INTEREST RATE RISK AND BANK PROFITABILITY: THE CASE OF TURKEY

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I. INTRODUCTION

The attempts for financial liberalization during the 1980s have exposed Turkish commercial banks to new sources of risk which were unknown to them in the preceeding period that can be characterized as one of financial repression. Two sources of such risk exposure are the interest rate risk and foreign exchange rate risk. The fact that techniques for managing interest rate and FX exposure are either novel to the bankers or nonexistent altogether, caused some banks to expose themselves to such risks unintentionally. On the other hand, some banks regarded these as profitable opportunities, thus they took positions for speculative purposes.

The objective of this paper is to investigate the interest rate exposure of Turkish banks and to examine their impact on bank profitability. To this end, the effects of the income and investment risk

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components of interest rate risk on bank interest margins are evaluated within a simple framework. It is argued that income risk is the relevant risk concept for Turkish commercial banks, since asset and liability maturities are rather short.

The traditional banking practice of borrowing short and lending long must be the superior strategy only when banks are faced with an upward sloping yield curve. Otherwise, i.e. if the yield curve is downward sloping, a short position will lead to higher profitability. These propositions are empirically tested using cross sectional data on commercial banks for the year 1990. To proxy interest rate risk, average maturities of interest sensitive assets and liabilities are used. This approach for measurement is not very conventional in empirical work on interest rate risk, mainly because of the unavailability of data. For example FLANNERY (1981) and (1984), uses accounting revenues and costs to proxy interest rate risk, and relates these to changes in market interest rates. MITCHELL (1985) employs a two-period, two-portfolio model, to estimate the interest exposure of U.S. banks. The main emphasis in MITCHELL (1985) is how banks adopted their portfolio to changes in interest rates and financial deregulation.

AKYÜZ (1987) uses FLANERY's (1981) model to test the impact of rising interest rates on the profitability of Turkish banks. He does not find substantial evidence for higher profits in times of rising interest rates. During the period under investigation, i.e. 1969-85, AKYÜZ (1987) reports a long position for his sample of banks. HANWECK and KILCOLLIN (1984) investigate the response of bank interest margins to changes in market interest rates, without taking interest exposure into consideration explicitly. They find small numerical differences in bank profitability between large and small banks, and question the usefulness of maturity composition of assets and liabilities as a predictor of interest rate risk. However, their model does not include maturity structure as an explanatory variable. In an attempt to measure effective maturity structure, FLANNERY and JAMES (1984) utilize stock price response to interest rate changes. Their presumption in this approach is that the market values of equity should reflect the changes in the market values of bank assets and liabilities due to interest rate fluctuations.

The response of stock prices to changes in interest rates is analyzed in JAMES and FLANNERY (1984) and AKELLA and CHEN (1990). JAMES and FLANNERY (1984) relate stock price responces to maturity structure, which is measured as the ratio of net short position to the market value of equity. In cross sectional analysis, the interest rate sensitivity of stock price and net short position are found to be negatively related.

This study takes into account cross sectional differences in the maturity structures of bank assets and liabilities, and relates them to bank interest margins. Empirical evidence indicates that income risk is the relevant concept for the interest rate risk of Turkish banks, and during the period under examination, banks with longer positions have experienced lower interest margins. This finding is consistent with the presence of a downward sloping yield curve together with rising interest rates during that period. The organization of the paper is as follows: Section II contains the simple framework of the analysis of interest rate risk. Empirical findings are presented in Section III. The summary and conclusions are stated in Section IV.

II. THE MODEL

Total profits of a bank, π, are assumed to be the sum of net interest margin and capital gains (losses). Net interest margin is defined as the difference between interest income on bank assets and expenses on liabilities. Capital gains (losses) are the changes in the market values of bank assets and liabilities resulting from changes in market interest rates. Two maturity classes of assets are assumed to exist: Short-term and long-term. Mathematically, bank profits, π, can be expressed as follows:

$$\pi = r_l X_l + r_s X_s - k_l Y_l - k_s Y_s + A_l + A_s - L_l - L_s \qquad (1)$$

