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# Keskusteluaiheita
# Discussion papers

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GOVERNMENT DEBT MANAGEMENT AND

THE PRICING OF THE DOMESTIC DEBT

IN FINLAND 1969 - 1977

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# GOVERNMENT DEBT MANAGEMENT AND THE PRICING OF THE DOMESTIC DEBT IN FINLAND 1969-1977

## 1. Introduction

In an economy where high priority is given to social allocation of capital, competitive market forces often are replaced by quantity and/or price constraints. The lack of market determined prices on borrowing and lending in the capital market changes also the role of government debt management.

Usually government debt management is thought of as a problem of the composition of the outstanding debt from long-term to short-term debt (or vice versa), and the impact on the economy is assumed to work indirectly through changes in the term structures of interest rates. The extent to which debt management can stimulate the economy rests in such cases mainly on the substitutability of assets in the portfolios of economic agents, and the interest rate sensitivity of various components of the demand for goods (Lang-Rasche (1977)).

Given, however, the use of quantity constraints and a rigid level of interest rates, the scope of government debt management becomes more narrow. With such an institutional framework debt management will mainly consist of the choice between foreign and domestic debt, the timing of new issues due to the availability of funds in the market, and the pricing of the new issues of the domestic debt. Government debt management thus reduces to the question of the pricing and the timing

of the new issues of domestic bonds, when the foreign interest rates are given. This is an important issue also in the traditional analysis of government debt management (Tobin (1963)). Our approach differs, however, from the stock adjustment approach.

## 2. Framework of the analysis

Assume an economy with rigid interest rates and where government by legislation or regulation can prevent entry to the market for new bond issues. The problem of government debt management can then be stated in the following way: given a public sector borrowing requirement $S_t$ at a specific point of time t, to what extent is government overpricing/ underpricing its borrowing requirement in the domestic bond market.

The aim of this paper is to analyse the pricing of government domestic borrowing in Finland. Using a simple theoretical framework we study whether the supply of new bonds has been over- or underpriced. By focusing on the (flow) supply of new issues and not on the composition of the total (stock of) government debt, whereby the traditional question of government debt management is excluded from the analysis, we stick to a narrow definition of debt management and an institutional framework of rigid interest rates, where interest rate expectations do not play a dominant role in the pricing process in the capital market.

In order to achieve our aim, we evaluate and extract the possible existence of excess supply or excess demand in the market for new issues.

If our results show that there has been excess supply of government bonds, we conclude that given the amount of bonds supplied in the market, the issues has been overpriced and the asked price (coupon respectively) has been too high (too low)[1)]. Evidence of excess demand implies on the contrary underpricing of an issue.

We first consider whether the bond market in Finland can be considered as a market in disequilibrium. This is achieved by estimating a disequilibrium model of the market and comparing it with an equilibrium approach. From the estimation results we are then able to obtain the optimal supply of and demand for new bonds and extract a measure of the excess supply in the market, which then is used to analyse the pricing of government bond issues.

Our empirical work relates to other studies on government debt and the bond market in Finland in at least two ways. On the one hand,we analyse the empirical relevance of the hypothesis, according to which the market for new issues in Finland can be characterized as a market in disequilibrium. On the other hand, our study tries to fill the gap caused by the lack of empirical analysis of the Finnish government debt by concentrating on one central part of the Finnish government debt, namely the long-term domestic debt.

A model of the demand for and the supply of new bonds is derived in section 2. Empirical results are given in section 3.

## 2. The model

In this section we construct a simple model of the market for new issues. We assume an economy where government by legislation or regulation can act as price setter.

