{1 + \frac{\Delta Cp}{\Delta D}}{\frac{\Delta Cp}{\Delta D} + \frac{\Delta RR}{\Delta D} + \frac{\Delta ER}{\Delta D}}$

[10] For an excellent review of the historical evolution of this concept see Humphrey (1987). For a detailed exposition of the process of multiple deposit creation and its influence on the money supply process refer to Visser (1974, p.54)

ΔB_t - total change in the monetary base in period (t)

"Monetary control, therefore, must be implemented through operating on the lending activities of both the central bank and the commercial banks. If the money supply is to be expanded there must be more lending at both levels, and if there is to be contraction, there must be less lending." (Simmons, 1947, p. 634). Equation [A.4] can now be substituted in the definition of the marginal money multiplier to arrive at its alternative mathematical representation:

$$m_t^{mg} \equiv \frac{\Delta M_t}{\Delta B_t} = \frac{\Delta B_t + \Delta L_t}{\Delta B_t}$$

$$m_t^{mg} = 1 + \frac{\Delta L_t}{\Delta B_t} \qquad [1.1.14]$$

Central bank's success in targeting the growth of the money supply depends crucially on its ability to predict correctly the value of the marginal money multiplier that will prevail in the period under consideration. If the portfolio preferences of economic agents change little over time[11], the observed value [1.1.13] of the marginal money multiplier in the preceding period may provide a reasonable estimate of its value in the current one. In this case, monetary authorities can effectively control the growth of the money supply by manipulating the size of the monetary base in a given period via indirect instruments of monetary control (such as open market operations and discount lending to commercial banks) and applying the historical value of the marginal multiplier to predict the resulting increase in the quantity of money in the economy. If instead the portfolio preferences of economic agents swing abruptly over short periods of time[12], the future values of the marginal money multiplier can not be extrapolated from its past behavior and the successful conduct of monetary policy requires the adoption of direct instruments of monetary control (such as credit ceilings) for stabilizing the value of the marginal money multiplier.

2.2 The Average and Marginal Money Multipliers in the General and in the Standard Model of Money Multiplier

The relationship between the values of the average and marginal money multipliers in the general model can be established by solving equation [1.1.10] for the money supply in two adjacent periods (t) and (t-1) and taking its difference:

$$\Delta M = B_t \cdot m_t^{av} - B_{t-1} \cdot m_{t-1}^{av}$$

[11] As seems to be the case in most developed countries.

[12] As is often the case in transitional countries in the early stages of their transition to market economies.

To introduce the marginal money multiplier in the formula, we divide both sides of the equation by the change in the monetary base in period (t):

$$\frac{\Delta M}{\Delta B} = \frac{B_t}{\Delta B} \cdot m_t^{av} - \frac{B_{t-1}}{\Delta B} \cdot m_{t-1}^{av}$$

$$m_t^{mg} = \frac{B_t}{\Delta B} \cdot m_t^{av} - \frac{B_{t-1}}{\Delta B} \cdot m_{t-1}^{av} \qquad [1.2.1]$$

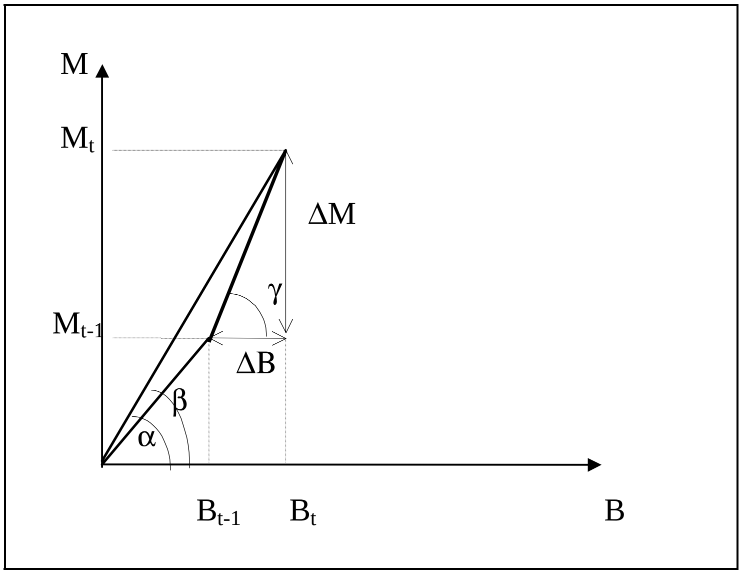
Equation [1.2.1] can now be solved for m_t^{av}. For positive values of the change in the monetary base, the average money multiplier has the interpretation of a weighted average of the corresponding value of the marginal money multiplier and the value of the average money multiplier in the preceding period:

$$m_t^{av} = \xi \cdot m_t^{mg} + (1-\xi) \cdot m_{t-1}^{av} \quad \text{, where} \qquad [1.2.2]$$

$$\xi = \frac{\Delta B}{B_t} \quad \text{and} \quad (1-\xi) = \frac{B_{t-1}}{B_t}$$

If the stock of money in the beginning of period (t) is some multiple of the size of the monetary base and throughout the period the money supply increases at a constant rate (relative to the increase in monetary base) different from this multiple, then the end-of-period ratio between the stocks of the money supply and monetary base should take a value between these two numbers. The weights in equation [1.2.2] then capture the relative importance of the two components of the monetary base (its value at the end of the previous period and the change in the current one), that have affected the quantity of money in the economy through the values of the two different multipliers. The connection between the intertemporal values of the average and marginal money multipliers is graphically presented in Figure 1. In it the tangents of angles α and β are equal to the values taken by the average money multiplier in two adjacent periods. The tangent of angle γ represents the value of the marginal money multiplier in the current period.

Figure 1. The Average and Marginal Money Multipliers in the General Model



Next, we show that the standard model of money multiplier is a special case of the general one, that is based on more stringent behavioral assumptions. The most important characteristics and policy implications of the standard model of money multiplier are elegantly summarized in the following paragraph taken from Robert H. Rasche's paper "Monetary Policy and the Money Supply Process", in Fratianni, Michele and Salvatore, Dominick "Monetary Policy in Developed Countries, Handbook of Comparative Economic Policies, Vol. 3, 1993:

> "Over an extended period of time, an economic theory of the behavior of individual depository institutions and the public developed, which hypothesizes that the marginal impact of a unit change in base money is measured by the size of the average money multiplier. The important elements of this theory are (1) individual depository institutions have optimal (or desired) fractions of transactions deposit liabilities that they wish to hold as deposits at the central bank, (2) individual nonfinancial economic agents have optimal (desired) currency-transactions deposits ratios, (3) all economic agents can maintain their actual portfolio shares equal to their desired portfolio shares, (4) changes in the stock of base money do not substantially affect the determinants of the optimal portfolio shares, and (5) the demand for loans from depository institutions is not perfectly inelastic." (Rasche, 1993, p.31)

In other words, the standard model of money multiplier is based on the idea that economic agents allocate their monetary balances according to an exogenously determined and invariant over time set of portfolio preferences. Therefore, if at the end of period (t-1) the structure of economic agents' portfolios complies with these preferences, in the next period they will try to preserve the relative shares of the various assets by investing the additions to their monetary holdings in proportions equal to the ratio between the stocks of these assets at the end of period (t-1):

$$\frac{\Delta Cp_t}{\Delta D_t} = \frac{Cp_{t-1}}{D_{t-1}}; \qquad \frac{\Delta ER_t}{\Delta D_t} = \frac{ER_{t-1}}{D_{t-1}}; \qquad \frac{\Delta RR}{\Delta D} = \frac{RR_{t-1}}{D_{t-1}} \qquad [1.2.3]$$

If economic agents always stick to the investment strategy assumed above, at the end of each time period they will possess currency and reserves in exactly the same proportions to the stock of bank deposits, as they did in all preceding periods[13]:

$$\frac{Cp_t}{D_t} = \frac{Cp_{t-j}}{D_{t-j}}; \qquad \frac{ER_t}{D_t} = \frac{ER_{t-j}}{D_{t-j}}; \qquad \frac{RR_t}{D_t} = \frac{RR_{t-j}}{D_{t-j}} \quad , \forall_j \qquad [1.2.4]$$

With the help of equations [1.2.3] and [1.2.4] we can establish the following relations between the intertemporal values of the marginal and average money multipliers in the standard model:

- the value of the marginal money multiplier in a given period is equal to the value of the average money multiplier in the preceding one:

$$m_t^{mg} = m_{t-1}^{av} \qquad [1.2.5]$$

- the value of the average money multiplier across periods remains constant:

$$m_t^{av} = m_{t-1}^{av} \qquad [1.2.6]$$

- the values of the average and marginal money multiplier in a given period are equal and their formulas merge in the well known formula of the money multiplier. This fact is established by substituting expression [1.2.6] in [1.2.5]:

$$m_t^{mg} = m_t^{av} = m$$

$$m = \frac{1+cr}{cr+rr+er} \qquad [1.2.7]$$

m - the money multiplier in the standard model

Figure 2 presents graphically the connection between the intertemporal and intratemporal values of the two multipliers in the standard model. The tangent of angle α represents both the values taken by the average money multiplier in two adjacent periods and the value of the marginal money multiplier in the current period.