where,

r_l, r_s: interest rate on long and short term assets

k_l, k_s: interest rate on long and short term liabilities

X_l, X_s: book values of long term and short term assets

Y_l, Y_s: book values of long term and short term liabilities

A_l, A_s: market values of long term and short term assets

L_l, L_s: market values of long term and short term liabilities

Notice that capital gains will be nonexistent if interest rates do not change during the period, i.e. $A_l + A_s = L_l + L_s$.(1) The effects of a change in the general level of interest rates on bank profits come from two basic sources. First, changes in interest rates will affect the interest margin. If the bank has a mismatched position, i.e. $X_l = Y_l$ and $X_s = Y_s$, the interest margin is generally affected. This source of uncertainty is known as the income risk. However, the income risk component is more complex than the above statements would suggest. One complicating factor is the case when interest rates on long and short-term assets and liabilities may not change by the same amount. In other words, the term structure of interest rates can be altered. Thus, a reversal of the shape of the yield curve may strengthen or reduce the overall effect. Even when the shift in the yield curve is parallel, i.e. when both long and short rates change by the same amount, there exists other mechanisms to neutralize or strengthen the interest effect. This occurs if the adjustment of interest rates on bank assets differs from rates on bank liabilities. For Turkish banks, AYDOĞAN (1990a) argues that banks, having market power in deposit markets, can control deposit interest rates, whereas they face a higher level of competition in loan markets. The asymmetry of competition in loan and deposit markets will influence the magnitude of interest rate risk. This competitive structure effect is stronger during times of rising interest rates since market power enables banks to hold back deposit rates. It is evident that not all banks possess the market power to benefit from rising interest rates. In sum, the presence of complicating factors reduces our ability to make generalizations about the impact of changing interest rates on bank margins.

(1) Here, we implicitly assume that market values of assets and liabilities are equal at the beginning of the period.

The second basic source of the interest rate effect on bank profits is the change in the market value of assets and liabilities resulting from interest rate changes. This type of uncertainty is known as *investment risk*. In general, the market values of financial assets vary inversely with market interest rates. However, the interest rate sensitivity of those assets depend on the maturity, or on the duration to be more exact, of the asset. The longer the duration, the higher the interest sensitivity of the financial asset. The investment risk works in the opposite direction of income risk. For example, during times of rising interest rates, banks with net long positions will, in general, enjoy higher interest margins, but suffer from declining net worth.

Mathematically, it is possible to see the effects of changing interest rates on bank profits by taking a partial derivative of (1) with respect to the general level of interest rates, p:

$$\frac{\partial \pi}{\partial p} = r_s\frac{\partial X_s}{\partial p} + X_s\frac{\partial r_l}{\partial p} + r_l\frac{\partial X_l}{\partial p} + X_l\frac{\partial r_l}{\partial p} - k_s\frac{\partial Y_s}{\partial p} - Y_s\frac{\partial k_s}{\partial p} - Y_l\frac{\partial k_l}{\partial p} - k_l\frac{\partial Y_l}{\partial p} + \frac{\partial A_s}{\partial p} + \frac{\partial A_l}{\partial p} - \frac{\partial L_l}{\partial p} - \frac{\partial L_s}{\partial p} \qquad (2)$$

Since the book values of assets and liabilities are not affected by interest rate changes $\frac{\partial X_s}{\partial p} = \frac{\partial X_l}{\partial p} = \frac{\partial Y_s}{\partial p} = \frac{\partial Y_l}{\partial p} = 0$. (2) Similarly, the market values of short term assets and liabilities are not very sensitive to changes in market rates, therefore we can safely assume $\frac{\partial A_s}{\partial p} = \frac{\partial L_s}{\partial p} = 0$. As a result (2) becomes:

$$\frac{\partial \pi}{\partial p} = X_s\frac{\partial r_s}{\partial p} + X_l\frac{\partial r_l}{\partial p} - Y_s\frac{\partial k_s}{\partial p} - Y_l\frac{\partial k_l}{\partial p} + \frac{\partial A_l}{\partial p} - \frac{\partial L_l}{\partial p} \qquad (3)$$

The first four terms of (3) represent the impact on the interest margin, M. The last two terms are related to the capital gains (losses) component, G.

