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Flow of Loans and Preferences in Loan Terms in the Polish Banking System. An Attempt at Evaluation

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Abstract

At the macro level, the time-series of the amounts of loans granted by (a flow) and repaid (a flow) to the banking system in each period are not available. However, one can get the information concerning the structure of loans (a stock variable) regarding their duration. Every month the loans are being granted for different terms: from overnight ones to those lasting several years. The preferences of the credit takers are reflected in the term distribution of the outstanding loans. In order to estimate these flows, the model has been developed aimed at linking the above-mentioned preferences, the levels of loans and flows. In the approach proposed, the amount of credit outstanding is a resultant of the rate of the new loan flow but also of the average duration of these loans. The evaluation results are presented.

1. Introduction

At the central bank level there is no data available concerning the rate of flow of loans granted by the whole banking sector in each time-period. This is so because the conventional methods developed for analysis preceding decision-making in the monetary policy do not require such information. If the conventional methods are good enough, then what is the purpose of the intended analysis? One can enumerate many reasons, the most important of which are discussed below.

The investment of enterprises is usually financed by bank loans; in the analysis of the impact of the bank loans (flow) on investment (flow), the loans granted in a given period should be compared with the investment outlays in the same or next periods. However, as the flow of loans is not available, the net change of loans (stock variable, a balance sheet category) is quite often used as an explanatory variable for determining change in investment. Admittedly, such an approach usually provides satisfactory results. Yet, whenever vast structural changes occur, this modeling shortcut is sometimes unjustified.

Whenever the term structure of the loans can be assumed constant, the risk of a an erroneous interpretation of data is negligible. It is not so whenever the term structure undergoes big changes. Consider the following example. Assume the simple equilibrium of the credit system: the flows of granted loans and the returned principal are equal and steady. When the flow of loans starts growing, then the credit will also grow and the principal returned will grow as well (but with a certain delay). In this case, the growth of the rate of loans causes the growth of the credit outstanding. The same increase of the credit outstanding can be a result of the steady rate of loans granted but diminishing repayment of the principal being the effect of, for example, increased deterioration of loans. In the latter case, the term structure of loans changed as the share of the longer-term loans increased. The example presented here shows limited usefulness of the changes of the loans outstanding as a measure for the changes of flow of the granted loans. It shows also that the rate of loans flowing through the banking system matters; dynamics of flows of both the loans granted and principal repaid have substantial impact on the volume of loans outstanding.

This study was also motivated by another factor – sheer curiosity. Since most heads of the central banks cannot directly answer the question what amounts of the loans are granted and repaid in each period, finding an answer to that question is compelling.

The approach presented here was proposed in Gadomski (2002).

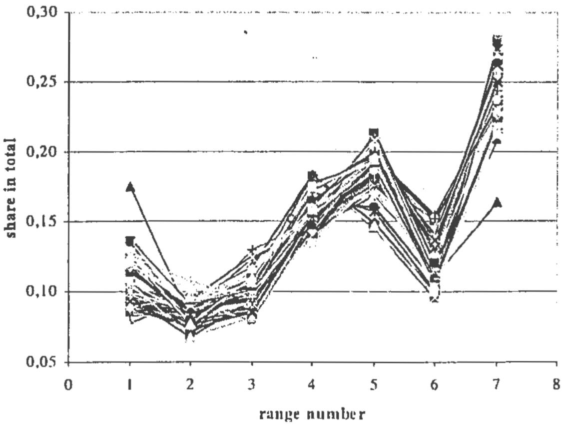

Fig.1 Structure of the outstanding loans in the Polish banking sector

The problem introduced above is, in a way, artificial. At the level of a particular bank, there is no need for such an analysis, as the question can be answered with little effort. However, for many reasons, appropriate data are not collected at the central bank level. In the case of Poland, the available data are the time-series of the outstanding loans with terms belonging to the ranges listed below:

1. to 1 month,
2. from 1 month to 3 months,
3. from 3 months to 6 months,
4. from 6 months to 12 months,
5. from 12 months to 36 months,
6. from 36 months to 60 months,
7. above 60 months.

In the analysis presented in this paper, the time series belonged to the period: December 1995 – November 2002. The chart showing shares of loans with the terms belonging to a particular range is shown in Fig. 1.

At the first sight, the structure seems to be stable. Table 1 presents shares of loans belonging to the particular range in the total loans outstanding.

Table 1.

range number k	0	1	2	3	4	5	6
average share $E[Z_k(t)/Z(t)]$	0,1035	0,0859	0,0995	0,1573	0,1864	0,1245	0,2428
standard deviation $\sigma[Z_k(t)/Z(t)]$	0,0173	0,0089	0,0111	0,0109	0,0151	0,0170	0,0231

Source: own calculation based on the data from NBP (National Bank of Poland - Polish central bank)

In the further analysis, an attempt was made to determine the average term $T_Z (t)$ of the loans outstanding. For this purpose, the following formula was adopted[1]:

$$T_Z (t)= \frac{\sum_{k=1}^{7} i_k Z^{(k)}(t)}{Z(t)} ,$$

where:

$Z(t)$ – total loans outstanding in period t,

$Z^{(k)}(t)$ – loans outstanding belonging to k-th range (defined above) in period t, k= 1,..,7; i

i_k – average term (mid range) in the k-th range, k= 1,..,7.