### 2.1. The supply function

Assume that government has a desired borrowing requirement DFD in period t, and that the funds are raised either as domestic or foreign long-term bonds. The borrowing costs in the foreign capital market are assumed to be given, while government can set the rate of interest on domestic bond issues. The optimal supply of domestic government bonds in the market for new issues is assumed to be given by

$$(1) \qquad q^S = q^S \left(\overset{-}{RP}, \overset{+}{FR}, \overset{+}{DFD}\right)$$

where $q^S$ indicates the desired supply of new issues, RP indicates the interest rate in the domestic bond market, FR the foreign interest rate and DFD the borrowing requirement of the public sector. Due to the aggregative nature of our approach, an assumed rigidity of the structure of interest rates and the exclusion of considerations of the maturity composition of the outstanding debt, only one domestic interest rate RP is included in the supply function. We could allow for considerations of the maturity structure of government bonds by correcting RP with a variable indicating the average maturity of the bond issues. An alternative, which is used here, is to assume that when setting the rate of interest on new bonds,

the duration of the bonds is taken into account. Assuming that debt management proceeds on the assumption that maturing issues can always be refunded, a variable AMR measuring the amount of redemption is included in the supply function[2]. The larger the government debt is and the shorter the maturity of the outstanding debt is the larger is the amount of refunding. By taking into account the refunding of government debt we allow for some influence of the existing stock of debt and the duration of the existing stock of debt. Nevertheless, we do not make use of the refunding variable as a device for shifting the maturity composition of the outstanding stock of debt. The variable only indicates a refunding of maturing debt.

Considering the government liability portfolio as a partial model separated from the government asset portfolio, and thus neglecting the possibilities that the adjustment of the government liability portfolio is influenced by for instance a hedging motive, the desired (flow) supply of new government bonds takes the form

$$(2) \qquad q^S = q^S (\overset{-}{RP}, \overset{+}{FR}, \overset{+}{DFD}, \overset{+}{AMR})$$

The effect on $q^S$ of an increase in FR, DFD or AMR is positive, while an increase in RP is negative.

## 2.2. The demand function

The (flow) demand function for bonds traded in the market for new issues $q^d$ is based on a choice theoretic model according to which the extent

to which an asset is included in the portfolio depends on the relative yields. According to equation (3)

$$(3) \qquad q^d = q^d (\overset{+}{RP}, \overset{-}{RA}, \overset{+}{Y})$$

this demand is a function of the own rate RP, the yield on an asset which is considered as a substitute for bonds in inventors' portfolio and a scale variable Y[3)].

Apart from relative yields, the demand for new bonds is also influenced by the availability of credits in the economy. Due to the use of quantity constraints in financial markets, the demand for new bonds is assumed to be influenced by a variable indicating the tightness of the credit market Z and the variable AMR indicating the redemptions of the maturing debt. The tighter the credit markets are the smaller is $q^d$. The larger part of the outstanding stock of bonds that is redeemed in period t, the larger is $q^d$. There are several reasons for considering AMR as a determinant of also the demand for new bonds. First, AMR can partly neutralize the tightness of credit markets thereby increasing the availability of funds in the capital market. Second, because transactions costs in the market for new issues are lower than in the market for seasoned bonds, an allocation of the redemptions is preferrred by investors relative to a reallocation of the composition of the existing portfolio as a means of achieving the desired composition of the asset portfolio. Last, the role of redemptions is accentuated in the absence of an active market for outstanding bonds.

We thus have the following demand function for new issues of government debt

$$(5) \qquad q^d = q^d \left(\overset{+}{RP}, \overset{-}{RA}, \overset{-}{Z}, \overset{+}{AMR}, \overset{+}{Y}\right)$$

where the effect of RP, AMR and Y on $q^d$ is positive, while that of RA and Z is negative.

In an equilibrium framework the observed quantity traded in the market is given by the intersection of the supply curve in (2) and the demand curve in (5). The model is closed using the equilibrium condition

$$(6) \qquad q^d = q^s = q$$

where the observed transactions are denoted by q.

An alternative hypothesis to the equilibrium condition in (6) is given by the hypothesis of the market for new issues being a disequilibrium market, where the trading is determined by the rule

$$(7) \qquad q = \min (q^d, q^s)$$

according to which the volume of new issues traded each period is given by the smaller amount of the two variables $q^s$ and $q^d$, where $q^s$ is given by equation (2) and $q^d$ by equation (5).