(2) Actually, banks may respond to interest rate changes by adjusting the composition of their portfolios of assets and liabilities. That possibility is ignored here.

$$\frac{\partial \pi}{\partial p} = \frac{\partial M}{\partial p} + \frac{\partial G}{\partial p}$$

$$\frac{\partial M}{\partial p} = +X_s \frac{\partial r_s}{\partial p} + X_l \frac{\partial r_l}{\partial p} - Y_s \frac{\partial k_s}{\partial p} - Y_l \frac{\partial k_l}{\partial p}$$

and

$$\frac{\partial G}{\partial p} = \frac{\partial A_l}{\partial p} - \frac{\partial L_l}{\partial p}$$

If there is a parallel shift in the term structure, i.e. $\frac{\partial r_s}{\partial p} = \frac{\partial r_l}{\partial p} = \frac{\partial r}{\partial p}$ and $\frac{\partial k_s}{\partial p} = \frac{\partial k_l}{\partial p} = \frac{\partial k}{\partial p}$, interest margin is not affected as long as there is no difference between the adjustment speeds of the asset and liability rates. However, as it was argued above, banks with large branch networks may hold back deposit interest rates when there is an upward movement in market rates. In that case since $\frac{\partial r}{\partial p} > \frac{\partial k}{\partial p}$, the interest margin will increase, regardless of the maturity structure: (3)

$$\frac{\partial M}{\partial p} = \frac{\partial r}{\partial p}(X_l + X_s) - \frac{\partial k}{\partial p}(Y_l + Y_s) > 0$$

Capital gains on the other hand, are nonneutral to any change in market rates as long as $A_l \neq L_l$.

When the shift in the yield curve is not parallel, i.e., $\frac{\partial r_s}{\partial p} \neq \frac{\partial r_l}{\partial p}$, and $\frac{\partial k_s}{\partial p} \neq \frac{\partial k_l}{\partial p}$, interest rate changes will have an impact on interest margins. For simplicity, assume that $\frac{\partial r_s}{\partial p} = \frac{\partial k_s}{\partial p}$, in other words, both asset and liability rates adjust at the same speed. Thus, $\frac{\partial r_s}{\partial p} = \frac{\partial k_s}{\partial p} = \frac{\partial i_s}{\partial p}$ and $\frac{\partial k_l}{\partial p} = \frac{\partial r_l}{\partial p} = \frac{\partial i_l}{\partial p}$, then:

$$\frac{\partial M}{\partial p} = \frac{\partial i_s}{\partial p}(X_s - Y_s) + \frac{\partial i_l}{\partial p}(X_l - Y_l) \qquad (+)$$

An increase in the slope of the yield curve would cause an increase in the interest margin if the bank has a net long position. Otherwise, margins are going to decline. The opposite conclusion is reached if there is a decline in the slope of the yield curve.

(3) Note that we assume $X_l + X_s = Y_l + Y_s$. This assumption is justified for the traditional commercial bank that finances fixed assets with equity, and therefore matches earning assets with non-equity funds.

As seen from equations (1)-(4), in the presence of an upward sloping yield curve, the traditional banking practice of borrowing short and lending long will cause banks to increase margins. Thus, banks with longer positions are expected to command higher interest margins. Market power in deposit collection improves margins whenever interest rates go up in general; it mitigates the unfavorable impact of a declining yield curve.

III. EMPIRICAL FINDINGS

As it can readily be inferred from the discussion in the previous section, making statements on the impact of interest rates on bank profits is quite difficult. One needs to know the initial setting and later developments in the financial markets before setting up hypotheses relating bank profitability and maturity structures of bank assets and liabilities. For this reason, the empirical part of the paper starts with a brief description of the background for the period under investigation. The empirical model and specific hypotheses are presented later. Finally, the findings are stated and discussed.

III.1. The Data and Time Period Covered

The data used in this study cover the period between January 1990-September 1990 for flow variables, and end of September 1990 for stock variables. Figures on bank financial variables are obtained from the Directorate of Banking Supervision of the Central Bank; other figures are drawn from Central Bank annual and quarterly reports, and Monthly Reports of the Undersecretariat of Treasury and Foreign Trade.