Off course, $Z(t)=\sum_{k=1}^{7} Z^{(k)}(t)$. Calculated values of $T_Z(t)$ are shown in Fig. 2.

Time profile in Fig.2 shows that two sub-periods can be distinguished: one, from December 1995 to December 2000, the other, from January 2001 to November 2002. Both sub-periods are characterized by different values of $T_Z(t)$; about 32 months in the former and 28 months in the latter. Transition from the first to the second sub-period was not gradual as there occurred an almost instant fall of that parameter by four months, i.e. 12%. This phenomenon can be explained: the fall of the value of $T_Z(t)$ in that period was caused by contracting investment. This in turn resulted in the diminished demand for bank loans on the one hand, and cuts in the long-term investment projects on the other.

The above remarks lead to the following questions:

1. In what way do the changes in the average term of the bank loan affect the amount of the credit outstanding and its structure?
2. Is there a relationship between the dynamics of the flow of the loans granted on the structure of the loans outstanding?

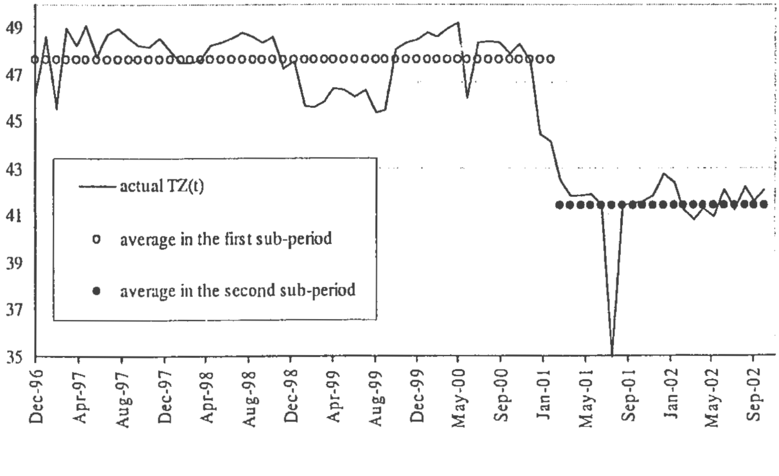

Fig. 2. Values of $T_Z(t)$ in the period December 1996 – November 2002.

[1] One can note that this formula is the weighted average and resembles, to a certain extent, the formula for calculating duration (see: Mishkin(1998)).

The analysis aimed at answering the above questions will be performed in stages. First, a model linking the flows of the loans granted, principal repaid and the amount of the credit outstanding will be introduced. This model is based on the assumption that the flow of the principal repaid can be presented as the distributed lag of the flow of the granted loans. The weight coefficients of that lagged relationship depend on the effective preferences of creditors and credit takers. In the second stage, a simple estimation of the preference weights will be performed. Finally, the estimated values of the flows of granted loans will be presented.

2. Flow of principal as a function of the flow of loans granted

The total amount of loans granted $X(t)$ in the month t consists of: the loans granted for the period shorter than 1 month $X_0(t)$, loans granted for the terms ranging between one month and two months $X_1(t)$, etc. [2] Denoting the longest term of the loan granted with n, we see that the total amount of loans granted $X(t)$ is distributed in the following way:

$$X(t) = X_0(t) + X_1(t) + X_2(t) + .. + X_n(t) = \sum_{i=0}^{n} X_i(t) \tag{1}$$

If the shares of loans of particular terms in total loans granted α_i, $i = 0, 1, 2,,...n$, are constant, then (1) can be rewritten in the following way:

$$X(t) = \alpha_0 X(t) + \alpha_1 X(t) + \alpha_2 X(t) + ... + \alpha_n X(t) = X(t)\sum_{i=0}^{n} \alpha_i \tag{2}$$

Obviously, $X_i(t) = \alpha_i X(t)$ and all $\alpha_i \geq 0$, $i = 0, 1, 2,.,n$, and $\sum_{i=0}^{n} \alpha_i = 1$

The set of $\alpha_i \geq 0$, $i = 0, 1, 2,,.,n$, will be called the term preference distribution, because these values are determined both by the destination of loans and the ability of credit takers to stand the burden of paying off the principal.

We assume that loans do not deteriorate and that the principal is being repaid in equal installments. For example, loans granted in the month t for three months are being repaid in three equal installments over the next three months. However, one has to consider that loans granted in the month t for less than one month are repaid partly in the very same month t, and partly in the next month, i.e. $t + 1$. The same goes for the loans granted in the month t for the periods between one

[2] It is assumed that the longest term equals 170 months. This assumption, which affects only the loans of the longest terms (mainly building loans), was made because of the numerical problems occurring in computations.

month and two months: one part of them is repaid in the month $t + 1$ while another is repaid in the month $t + 2$. This scheme has also been applied to the loans with longer credit terms.