Given the specification of the demand and the supply functions we next evaluate the empirical relevance of the equilibrium and the disequilibrium hypothesis.

## 3. Empirical evidence

### 3.1. Data sources and description

The equilibrium hypothesis given by equations (2), (5) and (6) and the disequilibrium hypothesis in equations (2), (5) and (7) are estimated using monthly data from the Finnish bond market for the period 1969 I - 1977 XII[4].

All government bonds issued to the public during the period are included in the study. The number of issues totalled to 44 and the average size of the issue was 80 million FIM. The term to maturity of the government bond issues is relatively short, the arithmetic average of the duration of the bonds being only 3.4 years over the whole period[5].

The appearant seasonality in government debt management is seen in figure 1, where the autocorrelation function of the observed supply of new bonds is depicted. The same regularity can also be found in the redemption payments.

The variables used in the empirical analysis are

$q_t$ amount of government bonds traded in the market for new issues

$RP_t$ weighted average of the yield on government bonds in the market for new issues. The weights are given by the supply of the bonds in the beginning of the period.

$RDEP_t$ yield on a 24 month bank deposit

$AMR_t$ sum of interest and redemption payments on all government bonds listed on the Stock Exchange

$FR_t$ average yield on dollar denominated bonds with medium life in the international bond market

$DFD_t$ government total borrowing in period t

$Y_t$ real wage

$RAT_t$ proxy for tightness of credit markets

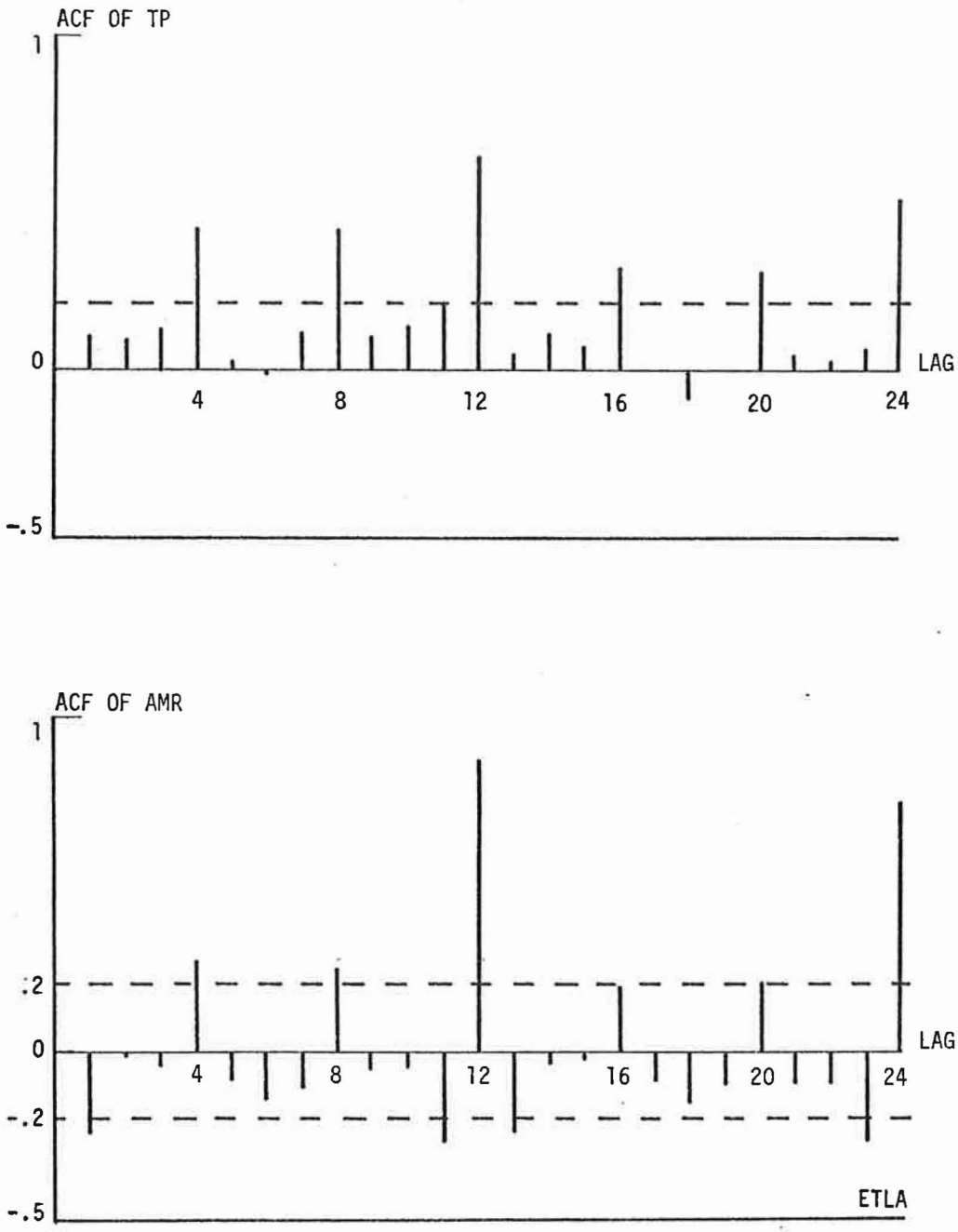
The data is seasonally unadjusted.