During the first three quarters of 1990, interest rates have, in general, started to move up, especially towards the end of the second quarter. This movement is not quite evident in deposit interest rates, as seen in Table 1. The rates were rather stable during the entire period. The term structure of deposit rates for 3-12 months is almost flat, while the very short end of the yield curve is lower. Interbank rates for overnight deposits, however, tell a different story. Monthly averages exhibit a significant increase from 38% to 85% starting with the second

quarter, and remain high throughout the period. The Central Bank followed the same trend in the interbank market, and starting with the second half of the year, increased the rediscount rate from 40% to 43% and then to 45% for the remainder of the year.

TABLE 1

Deposit Interest Rates

	Sight	1-month	3-month	6-month	1-year	Interbank
Jan	12.86	43.27	55.95	55.63	57.00	37.69
Feb	12.86	42.58	55.53	55.13	56.70	52.77
March	12.86	42.58	55.53	55.25	56.70	53.07
April	12.75	42.58	55.53	55.25	56.70	61.39
May	12.75	42.58	55.67	55.38	56.90	76.57
June	12.75	42.85	55.81	55.38	56.80	85.05
July	12.75	42.85	55.95	55.25	56.90	72.39
Aug	12.86	42.99	55.95	55.25	56.90	72.22
Sep	12.86	43.13	56.09	55.38	57.00	73.08

Rates on treasury bills and government bonds, on the other hand, were like the deposit rates. According to Table 2, between January 1990 and September 1990, rates did not exhibit much variation. The term structure was almost flat. With the evidence from the interbank money market and Central Bank rediscount rates, it is clear that banks must have received a signal for higher interest rates in the second half of the year. Whether this signal is reflected by the rates charged on bank assets is an empirical question which is investigated in the next section of this paper. The rates on treasury bills and government bonds did not reflect the upcoming jump in market rates later in the fourth quarter. Loan rates on the other hand, are not easy to come up with as there is no reported rate to serve like the prime rate.(4) The CBRT Annual Report argues that loan rates did not have big fluctuations during

(4) See AYDOĞAN (1990a) for a detailed discussion of computing bank lending rates in Turkey.

1990.[5] Yet it is highly unlikely that banks did not adjust rates on loans, especially short-term loans, when they started to experience higher rates in the interbank market and at the CBRT discount window. The sluggish response of deposit rates is consistent with the market power argument raised in the previous section.

TABLE 2

Interest Rates on T-bills and Bonds

	3-month	6-month	9-month	1-year	1+ year
January	46.46	48.28	50.43	50.77	57.29
February	47.37	47.70	50.00	50.26	55.57
March	47.16	49.28	49.95	50.41	55.29
April	47.05	49.50	50.59	50.54	55.29
May	47.00	50.50	50.57	50.33	55.29
June	47.58	51.27	50.80	50.39	54.30
July	50.17	52.08	51.22	n.a.	53.83
August	53.29	53.69	51.18	50.47	52.55
September	56.23	56.48	52.97	50.64	51.30

III.2. The Empirical Model

The ongoing discussion, together with the implications of equations (1)-(4), suggests that banks with net long positions should achieve lower interest margins during the first three quarters of 1990. This proposition is tested empirically using the data on 42 banks for which more reliable maturity data could be obtained. The sample banks include 5 publicly owned banks, 17 private Turkish banks and 20 foreign banks. Investment and development banks are deliberately excluded from the study. Other commercial banks are left out because of auditor statements about the inadequacy of asset-liability maturity information.

The empirical model tries to explain cross sectional differences in bank interest margins through the asset-liability maturity positions of the banks. As there are other factors that explain interest margins, they are included in the model as control variables. These variables are used

(5) CBRT (1990a) Annual Report, pp 33.

in AYDOĞAN (1990b) to explain cross sectional variation in bank profits. The model in specified as follows:(6)

where,

INTMAR : interest margin, defined as the difference between interest income and interest expenses,

CAPTA : Ratio of total equity to total assets,

PARTA : Ratio of equity participations to total assets,

DEPSHR : Share of deposits in the banking system,

AVMAT : Average net maturity position of asset and liability structures of banks.

are parameters and ϵ_i is the error term.