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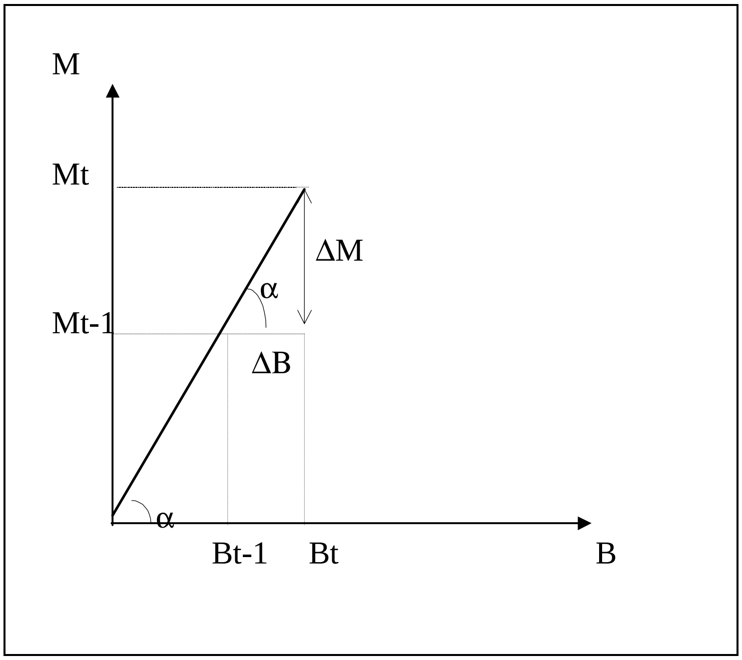
13 $\frac{\Delta Cp_t}{\Delta D_t} = \frac{Cp_{t-1}}{D_{t-1}}$ <=> $\frac{Cp_t - Cp_{t-1}}{D_t - D_{t-1}} = \frac{Cp_{t-1}}{D_{t-1}}$ <=> $\frac{Cp_t}{D_t} = \frac{Cp_{t-1}}{D_{t-1}}$ for all t

Figure 2. The Average and Marginal Money Multipliers in the Standard Model



The main conclusion of the standard model is that for the purposes of monetary forecasting, the historical values of the average money multiplier constitute a reasonably accurate estimate of the magnitude of the incremental effect of changes in the monetary base on the quantity of money in the current period.

The applicability of the standard model of money multiplier in a given country depends on the realism of its building assumptions. On theoretical grounds, the standard model can be used in the conduct of monetary policies in countries, in which the preferences of economic agents are invariant over time and in which monetary authorities use only indirect instruments of monetary control to affect the size of the monetary base. Below, we develop a statistical procedure for testing the applicability of the standard model of money multiplier in a given country. The test is based on the implied connection [1.2.6] between the intertemporal values of the average money multiplier in this model. If the standard model of money multiplier constitutes a reasonable approximation of the processes generating the data of monetary in a given country, the observed values of the average money multiplier in two adjacent periods should be equal:

$$m_t^{av} = m_{t-1}^{av} \qquad [1.2.6]$$

We can now apply expectation operators to both sides of the above expression, taken in period (t-1):

$$E_{t-1}\left(m_t^{av}\right) = E_{t-1}\left(m_{t-1}^{av}\right)$$

$$E_{t-1}\left(m_t^{av}\right) = m_{t-1}^{av} \qquad [1.2.9]$$

Equation [1.2.9] states that given the information set available in period (t-1), the best forecast of the future values of the average money multiplier is its contemporaneous value. Therefore, the difference between the observed value of the average money multiplier in period (t) and its optimal forecast [1.2.9] according to the standard model should be a white noise:

$$m_t^{av} - E_{t-1}\left(m_t^{av}\right) = \varepsilon_t$$

$$m_t^{av} = m_{t-1}^{av} + \varepsilon_t \qquad [1.2.10]$$

$$\varepsilon_t \ \text{ i.i.d. } N(0, \sigma^2)$$

The formal test of the applicability of the standard model of money multiplier in a given country can then be conducted in two alternative ways:

Estimation of regression [1.2.10] and test of the null hypothesis that the average money multiplier follows a random walk (the coefficient before its lagged value is unity and that the residual is a white noise). If for a given confidence level (95%) we accept H_0, then the standard model is a good approximation of the processes generating the data of the average money multiplier in this country

Test of the null hypothesis that the average money multiplier follows an unit-root process. If for a given confidence level (95%) we accept H_0 using the Augmented Dickey-Fuller and the Phillips-Perron Unit-Root Tests, the conclusion is that the standard model approximates well the processes generating the data of the average money multiplier.

2.3 Foreign Currency Denominated Assets and the Money Supply Process

The task of determining whether foreign currency denominated assets should be included in the official definitions of the money supply and the monetary base is significantly complicated by the lack of consensus in the economic literature, both on the definition of money and the set of criteria for establishing the "moneyness" of the various financial instruments. Below, we provide quick summary of the existing methodologies, as summarized in Georgio (1991) in two major categories: descriptive and prescriptive ones.

Two of the descriptive a priori approaches emphasize a particular function of money as the defining criterion of the moneyness of financial instruments. Among the most commonly used characteristics of money are its medium of exchange and liquidity functions. Only financial instruments that possess the designated by the researcher property can be included in the definition of monetary aggregates. Unfortunately, a broadly accepted empirical formulation of these theoretical concepts does not exist and consequently the use of these approaches in designing different measures of money does not result in clear cut results. Another technique that falls in this category is the so called empirical definition of money. According to it, depending on the particular relationship of interest to the scholar between the money supply and other macroeconomic variables different sets of financial assets can be included in the definition of money. The ultimate goal is to arrive at a monetary aggregate exhibiting a stable and predictable relationship with the respective macroeconomic variable. The weak point of the empirical approach is its lack of theoretical rationalization of the derived regularity, which deprives the economic models based on it of academic rigor.

The prescriptive approach emphasizes not only the existence of a stable and predictable relationship between the set of financial instruments termed money and a given macroeconomic parameter, but in addition requires these assets to be under the direct control of monetary authorities. A major drawback of this technique is that the search for assets that comply simultaneously with these divergent criteria, often results in an amputated versions of the appropriate monetary aggregate.

Overall, the decision of whether to include foreign currency denominated assets in the definitions of domestic monetary aggregates in a given country depends crucially on the institutional arrangements governing the role of these assets in the circular flows of goods and money in the economy. In transitional countries, the carrying out of transactions between domestic residents in foreign-currency is in most cases prohibited but at the same time there are few restrictions on the size and accessibility of foreign currency deposits (FCDs) held by individuals. Under such institutional setting, it is clear that foreign currency assets can not serve as a medium of exchange but they can be used as a temporary abode of purchasing power. Furthermore, under the empirical definition of money FCDs should become part of the money supply, because "...it is possible to argue that in periods of high inflation a measure of the money that includes FCDs would have a more stable relationship with nominal GNP than a measure of money that does not include FCDs." (Andreas Georgio (1991)). Despite this argument, the inclusion of FCDs in monetary statistics is not supported by the prescriptive approach because monetary authorities can hardly execute any control over the domestic currency value of FCDs. In contrast with the theoretical ambiguity of this issue, in practice FCDs are almost unanimously included in the official definitions of money supply in transitional countries.