## 3.2. Estimation results

The equilibrium hypothesis given by equations (2), (5) and (6) was estimated in its corresponding reduced form by OLS.

The estimation of the disequilibrium model is carried out using digression analysis. This estimation method is, however, not really appropriate for a 'pure' disequilibrium model (Quandt (1982)), since a minimum condition is not part of the model specification. Instead the selection of regime indicator is based on other criteria (Tarkka (1979)). Results using this approach are however documented here in order to serve as basis for a comparison with results obtained from methods which explicitly make use of either a deterministic or a stochastic minimum condition (Maddala and Nelson (1974), Ginsburgh, Tishler and Zang (1981)).

Figure 1. The autocorrelation function of transactions (TP) in the market for new issues and of redemption payments (AMR)



Results are given in table 1.

Table 1. Estimation of equilibrium and disequilibrium*
Models of the market for new bond issues in Finland, 1969-1977

| | $q^d$ | $q^s$ | q |
|---|---|---|---|
| RP | 11.506<br>(6.88) | -8.569<br>(2.51) | |
| RDEP | -7.762<br>(2.21) | | 5.165<br>(0.77) |
| FR | | 1.758<br>(0.55) | 1.230<br>(0.39) |
| AMR | 1.060<br>(24.78) | 0.114<br>(2.51) | 0.429<br>(7.75) |
| DFD | | 0.469<br>(11.86) | 0.196<br>(6.32) |
| RAT | -0.261<br>(1.14) | | 0.130<br>(0.27) |
| Y | 16.925<br>(0.37) | | -104.848<br>(1.43) |
| Constant | -46.465<br>(2.19) | 60.972<br>(2.32) | 42.470<br>(1.12) |
| $R^2$ | 0.930 | 0.817 | 0.55 |
| n | 61 | 47 | 108 |

* absolute values of the t-statistic are given below the parameter estimate

The first and the second column of table 1 refer to the disequilibrium model, while the third column refers to the equilibrium approach. Consider first the equilibrium approach. Two aspects are here worth notice. First, the only significant variables are the quantity variables AMR and DFD, yielding an effect on the volume of transactions in the market for new issues in accordance with the model above. This support the common view

of portfolio allocation in Finland that quantity variables and not price variables are of importance. Second, the price variables - here given by yields on substitutes - have the wrong sign and could not be estimated in a satisfactory way. This underlines the first point of the importance of the quantity variables. This also support the results of an equilibrium model in Rantala (1976) according to which substitution between term deposits, bonds and shares in Finland is relatively weak, and the differences in yields of small importance in the allocation of savings. On the whole, the equilibrium hypothesis cannot be said to be supported by the data.

