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Macroeconomic Uncertainty and Bank Lending: The Case of Ukraine

Abstract

Our study investigates the link between bank lending behavior and macroeconomic uncertainty. We develop a dynamic model of a bank's value maximization that results in a negative relationship between loan to capital ratio and macroeconomic uncertainty. This proposition is tested using a panel of Ukrainian banks collected from NBU and covering the period 2003q1-2005q3. The results indicate that banks increase their lending ratios when macroeconomic uncertainty decreases. We demonstrate that our results are robust with respect to the measurement of macroeconomic uncertainty. The reaction of banks to changes in uncertainty is not uniform and depends on bank-specific characteristics.

Keywords: Banks, macroeconomic uncertainty, Ukraine, banks' balance sheets

JEL: G21, G28, P27, P34

1 Introduction

During the last decade there is an emerging body of theoretical and empirical literature focused on banks' behavior. Such interest toward a bank system is caused by multiple instances of relations between a level of overall economic development, a standard of living and development of financial sector. Hence, bank lending decisions can be important not only to the financial sector, but to the whole economy as well. In this paper we explore the relationship between bank capital structure and macroeconomic environment. Specifically, we ask whether banks change lending behaviors in response to changes in macroeconomic uncertainty.

Funds are always available for positive net present value investment projects and the firm value is independent of its financial structure (Modigliani and Miller (1958)). Internal and external finance can be viewed as perfect substitutes in a world with perfect capital markets and without information asymmetries, transaction costs, or taxes. However, the real world is imperfect and the determination of optimal capital structure is considered as one of the important tasks of companies and banks. Therefore, some potentially profitable project can get no funding. Diamond and Rajan (1999) suggest that optimal bank capital structure trades off the effects of capital on the easiness of borrower repayment forcing, the expected costs of bank distress and liquidity creation.[1] Bigger banks are found to reduce liquidity creation and survive more often, thus avoiding bankruptcy than smaller banks.

Several papers have analyzed the interaction between macroeconomic environment and balance sheet structure. Topi and Vilmunen (2001) investigate the effects of monetary policy on bank lending channel for Finland. They find that bank lending responds positively to changes in real income and inflation, but negative to monetary policy shocks. Stein (1995) develops a theoretical model of bank asset and liability management and conclude that monetary policy affects bond-market interest rates only because of imperfections in the banking sector. Kashyap and Stein (2000) show that the impact of monetary policy on bank lending behavior is particularly strong for small American

[1]According to the modern theory of financial intermediation banks create liquidity by financing relatively illiquid assets, such as long-term commercial loans, into more liquid liabilities, such as short-term deposits. Bank liquidity creation may have important effects on economic growth by facilitating investments by firms, while allowing households and other firms that provide the savings to have access to liquid funds.

firms with less liquid balance sheets. Among other macroeconomic environment factors, uncertainty also plays a significant role in explaining changes in bank capital structure. Baum, Caglayan and Ozkan (2003) suggest that macroeconomic uncertainty plays an important role for explaining banks' lending decisions. They find that *growth* of total loans has a positive relationship with uncertainty proxies. None of these papers addresses the issue examined here, namely the relationship between asset structure of banks and macroeconomic volatility.[2] In terms of empirical prediction, a key feature of our paper is the link between the *level* of credits to capital ratio and conditional variances of macroeconomic indicators.

This paper adopts the theoretical models of Hubbard (1998) and Love (2003) by applying a Q model of investment to a representative bank. Banks managers choose optimal levels of investment, deposits from business agents, and credits to business agents to maximize bank's value, equal to a discounted stream of dividends. The model predicts a decrease in loan to capital ratio of the bank when macroeconomic uncertainty increases.

To test the model's predictions, we apply the System GMM estimator (Blundell and Bond, 1998) to a panel of Ukrainian banks. The banks data set is based on quarterly data on Ukrainian banks' balance sheets, which is published in the official NBU's monthly *'Visnyk NBU'* with in-depth data on the structure of bank's assets, liabilities and capital. After screening procedures our data in one sample include more than 1,500 quarterly bank observations with upwards of 150 banks per quarter. Since the impact of uncertainty may differ across categories of firms, we also consider splits of the sample on large and small banks, as well as on most- and least–profitable banks.