This paper advances the view that if the goal of monetary analysis is the projection of the marginal money multiplier under different regulatory regimes, the inclusion of FCDs and other foreign assets in domestic monetary aggregates is unwarranted and potentially misleading. The marginal money multiplier is not just a tautological expression formed by dividing the changes in the money supply and monetary base for a given period. Its formula reflects the structure and the workings of the multiple deposit creation process, that brings into existence the observed multiplication of money (see Appendix 1). Therefore, only items that in fact undergo this process should enter in the denominator of the marginal money multiplier and only items created as a result of the deposit multiplication should appear in its numerator. Foreign currency deposits do not undergo the process of domestic multiple deposit creation and therefore neither they nor banks' reserves in FC should be included in the definitions of the money supply and monetary base respectively.

To prove that FCDs do not participate in the process of domestic money creation, we start with the fact that in general the public is not allowed to carry domestic transactions with foreign currency. Thus, the recipients of credits in foreign currency can use these resources only for engaging in importing activities or investing abroad. This means that whenever banks extend part of the accepted FCDs as credits in foreign currency, these resources exit the country and return only in the form of either merchandise or services. It is evident that the latter could not take part in the multiple deposit creation in the domestic economy, whereas the foreign currency used for obtaining them certainly enters the similar cycle in the foreign country. Therefore, FCDs can not be included in the definition of money used for the derivation of the formula of the marginal money multiplier. Of course this doesn't mean that the institutional regulations governing the use of FCDs in transitional countries and Bulgaria in particular do not affect indirectly the working of the multiple deposit creation process. As we will see in Section 3.3 the ability of central banks to determine what percentage of the required reserves against FCDs should be held in domestic currency units has a profound effect on commercial banks' liquidity and their portfolio decisions. Nevertheless, the analysis of these effects should be carried out with the definitions of the money supply and monetary base that are consistent with the nature of the multiple deposit creation process.

2.4 THE MONEY SUPPLY PROCESS UNDER THE REGIMES OF TOTAL AND PARTIAL CREDIT CEILINGS

The imposition of credit ceilings on the rate of growth of different components of domestic credit has long been used as a stabilization measure in countries, in which the lack of financial discipline and well developed financial markets has driven the growth of monetary aggregates beyond the control of central banks. Different forms of asset quotas are also frequently implemented in International Monetary Fund-supported adjustment programs in developing and transitional countries. In this Section we examine the influence of credit ceilings on the value of the marginal money multiplier in transitional economies. Credit ceilings constitute legal restrictions on the rate of growth of pre-specified types of bank assets. As such, they can be viewed as direct instruments for achieving the structure of commercial banks' portfolio, that facilitates best the monetary goals of the central bank. In that sense, credit ceilings are inherently non-neutral in respect to portfolio preferences of economic agents and their influence on money creation can only be analyzed within the framework of the general model.

A credit ceiling is the maximum allowed percentage increase of the stock of pre-specified types of bank assets for a given period. Its value is usually set in reference to the stock of the controlled assets at the end of some base period. In mathematical notation we can define credit ceilings in the following manner:

$$cc_t = \frac{\Delta L_t^{\ *}}{L_{t-1}} \cdot 100 \qquad [1.4.1]$$

cc_t - the value of the credit ceiling in period (t) in percents

ΔL_t^* - the maximum allowed net increase of the stock of the controlled assets in period (t)

L_{t-1} - the reference value of the stock of controlled assets at the end of the base period (t)

In general, the various types of quotas on the earning assets of commercial banks can be classified in two major subcategories: total and partial credit ceilings. Total credit ceilings are in place when the central bank imposes limits on the rate of growth of all financial assets, that participate in the process of money creation. In our treatment of the multiple deposit creation process, that brings into existence the marginal money multiplier (see Appendix 1), we assumed that the only actively acquired asset by banks are the credits in domestic currency to the rest of the economy (*L*). In what follows, we retain this assumption noting that the imposition of a credit ceiling on the only asset that banks possess is a stylized way to model a regime of total credit ceilings. The economic theory behind the use of this type of direct monetary control is condensed in equation [A.4], which shows the connection between the growth of money supply and the domestic credit expansion:

$$\Delta M_t = \Delta B_t + \Delta L_t \quad \text{, where} \qquad [A.4]$$

ΔL_t - net change in the stock of bank credit in period (t)

ΔB_t - total change in the monetary base in period (t)

By imposing a limit on the amount of loans banks can legally extend, the central bank gains full control over the growth of money supply. From one hand, monetary authorities possess the ability to determine the changes in the quantity of high-powered money, and from the other, with the help of the credit ceilings they can directly command the size of the domestic credit expansion. To derive the formula of the marginal money multiplier under the total credit ceilings, we recall that in the general model the marginal multiplier can be expressed in terms of the domestic credit expansion and central bank's interventions in period (t):

$$m_t^{mg} = 1 + \frac{\Delta L}{\Delta B} \qquad [1.1.14]$$

If total credit ceilings are credibly enforced by the central bank, at the end of period (t) the total increase of the stock of domestic credit will be less than or equal to the absolute value of the credit ceiling for that period:

$$\Delta L_t \le \Delta L_t^*$$

The imposition of credit restrictions makes sense only if they force banks to lend less than otherwise desired. In this case, the profit-maximizing behavior of banks will result in complete utilization of the absolute value of the credit ceiling and thus the above expression can be written as an equality and then substituted for the absolute value of the credit ceiling in equation [1.4.1]:

$$\Delta L_t = cc_t \cdot \frac{L_{t-1}}{100} \qquad [1.4.2]$$

The formula of the marginal money multiplier under the regime of total credit ceilings is then obtained by substituting [1.4.2] for the value of the domestic credit expansion (ΔL) in the general formula of the marginal multiplier [1.1.14]:

$$m_t^{mgT} = 1 + \frac{L_{t-1}}{\Delta B_t \cdot 100} \cdot cc_t \qquad [1.4.3]$$

m_t^{mgT} - marginal money multiplier under the regime of total credit ceilings

All right-hand side variables in equation [1.4.3] are known to the central bank before the beginning of period (t). Thus, under the regime of total credit ceilings the central bank can exercise full control over the money supply process, commanding both the size of its own interventions and the rate at which the evoked increases in base money translate into multiple increase in the quantity of money in the economy. The imposition of total credit ceilings result in stabilization and predetermination of the values assumed by the marginal money multiplier.

Under the regime of partial credit ceilings, the acquisition of only selected types of banks' assets is under regulatory control. The banks are allowed to invest freely in the remaining unregulated assets. When the restricted and the unregulated assets in commercial banks' portfolio are perfect substitutes, the imposition of partial credit ceiling automatically leads to a higher demand for the unregulated assets. If the latter facilitate the process of multiple deposit creation discussed in Appendix 1, the imposition of partial credit restrictions will have no effect on money supply. It will change the channels through which money are created but not the size of the resulting pool. On the contrary, if the two types of assets are characterized by perfect non-substitutability, no leakages of funds through untapped channels occur and the partial credit ceilings produce outcome equivalent to the one, achieved under the regime of total credit restrictions:

$$m_t^{mgP} = m_t^{mgT} \quad \text{, where} \qquad [1.4.4]$$

m_t^{mgP} - marginal money multiplier under a partial regime of credit ceilings combined with perfect non-substitutability of bank assets

If instead there exists some degree of substitutability between the restricted and unregulated assets and the latter also participate in the process of money creation, then the value of the marginal money multiplier under the regime of partial credit restrictions will be higher than the value given by [1.4.4]:

$$m_t^{mgP} > m_t^{mgT} \qquad [1.4.5]$$

Equations [1.4.4] and [1.4.5] can be used in the design of a statistical procedure for testing the effectiveness of any kind of partial credit ceilings in limiting the growth of money supply, relative to the results obtained under total credit restrictions. Under the null hypothesis that the partial credit ceilings are as effective as the total ones for the purposes of monetary control, the expected value in period (t-1) of the marginal money multiplier in period (t) in the presence of partial credit restrictions is equal to its theoretical value under the regime of total credit ceilings (see[1.4.4]):

$$E_{t-1}\left(m_t^{mgP}\right) = E_{t-1}\left(m_t^{mgT}\right)$$

Therefore, under the null hypothesis H_o, the difference between the observed value of the marginal money multiplier in period (t) and its optimal forecast, given the information set at period (t-1) is a white noise:

$$m_t^{mgP} - \left(1 + \frac{L_{t-1}}{\Delta B_t \cdot 100} \cdot cc_t\right) = \varepsilon_t$$

$$m_t^{mgP} = \left(1 + \frac{L_{t-1}}{\Delta B_t \cdot 100} \cdot cc_t\right) + \varepsilon_t \qquad [1.4.6]$$

$$\varepsilon_t \sim \text{ i.i.d. } N\left(0, \sigma^2\right)$$

In deriving equation [1.4.6], we use the already established fact that under the regime of total credit restrictions, all information required for the deterministic projection of the value of marginal money multiplier in period (t) is in the information set, available to monetary authorities in period (t-1) (see [1.4.3]).