In order to solve this problem, the following solution has been adopted. It is assumed that one-half of the loans granted for less than one month is repaid in the same month, while the rest of that amount is repaid in the next month. Hence, the amount of loans granted for less than one month and repaid in period t, $Y_0(t)$, equals:

$$Y_0(t) = \frac{1}{2}a_0\left(X(t) + X(t-1)\right). \tag{3}$$

One-half of the loans granted for at least one month and not longer than two months is repaid in the first month, while the other half is repaid in the next month. The amount of loans granted for at least one month and not longer than two months and repaid in period t, $Y_1(t)$, equals:

$$Y_1(t) = \frac{1}{2}a_1\left[X(t-1) + \frac{1}{2}\left(X(t-1) + X(t-2)\right)\right].$$

One can notice that the above expression represents a mean value of the principal of the loans returned in one and two installments.

The amount of loans granted for at least two months, and not longer than three months, and repaid in period t, $Y_2(t)$, equals:

$$Y_2(t) = \frac{1}{2}a_1\left[\frac{1}{2}\left(X(t-1) + X(t-2)\right) + \frac{1}{3}\left(X(t-1) + X(t-2) + X(t-3)\right)\right].$$

The above expression is a mean value of principal of the loans returned in two and three installments.

Applying the same pattern for $i = 1, 2,..,n$, the amount of loans granted for at least i months and not longer than $i+1$ months, and repaid in period t, $Y_i(t)$, can be expressed by the following formula:

$$Y_i(t) = \frac{1}{2}a_i\left[\frac{1}{i}\left(X(t-1) + .. + X(t-i)\right) + \frac{1}{i+1}\left(X(t-1) + .. + X(t-i-1)\right)\right],\ i = 1, 2,..,n.$$

or its concise form:

$$Y_i(t) = \frac{1}{2}a_i\left[\frac{2i+1}{i(i+1)}\sum_{j=1}^{i} X(t-j) + \frac{1}{i+1}X(t-i-1)\right], \qquad i = 1, 2,..,n. \tag{4}$$

Each $Y_i(t)$, the expression (4), can be expressed in the form of a distributed lag:

$$Y_i(t) = \alpha_i \sum_{j=0}^{i+1} w_j^{(i)} X(t-j), \tag{5}$$

where $w_j^{(i)}, j = 0,..,i+1$;are weight coefficients of the distributed lag. For $i = 0$ we have: $w_0^{(0)} = ½$, $w_1^{(0)} = ½$ and $w_j^{(0)} = 0$ for $j > 1$; while for $i > 0$ we have: $w_0^{(i)} = 0$, $w_j^{(i)} = (2i+1)/[2i(i+1)]$ for $j \leq i$ and $w_j^{(i)} = ' = 1/[2(i+1)]$ for $j = i+1$.

Having in mind that $X_i(t) = \alpha_i X(t)$, $i = 1, 2,,.,n.$; we can rewrite equation (5) :

$$Y_i(t) = \sum_{j=0}^{i+1} w_j^{(i)} X_j(t-j) \text{ , } i = 1, 2,,.,n. \tag{6}$$

The following Table 2 contains the values of the weight coefficients $w_j^{(i)}, j = 0,..,i+1; j = 0,..,n$.

Table 2 Values of the weight coefficients $w_j^{(i)}, j = 0,..,i+1; j = 0,..,n$.

	$j=0$	$j=1$	$j=2$	$j=3$	..	$j=k+1$	..	$j=n+1$
$i=0$	1/2	1/2	0	0	..		..	0
$i=1$	0	3/4	1/4	0	..		..	0
$i=2$	0	5/12	5/12	1/12	..		..	0
:	.	.	.	.	..		..	.
i = k	0	(2k+1)/ [2k(k+1)]	(2k+1)/ [2k(k+1)]	(2k+1)/ [2k(k+1)]	..	1/ [2(k+1)]		0
:	.	.	.	.	..		..	0
$i=n$	0	(2n+1)/ [2n(n+1)]	(2n+1)/ [2n(n+1)]	(2n+1)/ [2n(n+1)]	..		..	1/ [2(n+1)]

It is easy to prove that for all i, $i = 0, 1, 2,..,n$, $\sum_{j=0}^{i+1} w_j^{(i)} = 1$, which is the consequence of the assumption that no loans can be lost. In other words, the sum of each row in Table 2 equals one.

Each lag (6) is characterized by the mean lag $T_i^{(Y)}$ that in this context can be interpreted as a mean time it takes 1 zloty of a loan from the i-th range to return to the bank as principal:

$$T_i^{(Y)} = \sum_{j=0}^{i+1} j w_j^{(i)} = \begin{cases} \frac{1}{2}, & i=0; \\ \frac{i}{2} + \frac{3}{4}, & i \geq 1. \end{cases} \tag{7}$$

The total flow of principal in the month t, $Y(t)$, is a sum of all $Y_i(t)$, $i = 0, 1, 2,..,n$:

$$Y(t) = Y_0(t) + Y_1(t) + .. + Y_n(t), \tag{8}$$

This means that the flow of money returning to the bank system is a sum of principal of all terms.