In this model, we expect positive signs for CAPTA and DEPSHR; negative signs for AVMAT and PARTA. The ratio of equity capital to total assets, CAPTA, is an indicator of capital adequacy. Use of equity as a source for bank earning assets will generally reduce the economic profits of a bank since the cost of equity is higher than the cost of alternative funding sources like deposits and borrowed funds. However, the cost of equity is an opportunity cost, and therefore is not accompanied by an explicit payment. Hence, banks with high equity positions would report higher margins as interest payments on equity funding do not exist. PARTA, on the other hand, is a proxy for asset quality. Some commercial banks have accumulated significant equity interest in non-financial corporations, either deliberately as a result of

(6) We are not testing the investment risk effect in this model. As it is discussed below, asset and liability maturities in Turkey are rather short. This reduces the price response of financial assets to interest rate changes. Moreover, capital gains (losses) are not recorded until realized, so that reported income (loss) for the period is not the same as the actual. The standard income statement does not report capital gains (losses) separately. Instead they are collected under the *extraordinary gains and losses* item on the income statement.

corporate strategy, or they had to acquire equity in exchange for the non-performing loans of a corporation. No matter how equity participations are acquired, income from them, neither dividend income nor capital gains will be reflected in interest margins. However, the presence of equity participations may indicate loans with preferential terms to these corporations, and they will lead to lower interest margins. DEPSHR is a proxy for market power, therefore it should be positively related with the net interest margin. The coefficient of AVMAT has to be negative due to the presence of a downward sloping yield curve, as evidenced by increased interbank rates.

The average net maturity position of a bank is defined as the difference between the average maturity of interest sensitive bank assets and the average maturity of bank liabilities. Average maturities of balance sheet items are obtained from the Directorate of Banking Supervision of CBRT. This information is provided by banks periodically on form number GE310, which classifies a balance sheet item on term-to-maturity expressed in months. The average maturity of assets are defined as the weighted average of term-to-maturity of all interest sensitive assets, the weights being the amounts in a particular maturity class. A similar computation is made for the interest sensitive liabilities. The difference is the net maturity variable of interest.

TABLE 3

Average Maturity Structures

	Av. Maturity of Assets	Av. Maturity of Liab.	Net Position
State Banks	13.14	6.88	6.26
Turkish Banks	6.76	3.34	3.42
Foreign Banks	5.01	2.11	2.91
All Banks	6.69	3.18	3.51

A closer look at average maturity structures reveals some important points on gap management. In general, the maturities of assets and liabilities are remarkably short. The overall average asset maturity is 6.69 months, and liabilities mature in 3.17 months on the average. Table 3 contains the term-to-maturities of various groups of

banks. State banks have longer maturities in both assets and liabilities. They are followed by Turkish private banks, and finally by foreign banks, with amazingly shorter maturities. Net maturity positions do not exhibit similar differences across banks of different classes. However, private Turkish and foreign banks are closer to each other.

Measurement problems with balance sheet items maturing in more than a year hamper the average maturity variable described above. First of all, form GE310 does not distinguish maturities above one year in detail. Thus, an arbitrary average assignment had to be done.(7) Second, the interest sensitivity of long-term assets and liabilities may be questionable. For example they may consist of items like preferential loans, loans to equity participations, etc. Therefore, an alternative maturity variable is constructed only including assets and liabilities maturing in less than one year.

TABLE 4

Average Maturity Structures

	Av. Maturity of Assets	Av. Maturity of Liabilities	Net Position
State Banks	2.35	3.80	-1.45
Turkish Banks	2.83	3.12	-0.29
Foreign Banks	2.81	1.95	0.86
All Banks	2.76	2.64	0.12

The new maturity variable shows a remarkable difference from the first one. As indicated in Table 4, the average maturity of assets of 2.76 months is almost identical to that of liabilities maturing in 2.64 months. However, when we examine different classes of banks, significant differences in net maturity structures can be observed. Specifically, state-owned banks are in a short position, private Turkish banks are almost matched, and foreign banks carry a slightly net long position.

(7) Items maturing in more than a year are assumed to have an average maturity of 24 months. We also tried an average of 18 months (not reported), but the results did not change.

III.3. The Findings

The empirical model in equation (5) is estimated twice, using two alternative maturity variables one at a time. The results are summarized in Table 5. When the former maturity variable is used, all explanatory variables carry the expected signs. However, only the coefficients for CAPTA and PARTA are significant. Although it is negative as hypothesized, the coefficient for the net maturity structure, AVMAT, is not statistically different from zero. The market power variable, DEPSHR, has a positive coefficient as expected, but is significant at a level of 0.15.