The test of the effectiveness of partial credit ceilings in limiting the growth of money supply, can then be conducted by estimating regression [1.4.6] and testing the null hypothesis that $\hat{\varepsilon}_t$ is a white noise and that the coefficient before $\left(1 + \frac{L_{t-1}}{\Delta B_t \cdot 100} \cdot cc_t\right)$ is equal to unity. If for a given confidence level (95%) we can not reject H_0, the conclusion is that partial credit ceilings are as effective in limiting the growth of money supply as the total ones.

Alternatively, if we are unable to accept H_0, the difference between the values of the marginal money multiplier under partial and the hypothesized regime of total credit ceilings is non-stochastic and indicates the degree of substitution between the controlled and unregulated banks' assets that takes place. To determine which assets are most widely used as substitutes for the regulated ones, we can regress the difference between the observed values of the marginal money multiplier under the partial credit ceilings and its benchmark values, that would have prevailed under total credit restrictions, on an index of the size of any given unregulated asset in commercial banks' portfolio and check for positive correlation and whether the estimated residuals are realizations of a white noise process. In case of affirmative results, the conclusion is that the existing gap between the observed and the benchmark values of the marginal money multiplier is driven in part by the rising share of this particular asset in banks' portfolio.

3. Empirical Evaluation of the Effectiveness of Selective Credit Controls in the Monetary Policy in Bulgaria

In the empirical part of the paper, we evaluate the effectiveness of the quotas on the earning assets of commercial banks, used by monetary authorities in Bulgaria to limit the growth of monetary aggregates. We start in Section 2.1 with a detailed description of the data set used in the regression analysis performed in latter sections. In Section 2.2 we test the hypothesis that the standard model of money multiplier constitutes a reasonable approximation of the processes generating the data of monetary aggregates in Bulgaria. Section 2.3 examines the effectiveness of the partial credit ceilings implemented in Bulgaria between 01/1991 and 06/1994 in limiting domestic money creation.

3.1 Description of the Data

Table 1 presents sample monthly data on monetary aggregates in Bulgaria. In the regression analysis conducted in this paper, we use definitions of the money supply and monetary base that include only items denominated in domestic currency units. The reasons for this are put forth in Section 1.3, in which we show that foreign currency components of monetary aggregates do not participate in the process of multiple deposit creation and hence should not be used in the calculation of the marginal money multiplier.

The values of the domestic-currency component of the money supply are extracted from the broad definition of the money supply in Bulgaria, by subtracting the domestic currency value of FCDs from the total. The resulting time serie is denoted by (***M***) and shown in raw 2 of the table.

The calculation of the domestic-currency component of monetary base in Bulgaria is considerably more complicated, because of the fact that BNB does not provide disaggregated data on its sub-categories. Official monetary statistics provide data only on the total value of monetary base, which includes the currency outside banks, required and excess reserves in domestic currency and the domestic-currency equivalent of the required and excess reserves held in foreign currency. To estimate the domestic-currency component of the monetary base, we first have to impute and then subtract the values of the last two sub-categories from the total value of the monetary base. We perform this task by adopting additional assumptions about the way banks allocate their resources.

Table 1. Domestic Currency Components of Monetary Aggregates in Bulgaria

/millions leva/

Abb.	**Parameters/Months**	**01.96**	**02.96**	**03.96**	**04.96**	**05.96**	**06.96**
	Money supply (M2)	563674	569963	570067	590320	667840	675140
Mt	**A. Domestic currency component of M2**	408952	416374	415353	420377	428934	435495
	A.1 Cash outside banks	56038	57723	57262	60175	65799	70257
Dt	A.2 Total deposits	352914	358651	358091	360202	363135	365238
	A.2.1 Demand deposits	37380	38058	35749	36103	37494	42108
	A.2.2 Time deposits	258534	263625	266137	268171	270424	268541
	A.2.3 Savings deposits	57000	56968	56205	55928	55217	54589
FCDs	B. Foreign currency deposits	154722	153589	154714	169943	238906	239645
	Monetary base	114111	112348	111083	112693	115956	129907
ER	A.Total excess reserves	9848	11085	10233	7456	-1016	-838
RR	B. Total required reserves	253818	256120	256402.5	265072.5	301020.5	302441.5
Bt	**DC component of Monetary base**	103760	102497	101420	103080	106206	118257
rr	**Required reserves/deposits ratio**	0.095	0.085	0.085	0.085	0.085	0.1
er	**Excess reserves/deposits ratio**	0.019	0.022	0.020	0.014	-0.002	-0.001
g	**% of RR against FCDs held in FC**	0.5	0.5	0.5	0.5	0.5	0.5
mav	**Average money multiplier (Mt/Bt)**	3.94	4.06	4.10	4.08	4.04	3.68

DC - domestic currency
FC - foreign currency

Source: AECD, BNB

The domestic equivalent of the required reserves held in foreign currency is calculated in two steps. We first multiply the domestic currency equivalent of all foreign-currency deposits (raw 8) by the appropriate reserve requirement ratio[14] (raw 13) to obtain the total value of the required reserves against FCDs. Then we multiply the result by the maximum allowed percentage of these reserves (**g**) that can be maintained in foreign currency (raw 15). The rationale for this is that under the existing regime of reserve regulations in Bulgaria, the central bank sets the upper limit of the percent of the required reserves against FCDs that can be held in foreign-currency. The banks then fully exhaust this limit because of the high foreign-exchange risks associated with the continuous depreciation of the Bulgarian national currency.

[14] In Bulgaria the reserve requirement ratio is the same for both domestic and foreign-currency deposits

The domestic equivalent of the excess reserves held in foreign currency is calculated by imposing an additional assumption about the way, in which banks accumulate their excess reserves. We assume that at the end of each period banks have excess reserves in domestic and foreign currency in equal proportions to the corresponding stocks of deposits (domestic and FCD):

$$er_t = er_t^{\$} \text{ , where} \quad [2.1.1]$$

$$er_t^{\$} = \frac{ER_t^{\$}}{D_t^{\$}} \quad [2.1.2]$$

$er_t^{\$}$ - desired excess reserves to FCDs ratio

$ER_t^{\$}$ - excess reserves held in foreign currency

$D_t^{\$}$ - foreign currency deposits

$$er_t = \frac{ER_t}{D_t} \quad [1.1.4]$$

er_t - excess reserves to domestic deposits ratio

Even though the realism of the above assumption is certainly questionable, compared to the existing alternatives it seems to be theoretically most appealing. Faced with the lack of official disaggregated data, we have to choose among [2.1.1], the assumption that all excess reserves are held in domestic currency or entirely in foreign-currency. The regression analysis in Sections 2.2 and 2.3 is performed with data constructed with the use of [2.1.1]. The latter was chosen over the other alternatives because it allows for the existence of both domestic and foreign-currency denominated excess reserves. The estimation of the regressions with data based on the alternative assumptions, leads to results similar to the ones presented in this paper. To calculate the the excess reserves to FCDs ratio ($er_t^{\$}$), we implement assumption [2.1.1], according to which this ratio equals the ratio between the total excess reserves in the banking sector and the sum of all domestic and foreign-currency deposits:

$$\frac{ER_t + E_t \cdot ER_t^{\$}}{D_t + E_t \cdot D_t^{\$}} = \frac{er_t \cdot D_t + er_t^{\$} \cdot E_t \cdot D_t^{\$}}{D_t + E_t \cdot D_t^{\$}} = \frac{er_t^{\$} \cdot \left(D_t + E_t \cdot D_t^{\$}\right)}{D_t + E_t \cdot D_t^{\$}} = er_t^{\$}$$

Thus, the value of the domestic currency equivalent of the excess reserves held in foreign currency is obtained by multiplying the domestic currency equivalent of FCDs in each period by the calculated ratio ($\boldsymbol{er_t^{\$}}$).