By substituting (6) into (8) we get the following expression:

$$Y(t) = \sum_{i=0}^{n} \alpha_i \sum_{j=0}^{i+1} w_j^{(i)} X(t-j) \,, \tag{9a}$$

and after rearranging the terms, we finally obtain the following relationship:

$$Y(t) = \sum_{i=0}^{n} \left(\sum_{j=0}^{n+1} \alpha_j w_i^{(j)} \right) X(t-i) = \sum_{i=0}^{n} w_i \, X(t-i) \,, \tag{9b}$$

where w_i, $w_i = \sum_{j=0}^{i+1} \alpha_j w_j^{(i)}$. The sum $\sum_{i=0}^{n} w_i = 1$, because $\sum_{i=0}^{n} w_i$ is the sum of n products of parameters α_i , $i = 0, 1,.., n$, and the sums of the i-th row in the Table 2. As the sum of each row equals one, the assumption concerning parameters α_i , $i = 0, 1,.., n$, leads to:

$$\sum_{i=0}^{n} w_i = \sum_{i=0}^{n} \alpha_i = 1.$$

The equation (9) shows that the principal (the flow of repaid loans) can be presented as the distributed lag function of the past flows of the granted loans. The lag distribution involved in this relationship is the product of two elements: the scheme of determining the installments and the preferences as to the term structure of the loans.

Value of $T^{(Y)}$, which stands for the average time a monetary unit spends in the stock of the loans outstanding, is (because of (8) and (9a)) defined as:

$$T^{(Y)} = \sum_{i=0}^{n} i \, w_i = \alpha_0 \, T_0^{(Y)} + \alpha_1 \, T_1^{(Y)} + .. + \alpha_n \, T_n^{(Y)}. \tag{10}$$

Note that equations (8) through (10) are valid regardless of the distributions of $w_j^{(i)}$, $j = 0,..,i+1; j = 0,..,n$.

3. Loans outstanding as a function of the flow of loans granted

Given the relationship between the flow of principal and the flow of loans, one can determine the amounts of the loans outstanding. Denote by $Z_i(t)$, $i = 0, 1,.., 170$, the amount of the outstanding loans belonging to the i-th range of the loan terms at the end of the period t. One should not confuse $Z_i(t)$ and $Z^{(k)}(t)$; the former denotes the amount of loans outstanding belonging to the term range as defined in Introduction, and the latter denotes the terms not smaller than i months and not greater than $i+1$ months. In other words, any $Z^{(k)}(t)$ can be expressed as the sum of at least one $Z_i(t)$.

A simple analysis shows that the amount of the loans outstanding can be expressed in terms of the weight coefficients:

$Z_0(t) = \frac{1}{2} X_0(t) . = \frac{1}{2} \alpha_0 X(t)$, because $\frac{1}{2} X_0(t)$ flowed out of the stock of the outstanding loans during the period t (see Table 2);

$Z_1(t) = X_1(t) + 1/4\, X_1(t-1) = \alpha_1 [X(t) + 1/4\, X(t-1)]$, because no part of the loans granted in the period t is repaid at the end of the period t, ¾ of $X_1(t-1)$ having been returned in the period t (see Table 2).

Using the same reasoning to analyze the loans outstanding belonging to the i-th range of the loan terms, we arrive at the following expression:

$$Z_i(t) = \sum_{j=0}^{i} \Big(1 - \sum_{k=0}^{j} w_k^{(i)}\Big) X_j(t-j), \quad i = 0,..,n. \tag{11a}$$

or

$$Z_i(t) = \sum_{j=0}^{i} v_j^{(i)} X_j(t-j) = \alpha_i \sum_{j=0}^{i} v_j^{(i)} X(t-j), \qquad i = 0,..,n, \tag{11b}$$

where:

$$v_j^{(i)} = \Big(1 - \sum_{k=0}^{j} w_k^{(i)}\Big) = \sum_{k=j}^{n} w_k^{(i)}, \quad i = 0,..,n. \tag{12}$$

The equation (11) shows that the amounts of the loans outstanding are also a distributed lag of the past loans, however coefficients $v_j^{(i)}$ do not form a lag distribution. The value of the expression in the brackets in (12) is non-negative, all $v_j^{(i)} \geq 0, j = 0,.,n$. The important property of the coefficients $v_j^{(i)}$ is that, regardless of the shape of the distribution of $w_j^{(i)}, j = 0,..,i$; the coefficients $v_j^{(i)}, j = 0,..,i$; are decreasing functions of j.

It is a very important property of this model that each sum $\sum_{j=0}^{i} v_j^{(i)}$, $i = 0,..,n$, is equal:

$$\sum_{j=0}^{i} v_j^{(i)} = \sum_{j=0}^{n} v_j^{(i)} = T_i^{(Y)}. \tag{13}$$

The equation

$$\sum_{j=0}^{n} v_j^{(i)} = \sum_{j=0}^{i} v_j^{(i)},$$

holds true, because for all $j > i$, $v_j^{(i)} = 0$.