The results change when moving to the disequilibrium approach. As for the demand function the own rate RP as well as the yield on the substitute RP contribute to the variations in the demand $q^d$ in accordance with the model in section 2. Although the parameter estimates for the income variable and the credit market proxy variable are not significant, the effect on $q^d$ is on line with theoretical considerations. Along with the effect of the yields also the redemption variable AMR explains the variations in $q^d$. In fact, one can argue that the demand function for bonds in Rantala (1976) should include this redemption variable. In the model specification (Rantala (1976) p. 67), the coefficient of AMR is constrained to -1 and thus what Rantala´s approach actually excludes is the effect on demand for bonds of the availability of funds created in the market by AMR.

The estimation of the supply function $q^s$ performs also quite well in that the influence of the variables is in accordance with the model outlined in section 2.

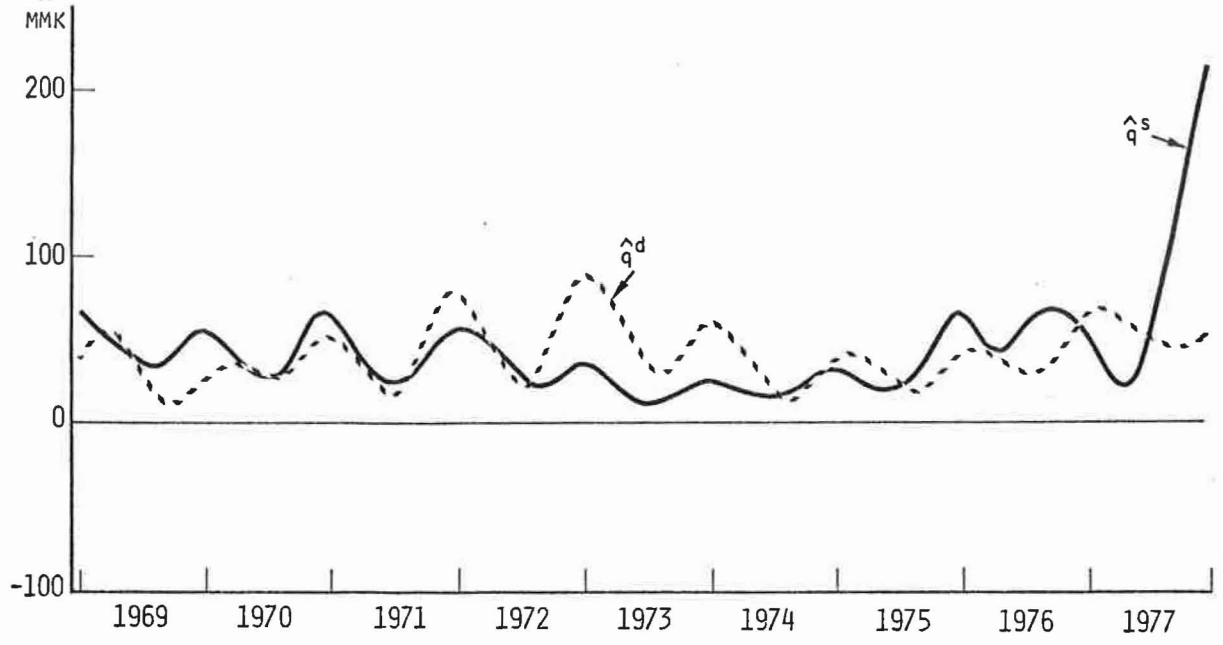
In all estimations of the disequilibrium hypothesis the observations were clustered by the program in such a way that less than half of the observations were grouped to the supply regime ($q^s < q^d$). Given the estimation results in table 1, the estimated demand for and supply of government bonds and the implied excess supply (or demand) in the market can be calculated. The results are given in figure 2[6].