The final step in the derivation of the domestic-currency component of monetary base in Bulgaria is to subtract the imputed values of the domestic currency equivalent of the required and excess reserves held in foreign currency from the total value of the monetary base. The resulting time serie is denoted with (***B***) and shown in raw 12 of Table 1.

The monthly values of the average money multiplier (m_t^{av}), that are used in the econometric analysis in Section 2.2, are then obtained by dividing the end-of-month values of the domestic currency components of the money supply (***M***) and monetary base (***B***).

The econometric analysis of the effectiveness of the partial credit ceilings in monetary policy in Bulgaria conducted in Section 2.3, uses yearly data of the values of the marginal money multiplier under different regulatory regimes. Table 2 presents sample monthly data on the absolute values of the partial credit ceilings and the domestic-currency components of the money supply (***M***) and monetary base (***B***), used in the calculations of the yearly values of the marginal money multiplier.

The absolute value of the credit ceilings for the year prior to (and including) the month in which this measure is calculated, is equal to the sum of the monthly credit ceilings in the past 12 months. The absolute monthly values of credit ceilings are obtained by first dividing the published value of the credit ceiling in percents (cc_t) by 100 and then multiplying the result by the reference value of the stock of domestic credit (L_{t-1}). In Bulgaria, the stock of domestic credit as at the end of the previous calendar year, served as the reference value, on which credit ceilings in the current year were based. This magnitude (raw 9) was estimated from the consolidated balance sheet of commercial banks, published by the Bulgarian National Bank.

To estimate the yearly change in money supply (ΔM) for January, 1993 we take the difference between its stock at the end of this month and its end-of -month value in January, 1992. The yearly change in monetary base (ΔB) is calculated in exactly the same way.

The yearly values of the marginal money multiplier (m_t^{mgP}) under the regime of partial credit ceilings in Bulgaria are then obtained, by dividing the corresponding yearly changes of money supply and monetary base. With the yearly data presented in Table 2 we can also estimate the theoretical value of the marginal money multiplier (m_t^{mgT}), that would have prevailed under a total regime of credit ceilings. To do this we first divide the absolute yearly value of credit ceilings by the yearly change in monetary base and then add one to the resulting expression (see equation [1.1.14]). Finally, in raw 5 we present data on the net claims to general government in domestic currency in Bulgaria. We transform this data into index (12/91=100) (***govndx***) and use it as an approximation for the size of the stock of government securities in commercial banks' portfolios (for which no direct monthly data exists).

Table 2. The Partial Credit Ceilings and the Marginal Money Multiplier in Bulgaria

Abb.	Parameters/Month	01'92	02'92	03'92	04'92	05'92	06'92	07'92	08'92	09'92	10'92	11'92	12'92
M_t	DC component of Money supply	70634	72707	75867	76721	79946	84426	89210	96294	100326	101749	102722	117459
ΔM_t	Yearly change in Money Supply												
B_t	DC component of Monetary base	23155	24229	24206	25362	25920	27147	28350	32146	32759	33544	32603	37962
ΔB_t	Yearly change in Monetary base												
	Net claims to government in leva	15596	17915	17063	15908	15995	17257	19480	22363	24407	26943	27678	34250
govndx	Index net claims to government 12/91=100	96	110	105	98	99	106	120	138	150	166	171	211
cc_t	Monthly credit ceilings in percents	2.33	2.33	2.33	1.50	1.50	2.00	3.00	3.00	3.00	3.00	3.00	2.00
L_{t-1}	Reference value of stock of domestic credit	60077	60077	60077	60077	60077	60077	60077	60077	60077	60077	60077	60077
$cc_t.L_{t-1}$	Absolute monthly credit ceilngs	1402	1402	1402	901	901	1202	1802	1802	1802	1802	1802	1202
	Absolute yearly credit ceilngs												
m_{mgP}	Yearly marg. money mult. under partial cc												
m_{mgT}	Yearly marg. money mult. under total cc												

Abb.	Parameters/Month	01'93	02'93	03'93	04'93	05'93	06'93	07'93	08'93	09'93	10'93	11'93	12'93
M_t	DC component of Money supply	118129	121392	125735	131549	136899	145092	153729	159589	165772	167978	169447	186318
ΔM_t	Yearly change in Money Supply	47495	48685	49868	54828	56953	60666	64519	63295	65446	66229	66725	68859
B_t	DC component of Monetary base	41406	38341	37717	41000	41978	41688	43381	45486	45662	45713	45586	49869
ΔB_t	Yearly change in Monetary base	18251	14112	13511	15638	16058	14540	15031	13340	12903	12169	12983	11907
	Net claims to government in leva	36515	40231	43056	45853	48315	50114	56985	59386	62953	68847	73226	103137
govndx	Index net claims to government 12/91=100	225	248	265	282	298	309	351	366	388	424	451	635
cc_t	Monthly credit ceiling in percents	2.00	3.00	3.00	2.00	2.00	2.00	2.00	1.50	1.50	1.00	1.00	1.00
L_{t-1}	Reference value of stock of domestic credit	80582	80582	80582	80582	80582	80582	80582	80582	80582	80582	80582	80582
$cc_t.L_{t-1}$	Absolute monthly credit ceilngs	1612	2417	2417	1612	1612	1612	1612	1209	1209	806	806	806
	Absolute yearly credit ceilngs	17632	18648	19664	20374	21084	21495	21304	20710	20117	19120	18124	17728
m_{mgP}	Yearly marg. money mult. under partial cc	2.60	3.45	3.69	3.51	3.55	4.17	4.29	4.74	5.07	5.44	5.14	5.78
m_{mgT}	Yearly marg. money mult. under total cc	1.97	2.32	2.46	2.30	2.31	2.48	2.42	2.55	2.56	2.57	2.40	2.49

DC - domestic currency
cc - credit ceilings
marg. money mult. - marginal money multiplier

Source: AECD, BNB

3.2 EVALUATION OF THE APPLICABILITY OF THE STANDARD MODEL OF MONEY MULTIPLIER IN BULGARIA

In this Section we implement the statistical procedure developed in Section 1.2 for testing the ability of the standard model of money multiplier to predict correctly the future values of the money multiplier in Bulgaria. This procedure is based on the implied connection between the intertemporal values of the average money multiplier in the standard model:

$$m_t^{av} = m_{t-1}^{av} \qquad [1.2.6]$$

If this model approximates well the processes generating the data of monetary aggregates in Bulgaria, the observed value of the average money multiplier in the preceding period provides an unbiased estimate of its value in the current one:

$$E_{t-1}\left(m_t^{av}\right) = E_{t-1}\left(m_{t-1}^{av}\right)$$

$$m_t^{av} = m_{t-1}^{av} + \varepsilon_t \qquad [1.2.10]$$

$$\varepsilon_t \ \text{ i.i.d. } \ \mathrm{N}(0, \sigma^2)$$

The formal test of the applicability of the standard model of money multiplier in Bulgaria is then conducted with the help of two different econometric techniques:

1. Estimation of regression [1.2.10] with data on the average money multiplier over the period 12/1990 - 01/1997 and test of the null hypothesis that its values follow a random walk (the coefficient before its lagged value is unity and that the residual is a white noise). The results of this regression analysis are presented in the second column of Table 2.

2. Test of the null hypothesis that the average money multiplier follows an unit-root process with the Augmented Dickey-Fuller and the Phillips-Perron Unit-Root Tests.

The results of the conducted econometric analysis are summarized in Table 3, in which the first column lists the independent variables and the most important statistics associated with it.