Since for all $i, \sum_{j=0}^{i+1} w_j^{(i)} = 1$, we see that

$$\sum_{j=0}^{i} v_j^{(i)} = \sum_{j=0}^{i} \left(1 - \sum_{k=0}^{j} w_k^{(i)}\right) = \sum_{j=1}^{i}\sum_{k=j}^{i} w_k^{(i)},$$

which can be written in the form:

$$\begin{aligned}\sum_{j=1}^{i}\sum_{k=j}^{i} w_k^{(i)} &= w_1^{(i)} + w_2^{(i)} + .. + w_i^{(i)} + \\ &\quad + w_2^{(i)} + .. + w_n^{(i)} + \\ &\quad \dots\dots\dots\dots\dots\dots \\ &\quad + w_i^{(i)}.\end{aligned}$$

In the above equation one can notice that $w_1^{(i)}$ appears once, $w_2^{(i)}$ appears twice, and $w_i^{(i)}$ is repeated i times, hence we have:

$$\sum_{j=0}^{i} v_j^{(i)} = \sum_{j=1}^{i}\sum_{k=j}^{i} w_k^{(i)} = \sum_{j=1}^{i} j w_j^{(i)} = T_i^{(Y)}. \tag{14}$$

Because in the proof no particular distribution has been assumed, the relationship (14) is true for all possible distributions of weight coefficients.

The total amount of the loans outstanding $Z(t)$ can be expressed, on the basis of (11b), by the sum:

$$Z(t) = \sum_{i=0}^{n} Z_i(t) = \sum_{i=0}^{n} \alpha_i \sum_{j=0}^{i} v_j^{(i)} X(t-j),$$

which, on the basis of (14), can be rewritten in the following form:

$$Z(t) = \sum_{i=0}^{n}\left[\alpha_i T_i^{(Y)} \sum_{j=0}^{i} \varpi_j^{(i)} X(t-j)\right], \tag{15}$$

where $\varpi_j^{(i)}$, $i = 0, 1,..,n$; $i = 0, 1,..,n$; are weight coefficients of the lag distribution obtained by dividing all coefficients $v_j^{(i)}$ by the value of the average time $T_i^{(Y)}$ a monetary unit spends in the stock of loans outstanding $Z_i(t)$ associated with the i-th range of terms:

$$\varpi_j^{(i)} = v_j^{(i)} / T_i^{(Y)}. \tag{16}$$

The weight coefficients $\varpi_j^{(i)}$ $i = 0, 1,..,n$; $i = 0, 1,..,n$; fulfill conditions : $\sum_{j=0}^{n} \varpi_j^{(i)} = 0$ and $\varpi_j^{(i)} \geq 0$.

One will note that the expression in the square brackets in (15) is the rewritten equation (11). In conclusion, the stock of loans outstanding $Z(t)$ can be also expressed as the following distributed lag function of the loans granted:

$$Z(t) = \sum_{k=0}^{n} \alpha_k T_k^{(Y)} \sum_{i=0}^{n} \varpi_i X(t-i), \tag{17}$$

where $\varpi_j = \sum_{i=0}^{n} \frac{v_j^{(i)} \alpha_i}{\sum_{k=0}^{n} \alpha_k T_k^{(Y)}}$, $j = 0, 1,.., n$. The latter was obtained due to the fact that each sum:

$$\sum_{j=0}^{i} v_j^{(i)} = T_i^{(Y)}, i = 0, 1,..,n, \text{ and } \sum_{i=0}^{n} \sum_{j=0}^{n} v_j^{(i)} \alpha_i = \sum_{k=0}^{n} \alpha_k T_k^{(Y)}.$$

Similarly to the properties of the individual range of terms (see comments to the equation (12)), all coefficients ϖ_j, $j = 0, 1,..,n$, regardless of the lag distribution of w_j, $j = 0, 1,..,n$, are decreasing functions of j (because the sum of the decreasing functions is a decreasing function). This means that whatever the shape of the term distribution of loans (which can even increase with the loan duration), the impact of the past loans on the total amount of the loans outstanding decreases with time. The impact of the past flows of granted loans on the flow of principal is in a significant part determined by the term preference distribution. In the case of the loans outstanding, this impact is considerably weaker.

The above considerations show that knowing the term preference distribution α_i, it is easy to calculate the lag coefficients $w_j^{(i)}$, w_j, $v_j^{(i)} v_j$, $\omega_j^{(i)} \omega_j$, $j = 0, 1,..,n$, $i = 0,..,n$.

Now we will try to answer the question in what way the dynamics of the flow of granted loans affects the term structure of the outstanding loans. In the Introduction, a function $T_Z(t)$ was proposed aimed at calculating the average term of the outstanding loans on the basis of available data.