The second maturity variable, referred to as AVMAT2 in Table 5, gives better results. The sign of the regression coefficient for this variable is negative but the attained significance is 0.14. Signs of other variables are the same as before.

It is clear that the extent of equity funding and asset quality can explain cross sectional variation in bank margins quite succesfully. Maturity structure and deposit shares are only marginally significant, mostly with the correct sign. A longer time period could improve the results, especially for maturity variables. When the values of CAPTA for individual banks are analyzed it is seen that equity funding is an important source of funds for smaller and foreign banks. These banks do not depend on the traditional source, i.e. deposits, for funding their assets. As equity does not require explicit interest payments, margins turn out to be higher. Actually, when CAPTA is excluded from the model, the sign of AVMAT is reversed. PARTA, on the other hand, is higher for medium and large Turkish banks, both private and public. In our opinion, the negative sign of PARTA is due to the presence of loans outstanding at less than competitive rates for those companies.

TABLE 5

Estimation Results

Variable	Coefficient	t-stat	Variable	Coefficient	t-stat
Constant	0.0201	2.29	Constant	0.0180	2.43
CAPTA	0.3521	10.96	CAPTA	0.3686	11.14
PARTA	-0.2574	-2.70	PARTA	-0.3174	-3.08
DEPSHR	0.1393	1.53	DEPSHR	0.1223	1.42
AVMAT1	-0.008	-0.81			
			AVMAT2	-0.0026	-1.51
	R^2_a = 0.76			R^2_a = 0.77	

Alternative measures for the maturity structure are also considered. Equation(4) implies that banks with short term assets exceeding short term liabilities should achieve higher margins when short rates go up with unchanged long rates. Another proxy for the maturity structure could be the ratio of long-term assets to short-term assets. The empirical model(5) is reestimated twice by replacing AVMAT first with the ratio of short-term assets to short-term liabilities, STASTLB, and then with the ratio of long-term assets to short-term assets, LTASTA. The results are presented in Table 6. Contrary to our expectations, the coefficient for STASTLB is negative, although it is not statistically significant. The regression coefficient for LTASTA is negative, yet it also lacks significance.

TABLE 6

Estimation Results

Variable	Coefficient	t-stat	Variable	Coefficient	t-stat
Constant	0.0234	2.92	Constant	0.0203	2.67
CAPTA	0.3576	10.90	CAPTA	0.3520	10.57
PARTA	-0.3354	-4.40	PARTA	-0.3141	-4.12
DEPSHR	0.1011	1.19	DEPSHR	0.1112	1.19
STASTLB	-0.0018	-0.89			
			LTASTA	-0.0001	-0.07
	R^2_a = 0.74			R^2_a = 0.74	

IV. CONCLUSIONS

This paper investigates the interest rate risk exposure of Turkish commercial banks for the period extending into the first three quarters of 1990. The simple model developed in Section II set up the framework for empirical analysis. The link between interest margins and maturity structures of bank asset and liabilities under different background scenarios of interest rate movements were specified. It is hypothesized that during the period under investigation, banks with net long positions should experience lower margins. In order to test this hypothesis empirically, alternative measures for asset-liability maturity structures were constructed, and were used as an explanatory variable with other control variables to explain cross sectional variation in net interest margins. Although maturity variables mostly carry the correct sign, they are not statistically significant.

The period covered in this study is not long enough for market interest rates to reveal their long term movement. As the reader will recall from the discussion in Section III, no change in deposit and government bond interest rates was observed in this period. The only hint for an increase in market rates came from the interbank market and Central Bank rediscount rates. Therefore, claiming that there was an upward shift in the yield curve with a decline in its slope may be a premature statement, especially after witnessing the increase in the level of longer term rates later in the year. Another shortcoming of the empirical analysis is the use of stock variables to reflect the maturity composition of bank assets and liabilities. As they reflect the position of a bank as of the end of the period, an implicit assumption that banks have been carrying the same position throughout the period is required.

A possible avenue for further research is to extend the period covered for a similar study. This way, longer movements in market rates can be observed, and the impact of stock variables can be reduced by averaging them intertemporally. Additionally, foreign exchange exposure risk can be incorporated in the study. Inclusion of foreign exchange risk will complete the overall picture for the risk exposures of Turkish banks.

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