Table 3. Tests of the Applicability of the Standard Model of Money Multiplier in Bulgaria

Notes: Unless otherwise indicated the numbers in parenthesis are t-statistics

Type of Test	OLS	ADF Unit-Root Test	PP Unit-Root Test
Parameters	m_{av}	Δm_{av}	Δm_{av}
C	**3.61****	yes	yes
	(20.69)		
$m_{av(t-1)}$	**0.87****		
	(22.68)		
Number of lags in unit-root test		0	3
Regression Statistics			
R-squared	0.88		
Durbin-Watson	2.15	2.15	2.15
F-stat. of $\beta(m_{av(t-1)})=1$	12.17		
	(0.0008)^		
Ljung-Box Q-stat. (# of lags - 32)	**20.46**		
	(0.93)^		
ADF Test Statistic	-	-3.49*	-
		(-2.90) '	
PP Test Statistic	-	-	-3.53**
			(-3.52) "

* - significant at 5% confidence level
** - significant at 1% confidence level
^ - Probability Value
' - MacKinnon 5% critical value for rejection of hypothesis of a unit root
" - MacKinnon 1% critical value
ADF - Augmented Dickey-Fuller
PP - Phillips-Perron

Both the Augmented Dickey-Fuller and Phillips-Perron Unit-Root tests strongly reject the null hypothesis of existence of an unit root - the Augmented Dickey-Fuller Unit-Root Test at the 95% and the Phillips-Perron Test at the 99% level of confidence. Furthermore, the Augmented Dickey-Fuller test suggests that the average money multiplier in Bulgaria follows a stationary first-order autoregressive process AR(1). In Column 2 we present the results from the OLS estimation of this process. The coefficient before the lagged value of the average money multiplier is highly significant and the hypothesis that it is equal to one, as postulated by the standard model, is strongly rejected at 99% level of confidence with a standard F-test. The conducted Q-tests on regression residuals support the hypothesis that the latter are realizations of a white noise process, which allows us to conclude that our OLS estimates of the regression coefficients are statistically robust. Therefore, the monthly average money multiplier in Bulgaria follows a stationary first-order autoregressive process with a drift.

Overall, the conducted empirical analysis of the applicability of the standard model of money multiplier in Bulgaria strongly rejects the hypothesis, that the latter can serve as a good theoretical approximation of the nature of money supply process in this country. This robust statistical result serves as an empirical argument in favor of the use of the general model of money multiplier developed in this paper in modeling the process of money creation in countries, that use direct instruments of monetary control for limiting the growth of domestic monetary aggregates.

3.3 Evaluation of the Effectiveness of the Partial Credit Ceilings in Bulgaria

In the period 01/1991 - 06/1994, Bulgarian National Bank enforced periodic bank-by-bank credit ceilings, that set the maximum percentage increase of bank advances in domestic currency to businesses in relation to a certain base period. The other major investment alternatives available to commercial banks - credits in foreign currency and purchases of government securities remained unregulated. In this Section, we evaluate the effectiveness of these credit restrictions in limiting the growth of domestic monetary aggregates. To this end, we implement the analytical techniques and statistical procedures developed in Section 1.4 of the paper. The statistical analysis performed below is based on the theoretical result that if partial credit ceilings are as effective as the total ones, in limiting the growth of monetary aggregates, then the expected value in period (t-1) of the marginal money multiplier in the presence of partial credit restrictions in period (t) is equal to its benchmark value under the regime of total credit ceilings:

$$E_{t-1}\left(m_t^{mgP}\right) = E_{t-1}\left(m_t^{mgT}\right)$$

$$m_t^{mgP} = \left(1 + \frac{L_{t-1}}{\Delta B_t \cdot 100} \cdot cc_t\right) + \varepsilon_t \qquad [1.4.6]$$

$$\varepsilon_t \sim \text{ i.i.d. } \mathrm{N}\left(0, \sigma^2\right)$$

Therefore, under the null hypothesis $\mathrm{H_o}$, the coefficient before $\left(1+\frac{L_{t-1}}{\Delta B_t \cdot 100}\cdot cc_t\right)$ is equal to unity and the regression residuals are realizations of a white noise process. We estimate regression [1.4.6] with the yearly values[15] of the marginal money multiplier under the two policy regimes for the period 02/1992-06/1994. The use of yearly data in the calculation of the marginal money multiplier is justified by its interpretation as a quantitative measure of the impact of the multiple deposit creation process on the money supply. In order to get meaningful estimates of this measure, we have to allow enough time for the process of deposit multiplication to evolve. We have excluded the yearly values of the marginal money multiplier in December, 1991 and January, 1992 from our data set, because their estimated values are negative, which contradicts the theoretical interpretation of the marginal money multiplier in the general model. The results from the estimation of regression [1.4.6] with the absolute observed and benchmark values of the marginal money multiplier in Bulgaria are presented in the second column of Table 4. The first column presents the independent variables used in the econometric analysis and the most important statistics associated with it.

The OLS estimate of the coefficient in front of m_t^{mgT} in the second column is equal to 1.74, but the conducted Ljung-Box Q-statistic tests on the regression residuals show that they are non-stationary and consequently our OLS estimates are unreliable. We then estimate the same regression in first-differences. We get an even higher value of the coefficient in front of Δm_t^{mgT} 2.69, which is statistically significant at the 99 percent level of confidence. The conducted F-test of the restriction on its value implied by the standard model ($\beta(\Delta m_t^{mgT})=1$) strongly rejects it at the 99% confidence level. The Ljung-Box Q-statistic, when computed using the autocorrelations of the estimated residuals up to 23 lags (out of 26 possible), has sufficiently high P-value to allow us to conclude that the residuals are realizations of a white noise process. When the same test is performed by taking into account all possible autocorrelations in the residuals serie though, we can not reject the hypothesis that the regression residuals are non-stochastic. Thus, one should interpret with caution the OLS estimates obtained from this regression. Overall, we find that the estimated coefficient in front of m_t^{mgT} is different than unity, which refutes the hypothesis that the observed and the benchmark values of the marginal money multiplier are of the same magnitude. Furthermore, the plot of their values in Figure 3 suggest that the difference between the observed values of the marginal money multiplier in the presence of partial credit ceilings (m_t^{mgP}) and its benchmark values (m_t^{mgT}), that would have prevailed under the regime of total credit restrictions is non-stationary. The observed values of the marginal money multiplier are always higher than the theoretical ones and the gap between the two is widening over time, which indicates that the leakage of bank funds through channels untapped by the partial credit ceilings in Bulgaria has increased over time.

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[15] For example, the yearly value of the observed marginal money in February, 1992 is calculated by dividing the changes of the money supply and monetary base over the last 12 months (between the end of February, 1991 and the end of February, 1992). For a detailed description of the data set see Section 2.1.

Table 4. Regression Estimates of the Effectiveness of the Partial Credit Ceilings in Bulgaria

Type of Test	OLS	OLS	OLS
Parameters	m_{mgP}	Δm_{mgP}	$m_{mgP}-m_{mgT}$
m_{mgT}	1.74 (16.40)	-	-
Δm_{mgT}	-	**2.69**** (17.18)	-
govndx	-	-	**0.007**** (11.31)
Regression Statistics			
R-squared	0.57	0.92	0.63
Ljung-Box Q-statistic (# of lags 23)		**30.61** (0.13)^	
Ljung-Box Q-statistic (# of lags 26)		47.15 (0.007)^	
Ljung-Box Q-statistic (# of lags 27)	**198.42** (0.0001)^		**11.33** (0.996)^
F-stat. on β(ΔmmgT)=1	-	116.38 (0.0001)^	-

Notes: Unless otherwise indicated the numbers in parenthesis are t-statistics
** - significant at 99% level of confidence
^ - Probability Value

Because commercial banks' holdings of government securities in Bulgaria is their largest domestic-currency denominated asset, which is not subject to any regulatory restrictions, we next test the hypothesis that the rapid growth of commercial banks' holdings of government securities substantially undermined the effectiveness of the partial credit ceilings in Bulgaria. Figure 4 plots the difference between the yearly observed and benchmark values of the marginal money multiplier ($m_t^{mgP} - m_t^{mgT}$) together with the index of the net claims to general government in Bulgaria, which is used as an approximation of the stock of government securities accumulated by commercial banks[16]. The graph provides evidence in support of the view that the two series are interrelated. We can evaluate econometrically the sign and the significance of this relation, by regressing the difference between the observed and benchmark values of the marginal money multiplier on the index of the net claims to general government in Bulgaria with yearly data from 02/1992 to 06/1994. The results of the

[16] In the early stages of transition, commercial banks in Bulgaria were the sole buyer of government debt instruments, which were usually held until maturity.