Assume the constant term preference distribution and the flow of the granted loans decreasing at a steady rate. Obviously, the stocks of the outstanding loans and the flow of the principal will also decrease. How does it influence the term structure of the loans outstanding? Older (bigger) loans still reside in the longer-term outstanding loans, while newer (smaller) loans dominate in the shorter-term loans outstanding. In result, the value of $T_Z(t)$ will be bigger than during the static steady state[3], when all $X(t-i)$ are equal. In the case of the increasing flow of the granted loans the structure will be affected in the opposite way; and the value of $T_Z(t)$ will be smaller than in the steady state condition. These considerations lead to the conclusion that the term structure of the loans outstanding is determined both by the term preference distribution and by the dynamics of the flow of the loans granted.

4. Evaluation of the flow of the loans granted

Our aim now is to deduct the monthly flow of the loans granted from the available data which, as it was mentioned in the Introduction, is not abundant. NBP does not publish any direct information on this subject. Only the strongly aggregated time-series of the loans outstanding belonging to seven ranges of the loan terms are at the disposal. These data were used in the analysis of $T_Z(t)$ illustrated in Fig.2.

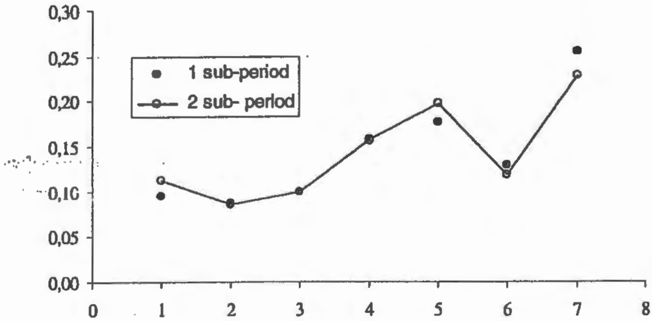

Fig. 3. Shares of the loans outstanding of the particular term range in total loans outstanding.

The continuous line in Fig.3 represents shares of the loans outstanding belonging to the particular term range in the period of December 1996 – December 2000, while the dotted line represents the shares of the loans outstanding belonging to the period of January 2000 - November 2002. Fig.3 shows that the transition from the first to the second sub-period was associated with the change of the term preference distribution. The share of the longest-term loans is smaller and the share of the shortest-term loans is bigger in the second sub-period than in the first sub-period. What was the

[3] In the meaning as given in Solow(2000)

reason of that change? We know from Section 3, that the changes of the term structure of outstanding loans can be the result not only of the change in the term preferences but also of the change in the dynamics of the flow of granted loans. Moreover, the time-series show (Fig.4), that in the first sub-period the zloty denominated loans outstanding were increasing at the average yearly rate of almost 20%, and in the second sub-period there occurred a decrease of those loans at the average yearly rate of about 3.2%. One element in Fig. 4 requires a comment, namely a sharp rise and then fall of the loans outstanding respectively in June and July 2000. These fluctuations were caused by the less then one month loan for the privatization of oil industry.

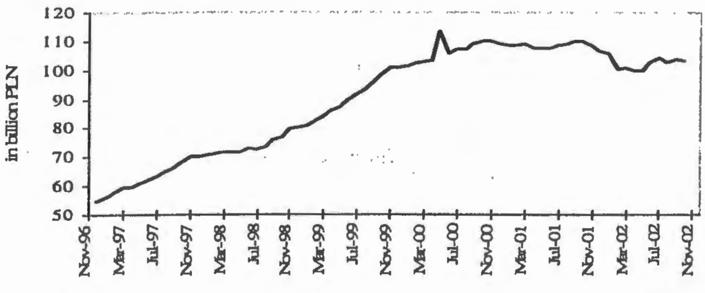

Fig.4. The Polish zloty (PLN) denominated total outstanding loans.

It is a fortunate fact that the change of the average loan term colludes with the change of trend in total loans. In further analysis, we will assume that during the first sub-period there was a steady growth of the flow of loans granted (causing a steady growth of the loans outstanding at the same rate) and that the term preferences of loan takers were constant. Under such assumptions, it will be possible now to make a rough estimation of the weight coefficients α_i, i=0,..,170.

The average values of $Z^{(k)}(t)/Z(t)$ (k is the number of term range, $k=1,..,7$; see Introduction) are the result of both the flow dynamics of the granted loans and the term distribution of preferences. Assuming the rate of growth of that flow is 20% per year, our task now is to find values of α_i, i=0,..,170, approximating the shares of loans outstanding belonging to the particular term ranges in the total loans outstanding.

It turned out that it was impossible to find a common distribution that would fit the data sufficiently well. In order to solve this problem, the following method was adopted. The term preference distribution is the weighted average of at least three distinct distributions revealing the preferences of the loan takers concerning short-term, mid-term and long-term loans:

$$a_i = u_1 a^1_i + u_2 a^2_i + u_3 a^3_i , \qquad (18)$$

where:

u_1, u_2, u_3 – weights associated with the respective term preference distribution

a^j_i – weight coefficient of the j- term preference distribution, $j = 1, 2, 3$; $i = 0, 1,...,170$.