As noted earlier the volume of transactions in the market has a clear seasonal pattern due to the government debt management. The peaks occur in January, May and October. In years of high borrowing the seasonality is partly blurred. Let us next analyse closer whether, the months of high borrowing are classified by the estimated model as excess supply or excess demand regimes.

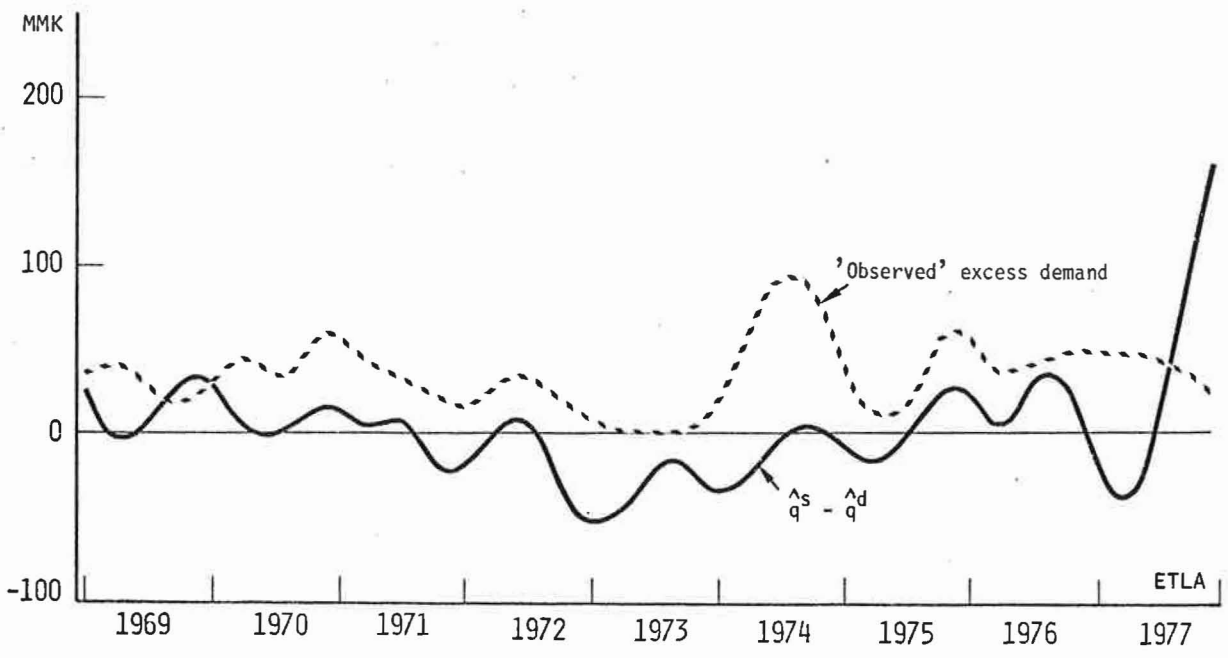
For the whole period the results tend to support the view that the supply of domestic bonds by the public sector, given the domestic and foreign interest rate, has been too large. Moreover, given our estimated supply and demand, all the bond issues during the subperiod 1970 I - 1976 I carried a coupon which was higher than that neccessary to equilibrium the market, i.e. the market was characterized by excess demand[7].

These results tend to be in contrast to the view obtained from the observed excess demand in the market. By the measure 'observed excess demand' we mean the observed supply in excess of the transaction $q_t$[8]. The observed supply is given by the amount of new issues that come to the market in period t plus the unsold amount of earlier issues. This measure of the

Figure 2. Estimated demand for and supply of government bonds.




Estimated and 'observed' excess supply of government bonds



excess demand in the market for new issues is shown in figure 2. As the graph indicates the market is characterized by excess supply over the whole period with the exception of a short period in 1973.