OLS estimation of this regression are presented in the last column of Table 4. The estimated coefficient in front of the index of the net claims to general government (0,007) is positive and statistically significant at 99% level of confidence. Furthermore, the conducted Q-tests on regression residuals support the hypothesis that they are realizations of a white noise process and hence re-affirm the statistical robustness of our OLS estimates. An one hundred basis points increase in the quantity of outstanding government debt widens the gap between the observed and the benchmark value of the marginal money multiplier in a given period by 0.7. The R^2 of the regression is high, indicating that 63% of the variability in $m^{mgP} - m^{mgT}$ can be attributed to the growth of the net claims to general government, that were predominantly acquired by commercial banks. These results provide robust empirical support for the theoretical argument put forth by Miller (1994) and appearing in Yossifov (1994), that the gradual development of the market for government securities in Bulgaria de-emphasized the role of credit ceilings in controlling money creation and enhanced their importance in redistributing credit flows into the hands of state bureaucrats.

Figure 3. The Observed and the Benchmark Values of the Marginal Money Multiplier in Bulgaria

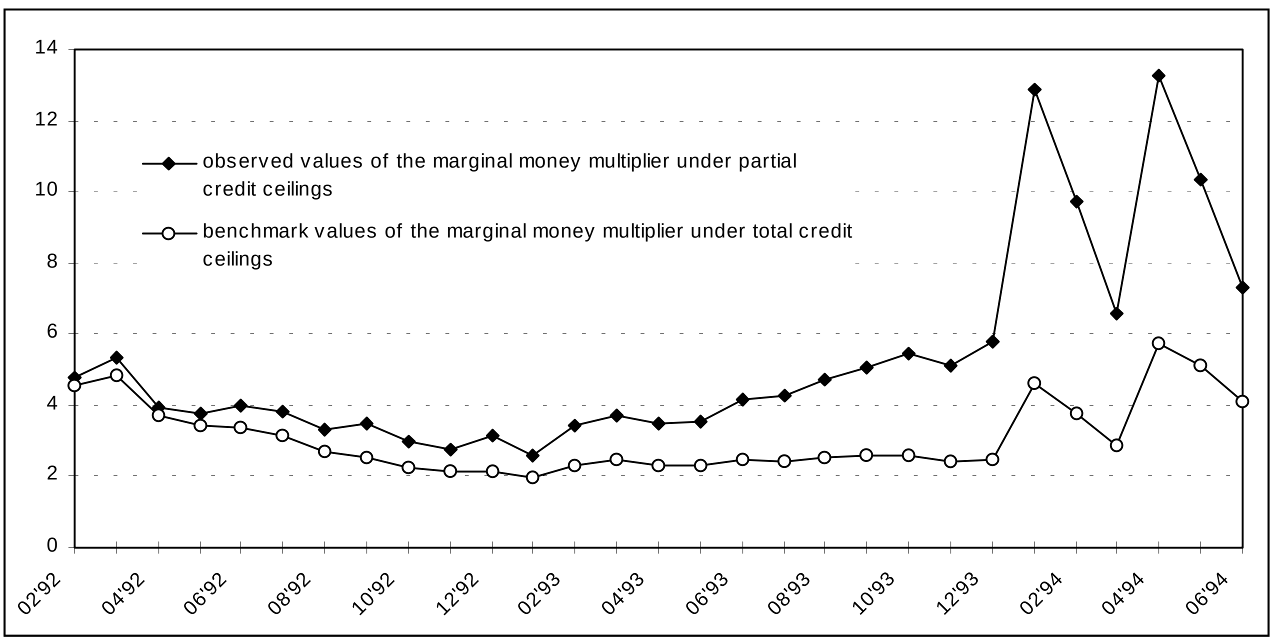
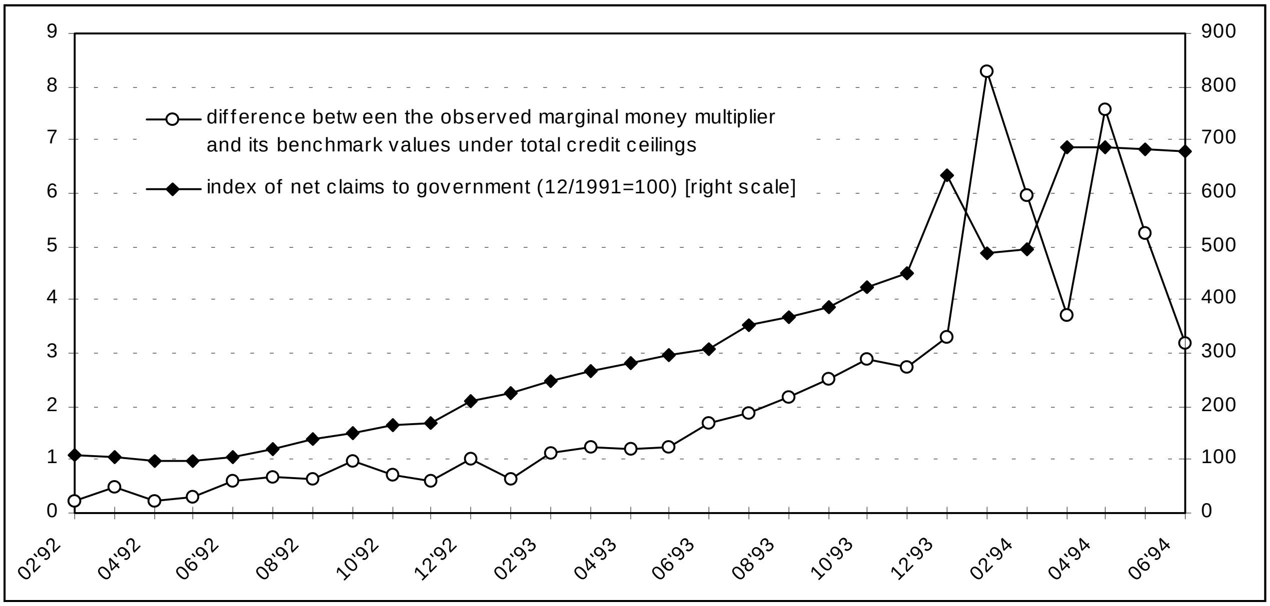


Figure 4. Effectiveness of the Partial Credit Ceilings in Bulgaria and the Growth of the Net Claims to General Government



APPENDIX 1. THE MULTIPLE DEPOSIT CREATION PROCESS AND THE MARGINAL MONEY MULTIPLIER IN THE GENERAL MODEL

The mechanism through which the changes in the monetary base are channeled and magnified into changes of the quantity of money in the economy is called the multiple deposit creation process (for a thorough discussion on this topic see Visser (1974)). In order to formalize this process and derive rigorously the formula of the marginal money multiplier, we need to put more structure in the model and pinpoint the specific role played by each of the three main players in money markets - the central bank, commercial banks and the public.

In analyzing central bank's balance sheet, we assume that the only assets in its portfolio are IOUs from the rest of the economy denominated in domestic currency (DA - domestic assets):

Figure 5. Central Bank's Balance Sheet

A	L
DA	Cp
	RR
	ER

These assets can be divided in two major categories: holdings of government bonds and credits (refinancing) to commercial banks. The liabilities of the central bank are composed of the currency outside banks and bank deposits in the form of required and excess reserves. The assets of the central bank always equal its liabilities (plus the net worth which is surpressed in our analysis) both in absolute terms and as changes:

$$DA_t = Cp_t + RR_t + ER_t$$

$$\Delta DA = \Delta(Cp + RR + ER) \qquad [A.1]$$

The left-hand sides of the above equations are respectively equal to the absolute value and the change in monetary base in period (t). Equation [A.1] implies that the central bank can increase (decrease) the monetary base by expanding (contracting) its credits to the rest of the economy. This can be achieved either through open market operations with government securities or by controlling the availability of refinancing facilities to commercial banks. In both cases the result of central bank's intervention is a single and equal in magnitude change in monetary base. Thus, the total change in monetary base for a given period should be exactly equal to the sum of central bank's interventions.