In the simplified interpretation, the first distribution is responsible for the loans drawn for solving liquidity problems as well as the short-term consumer loans. The second distribution is related to the investment loans and loans for the purchases of the durable consumer goods. The third distribution is related to the longest-term investment loans as well as the building loans. Each set of weight coefficient, a^1_i, a^2_i, a^3_i , $i = 0,1,..,170$; follows Pascal's distribution[4] having two parameters: first, r_j- called the order of the distribution, and the second λ_j - associated with the average lag T_j by the relation:

$$\lambda_j = r_j/(r_j + T_j), \qquad (18a)$$

moreover, each weight coefficient $a^j_i, j = 1, 2, 3$; is determined by the following equation:

$$a^j_i = \binom{r_j+i-1}{i} (\lambda_j)^i (1-\lambda_j)^{r_j}, \qquad (18b)$$

Because of the strong nonlinearity of (18b), the values of a^j_i were determined by trial and error.

The estimated values of parameters T_j, r_j and u_j are shown in Table 3. The estimated and actual shares of the loans outstanding belonging to particular term ranges are shown in Fig. 5.

Table 3. The estimated values of parameters T_j, r_j and u_j.,

	sub-period Dec-96 – Dec-00			sub-period Jan- 01 – Nov-02		
	T_j (months)	r_j	u_j	T_j (months)	r_j	u_j
j = 1	0.325	1	0.715	0.25	1	0,759
j = 2	8	3	0.2325	8	3	0.21
j = 3	60	6	0.0525	58	6	0.031

The best results were obtained for the value of r_1 equal one, which means, that the first distribution is a geometric (or the Koyck) distribution, i.e. a special case of the Pascal distribution of order equal 1.

[4] See, for example: Dhrymes(1981): Maddala(1977)

As the value of $T_Z(t)$ for the first sub-period was 46.2 month and the estimated value was 46.24 month and the value of $T_Z(t)$ for the first sub-period was 4.1 month and the estimated value was 41.5 month, this method has produced satisfactory approximation.

Knowing the estimated values of a_i, i = 0, 1,..., 170; and coefficients from Table 2, it is easy to reconstruct the weight coefficients of the distributed lag (9b), Fig. 6. These, in turn, enabled calculation of $T^{(Y)}$, the average time a monetary unit spends in the stock of the loans outstanding (see equation (10)). Hence, $T^{(Y)}$ = 3.23 months, in the first sub-period and $T^{(Y)}$ = 2.25 in the second sub-period. Note the difference between the values of $T_Z(t)$ and $T^{(Y)}$. The former tells us what the mean time 1 zloty spends in the outstanding loan (debt) is, while the latter tells us, how long it took 1 zloty to return (in the form of principal) to the banking system.

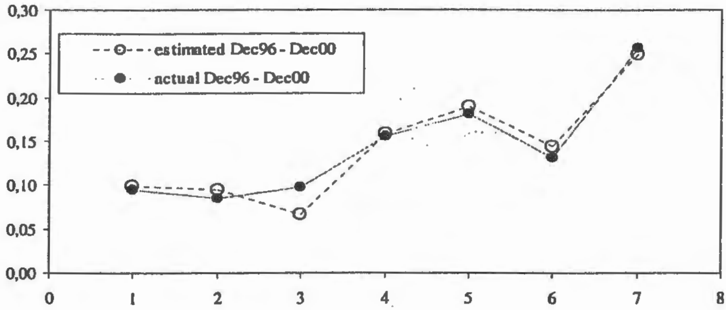

Fig. 5a. The estimated and actual shares of the loans outstanding belonging to the particular term ranges in the first sub-period.

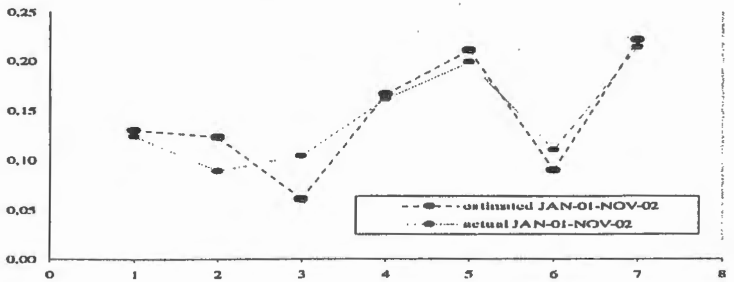

Fig. 5b. The estimated and actual shares of the loans outstanding belonging to the particular term ranges in the second sub-period.

The aim of the next step was the estimation of the flows of the loans granted. In order to perform that task, the lag distribution (equation (10)) was approximated with the geometric (Koyck's) lag, provided that the mean values $T^{(Y)}$ of the original lag distribution and the distribution used for approximation are equal. Approximation using the geometric distribution is easy, as it requires only one parameter $T^{(Y)}$ (or λ). On the other hand, this simplicity is obtained at the cost of undervaluing the impact of the shortest-term loans and overvaluing the impact of longer-term loans, Fig.6.