In two periods the estimated and the observed excess demand schedules tend to divert from each other largely, the first being in 1974 and the second being in the beginning of 1977. For 1974 the observations from the market indicate a large excess supply, while the estimated figure characterized the market almost in equilibrium. The large difference comes from the supply side of the market. According to our estimation results the actual supply of new domestic bonds was much larger than the optimal supply, given the domestic and foreign interest rates. However the actual supply of bonds was in this period directed to the domestic bond market, but the loan conditions were unfavourable to the investors.

The same line of reasoning goes for the latter period, in the beginning of 1977, when government borrowing abroad was equal to zero.

## 4. Conclusions

Using a simple model of portfolio choice demand and supply functions for the new domestic government bonds were formulated. The model was estimated using monthly data from the Finnish bond market. Both an equilibrium and a disequilibrium hypothesis were tested. The results tend to be in favour of the disequilibrium approach[9)].

The common view of the market for new issues in Finland holds that government by legislation and regulation has been able to borrow cheap without quantity restrictions. If the demand for funds has not been met in the market, government has raised the bond yield towards the equilibrium level. According to this view the market has always been constrained by the demand for new bonds, the yield has always been below its equilibrium level and the only possible excess demand situations observable have been those characterized by a totally lacking supply of new bonds.

The estimation results in this study however suggest that this view is not correct. A large part of the period, specially the months characterized by high government domestic borrowing, is characterized by excess demand, the domestic bond yield thus being set too high, above the equilibrium level. Thus the market has to a large extent been constrained by the supply of new bonds and the government has been underpricing its domestic bond issues.

FOOTNOTES

1) Because of no competitive bidding in the market for new issues, the market reacts to overpricing by adjusting the quantity demanded and thus actually traded.

2) As a particular issue matures it is refunded into another issue.

3) The demand function is here written as a flow relationship. Standard portfolio theory nevertheless usually formulates asset demand in terms of relative shares of assets of total wealth. When dealing with the market for new issues the (flow of) bonds traded in the market at period t becomes instantaneously part of the stock of outstanding bonds.

4) The period analysed was not extended beyond the end of 1977 because of an agreement between the banks and the government, according to which the role of banks in the bond market changed and the banks became dealers in the market (trading earlier in the market as brokers).

5) The duration of a bond is given by equation (i)

$$(i) \quad DUR_i = \sum_{t=1}^{n} AMR_t(t)/(1+r)^t \; / \sum_{t=1}^{n} AMR_t/(1+r)^t$$

where $DUR_i$ is duration of bond i

$AMR_t$ is interest and/or redemption payments in period t

(t) is the length of time to the interest and/or redemption payment

n is the length of time to the final maturity

r is the yield to maturity

The denominator is the present value of the stream of redemption and interest payments. The numerator is the present value, but the payments are weighted by the length of the interval between the present time and the time that the payment is to be received.
The average duration in the market for new issues was obtained by equation (ii)

$$(ii) \quad DUR_t = \sum_{i=1}^{N} w_{it} \, DUR_{it}$$

where $w_{it}$ is the relative shares of the bond issue i of the total supply of new issues in the market at time t.

6) Due to the large variation in the demand and supply a 15 months moving average of the variables are given in figure 2.

7) Our conclusions are based on an rule according to which the period is classified as an excess demand regime if the estimated excess demand exceeds 25 million FIM. Thus we allow for a margin and do not require strictly $q^s = q^d$.

8) The supply in the market for new issues is here given by equation (iii)

$$(iii)\quad S_t = \sum_{j=1}^{t-1} \sum_{i=1}^{n} (S_{ij} - q_{ij}) + NEW_t$$

where $S_t$ is the total supply in the market at time t

$S_{ij}$ is the unsold stock of bond i at the beginning of period j

$q_{ij}$ is the quantity sold of bond i during period j

$NEW_t$ is the quantity of new bond issues that come to the market during period t, i.e. the date of issue equals t.

9) Using a test procedure by Davidson and MacKinnon (1981) the validity of the two nonnested hypothesis, i.e. the equilibrium and the disequilibrium models, can be tested. Results obtained clearly indicate that we cannot reject the disequilibrium hypothesis.

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