Next, we examine the balance sheet of the banking sector. Figure 6 presents the consolidated balance sheet of commercial banks in the economy:

Figure 6. Consolidated Balance Sheet of Commercial Banks

A	L
RR	D
ER	
L	

We assume that the only assets of banks, beyond their reserves at the central bank, are IOUs in domestic currency from the rest of the economy (L). The basic accounting identity for the banking sector in period (t) then is:

$$D_t = RR_t + ER_t + L_t$$

The above equation can be used in the formulation of one implicit behavioral assumption of the general model of money multiplier. To derive it explicitly, we first express the above balance identity in terms of changes in banks' assets and liabilities and then divide both sides by the amount of newly attracted deposits in period (t):

$$\Delta D_t = \Delta RR_t + \Delta ER_t + \Delta L_t$$

$$1 = \frac{\Delta RR_t}{\Delta D_t} + \frac{\Delta ER_t}{\Delta D_t} + \frac{\Delta L_t}{\Delta D_t}$$

$$\tilde{lr}_t = 1 - \tilde{rr}_t - \tilde{er}_t \qquad [A.2]$$

Where,

$$\tilde{lr}_t = \frac{\Delta L_t}{\Delta D_t}. \qquad [A.3]$$

$\tilde{lr}_t = const.$ - desired proportion between the newly extended loans and accumulated bank deposits in period (t)

Equation [A.2] states that out of every new dollar received as deposits in period (t), banks extend a fixed part in the form of loans to the rest of the economy. If banks follow the investment strategy assumed above, at the end of period (t) the ratio between the total change in their claims to the rest of the economy and the amount of newly attracted deposits will be equal to the marginal rate at which new credits are extended. The time subscript in expression [A.2] indicates that banks can adjust the rate of credit accumulation out of their new deposits across time periods.

We are now in position to explore all aspects of the complex interaction between the different sectors of the economy, that bring into existence the observed muliplication of money. The analysis starts in the beginning of period (t), when economic agents give values to the marginal rates, at which they will accumulate assets out of their new monetary holdings. The process of multiple deposit creation is then triggered by monetary authorities through a deliberate increase of the size of their liabilities. In what follows, we consider the case in which the latter is achieved through open-market operations with government securities (the alternative way involving the easing of commercial banks' refinancing leads to exactly the same results). The central bank increases monetary base by (ΔB) by purchasing government bonds from the public and paying the sellers by checks of the amount of this transaction. This raises the monetary holdings of the public and invokes the need for allocation of the additional money in its portfolio. A direct implication of behavioral assumption [1.1.6] is that people will keep only part of the newly acquired money in the form of deposits, using the rest to increase their cash holdings.

To determine the initial increase in bank deposits, triggered by central bank's open market puchase, we solve equation [1.1.6] for the change in bank deposits, noting that the first change in the quantity of money is equal to ($\Delta_0 M = \Delta B$):

$$\Delta_1 D = \frac{1}{1+\tilde{cr}} \cdot \Delta_0 M \text{, where } \Delta_0 M = \Delta B$$

Now, the banking system sees its deposit base replenished and it has to decide how to distribute the new resources in its portfolio. Looking back at equations [A.2] and [A.3] we determine that commercial banks will lend only a portion of the newly acquired deposits, using the rest to meet the reserve regulations and amass excess reserves. The total amount of new loans extended by banks at this first stage of the multiple deposit creation process will be equal to:

$$\Delta_1 L = \tilde{lr}_t \cdot \Delta_1 D \text{, where } \Delta_1 D = \frac{1}{1+\tilde{cr}_t} \cdot \Delta B$$

$$\Delta_1 L = \frac{\tilde{lr}_t}{1+\tilde{cr}_t} \cdot \Delta B$$

New money is created by banks when these loans are made. The deposit accounts of the borrowers are honored with the corresponding amount and the money supply rises again ($\Delta_1 M = \Delta_1 L$). This in turn creates a new cycle of portfolio adjustments:

First, the population retains part of the new balances in the form of bank deposits:

$$\Delta_2 D = \frac{1}{1+\tilde{cr}_t} \cdot \Delta_1 M \text{, where } \Delta_1 M = \frac{\tilde{lr}_t}{1+\tilde{cr}_t} \cdot \Delta B$$

$$\Delta_2 D = \frac{\tilde{lr}_t}{\left(1+\tilde{cr}_t\right)^2} \cdot \Delta B$$

New loans will then be extended:

$$\Delta_2 L = \tilde{lr}_t \cdot \Delta_2 D \ \ , \text{ where } \Delta_2 D = \frac{\tilde{lr}_t}{(1+\tilde{cr}_t)^2} \cdot \Delta B$$

$$\Delta_2 L = \left(\frac{\tilde{lr}_t}{1+\tilde{cr}_t} \right)^2 \cdot \Delta B$$

The initial intervention of the central bank has resulted in a multiple increase in the quantity of money. Each successive increment to money supply, except the very first one (which is equal to the initial central bank's intervention), is equal to the amount of the new loans extended by banks during that cycle. Therefore, the n^{th} increase in the money supply ($\Delta_n M = \Delta_n L$) can be concisely written as follows:

$$\Delta_n L = \left(\frac{\tilde{lr}_t}{1+\tilde{cr}_t} \right)^n \cdot \Delta B$$

The total change in the money supply in period (t) is then equal to:

$$\Delta M_t = \Delta_0 M + \Delta_1 M + \Delta_2 \mathrm{M} + \Delta_3 \mathrm{M} + ... + \Delta_{\mathrm{n}} \mathrm{M}$$

$$= \Delta B + \Delta_1 L + \Delta_2 L + ... + \Delta_n L \ \ , \ n \to \infty$$

$$\Delta M_t = \Delta B_t + \Delta L_t \text{ , where} \qquad [A.4]$$

ΔL_t - net change in the stock of bank credit in period (t)

ΔB_t - total change in the monetary base in period (t)

This becomes:

$$\Delta M_t = \Delta B + \frac{\tilde{lr}_t}{1+\tilde{cr}_t} \cdot \Delta B + \left(\frac{\tilde{lr}_t}{1+\tilde{cr}_t} \right)^2 \cdot \Delta B + ... + \left(\frac{\tilde{lr}_t}{1+\tilde{cr}_t} \right)^n \cdot \Delta B \ \ , \ n \to \infty$$

$$\Delta M_t = \sum_{i=0}^{\infty} \left(\frac{\tilde{lr}_t}{1+\tilde{cr}_t} \right)^i \cdot \Delta B$$

The quotient of the constructed geometric serie accepts values between 0 and 1, because its numerator ($\tilde{lr} = 1 - \tilde{rr} - \tilde{er}$) is a positive number smaller than one while its denumerator $(1+\tilde{cr})$ is greater than unity. Thus, we can apply the formula for convergent sum of infinite geometric serie:

$$\Delta M_t = \frac{1}{1-\left(\dfrac{\tilde{lr}_t}{1+\tilde{cr}_t}\right)} \cdot \Delta B_t$$

To arrive at the already familiar representation of the marginal money multiplier, we substitute equation [A.2] for $(\tilde{lr})$ and simplify:

$$\Delta M_t = \frac{1+\tilde{cr}_t}{1+\tilde{cr}_t-\tilde{lr}_t} \cdot \Delta B_t$$

$$\frac{\Delta M_t}{\Delta B_t} = \frac{1+\tilde{cr}_t}{1+\tilde{cr}_t-\left(1-\tilde{rr}_t-\tilde{er}_t\right)} = \frac{1+\tilde{cr}_t}{\tilde{cr}_t+\tilde{rr}_t+\tilde{er}_t}$$

$$m_t^{mg} = \frac{1+\tilde{cr}_t}{\tilde{cr}_t+\tilde{rr}_t+\tilde{er}_t} \qquad [1.1.13]$$

Thus, the formula of the marginal money multiplier is not just a tautological expression, constructed from the accounting identities in the balance sheets of different sectors in the economy. It captures the essence of the real world mechanism, through which the changes in monetary base are channeled and magnified into changes in money supply.

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