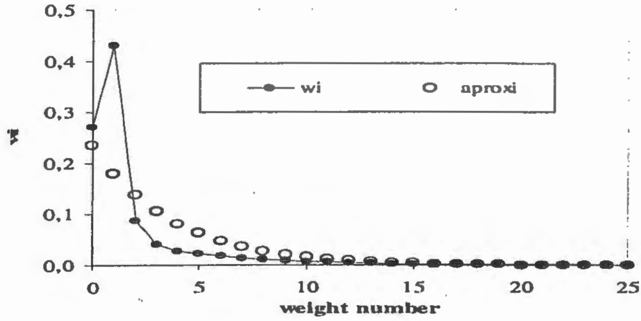

Fig. 6. The estimated weight coefficients and their geometric approximation in the first sub-period.

For determining the rates of flow of the loans granted in each month, two equations are engaged. The first one describes the relation between the flow of principal repaid $Y(t)$ and the flow of the loans granted in the period t:

$$Y(t) = \lambda X(t) + (1 - \lambda) Z(t - 1). \tag{19a}$$

The second equation describes the amount of the loans outstanding $Z(t)$ at the end of the month t:

$$Z(t) = Z(t - 1) + X(t) - Y(t). \tag{19b}$$

The two above equations are easily transformed into the relationship:

$$Y(t) = \lambda X(t) + \lambda (1 - \lambda) X(t-1) + \lambda (1 - \lambda)^2 X(t-2) + \ldots,$$

equivalent to the Koyck lag.

From (19a) and (19b), it is easy to obtain the following relation:

$$X(t) = Z(t)\left(\frac{1}{1-\lambda}\right) - Z(t-1) \text{ or } X(t) = Z(t)\left(\frac{1+T^{(Y)}}{T^{(Y)}}\right) - Z(t-1), \tag{20}$$

used for determining the values of $X(t)$ (the value of $T^{(Y)}$ was calculated earlier). Then the values of $Y(t)$ are determined using (19b).

The evaluated values of the monthly flows of the loans granted and the monthly flows of repaid principal are shown in Fig. 7.

At the first sight, the differences between Fig. 4 and Fig. 7 are minor. According to the assumptions, the division into the two sub-periods is preserved. However, one can notice that at the very end of the first sub-period there occurred an acceleration of the flows of interest.

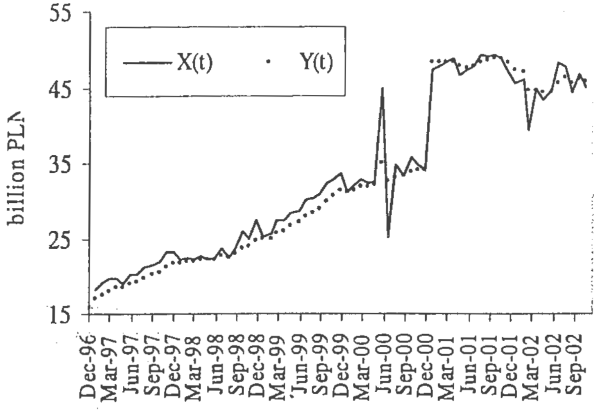

Fig. 7. The evaluated monthly flows of the loans granted and principal.

This acceleration was caused by the increased rate of flow of granted loans, which, in turn, was the effect of the decreased demand for the longer-term loans. The above mentioned drop of demand was the result of the crisis in investment, which began at that time. This is a paradox that decreased demand for loans causes an increase of the flow of the loans granted.

The method for evaluating the flows of the loans granted and principal proposed here does not account for the losses caused by the deterioration of loans. This is an important drawback of the method proposed. However, assuming certain rates of the flow of losses could help to solve this problem.

4. Conclusions

The above-presented considerations show that the relationship between the flow of the loans granted and the amount of the loans outstanding is complex. The factors having an impact on that relationship are the following: the loan term preferences, scheme of the repayment of principal and the deteriorated loans (which were not considered in this study). When drawing a loan the loan-taker makes two decisions: on the required amount of the loan, and how long would it take to fully repay the capital. The changes in the economic environment affect the demand for the investment loans and have significant impact on the term structure of the loans drawn.

The structure of the loans outstanding is influenced by the term preferences and by the very dynamics of the loans granted. The bigger the rate of growth given unchanged term preferences, the smaller the share of long-term loans and smaller the mean time a monetary unit spends in the loans outstanding. And the opposite: a decrease in the flow of the loans granted results in the increase of the share of the long-term loans, thus increasing the mean time a monetary unit spends in the loans outstanding. On the other hand, a change of the term preferences, ceteris paribus, may result in significant changes of the loans outstanding.

What general conclusion can one draw from of the proposed method of analysis? The dynamics matters: the amount of the loans outstanding can grow: either with the growth of the loans granted or with the decrease of the loans granted. Hence, the dynamics of the loans granted and changes in the term preferences should be taken into account in the formulation of the monetary policy.

It was proved that the flow of the loans granted could be evaluated on the basis of available data.

The performed analysis made it possible to answer the question on the amounts of loans granted and repaid in each period (month, quarter or a year). However, if the central bank collected that information from the banks, all the effort would be unnecessary.

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