Our main empirical findings can be summarized as follows. We find strong evidence for a negative association between the optimal level of bank lending and macroeconomic uncertainty as proxied by the conditional variance of consumer or producer inflation or volatility of money supply (M1 and M2) and its components (demand and time deposits) growth. There are also differences in sensitivity of lending with respect to macroeconomic uncertainty among banks' size and profitability subsamples.

This research is particular important during the period of fast lending growth. According to the International Monetary Fund, Ukraine experiences a credit boom.[3] While

[2]We use the terms *uncertainty* and *volatility* interchangeably.

[3]See International Monetary Fund (2004). Rapid credit growth occurs as part of financial deepening

the distinction between the rapid growth and a boom is arbitrary for economies in transition, there is also high probability of financial crisis, coming from macroeconomic imbalances and banking sector distress. Thus, policymakers should minimize the risks of crisis, at the same time, allowing lending to contribute to a higher growth of the economy.

The rest of this paper is organized as follows. Section 2 presents the theoretical framework. Section 3 describes the data and illustrates econometric results. Finally, Section 4 briefly reviews the conclusions.

2 Theoretical model

2.1 Model setup

The first step of our analysis is to setup a framework of a bank that consumes deposits and produces loans. Our basic model is a simple representation of a dynamic problem, which is standard in the investment literature. It is focused on the bank value optimization problem and represents a generalization of the standard Q models of investment.[4] The bank's managers choose investment, borrowing and loans to maximize at time t the present value of the bank, equal to the expected discounted stream of D_t, dividends paid to shareholders[5]

$$V_t(K_t) = \max_{\{I_t, B_{t+1}, L_{t+1}\}_{s=0}^{\infty}} E_t \left[\sum_{s=0}^{\infty} \beta_{t+s} D_{t+s} \right] \tag{1}$$

where β_{t+s} is the discount factor used in period t to discount expected dividends in period $t+s$, with $\beta_t = 1$. $E_t[.]$ denotes an expectation conditioned on information available in period t.

The bank maximizes equation (1) subject to four constraints. The first is capital stock accounting identity

$$K_{t+1} = (1 - \delta)K_t + I_t, \tag{2}$$

(trend) and normal cyclical upturns. A credit boom represents an excessive and therefore unsustainable cyclical movement.

[4]See papers by Love (2003), Hubbard (1998).

[5]The bank index i is suppressed except when needed for purposes of clarity.

where K_t is beginning-of-the-period t capital stock, I_t is the investment expenditures at time t, and δ is the constant rate of capital depreciation. The second constraint defines bank dividends

$$D_t = \Psi(K_t, \xi_t) - C(I_t, K_t) - I_t + B_{t+1} - (1 + r_t^B(B_t, K_t))B_t \tag{3}$$
$$-L_{t+1} + a(\nu_t)L_t(1 + r_t^L(L_t)),$$

where

$\Psi(K_t, \xi_t)$ = the maximized value of current profit taking as giving the beginning-of the-period t capital stock, and a profitability shock ξ_t,

$C(I_t, K_t)$ = real cost of adjusting I_t units of capital at time t,

B_{t+1} = bank's borrowing from households and firms at time t,

$r_t^B(B_t, K_t)$ = interest rate for borrowing, B_{t+1} determined at time t,

L_{t+1} = bank's lending to households and firms at time t,

$r_t^L(L_{t+1})$ = net interest rate for lending, L_{t+1}, determined at time t,

$a(\nu_t)$ = the percentage of returned loans at time t, is a decreasing function of macroeconomic uncertainty, ν_t. Higher uncertainty leads to higher probability of credit default.

Financial frictions are introduced through a non-negativity constraint for dividends, $D_t \geq 0$ and the corresponding Lagrange multiplier $\lambda_t = \partial V_t / \partial K_t$.

$$D_t \geq 0 \tag{4}$$

The last equation is for a transversality condition, which prevents the bank from borrowing an infinite amount and paying it out as dividends.

$$\lim_{T\to\infty} \left[\Pi_{j=t}^{T-1} \beta_j\right] B_T = 0, \forall t \tag{5}$$

Substituting (3) into (1) for D_t, and using (2) to eliminate I_{t+1} from the problem, the first order condition for investment can be calculated as:

$$C_I(I_t, K_t) + 1 = \beta E_t\{\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}\Psi_K(K_{t+1}, \xi_{t+1}) \tag{6}$$
$$+(1-\delta)\left(C_I(I_{t+1}, K_{t+1}) + 1\right) - B_{t+1}\frac{\partial r_{t+1}^B(B_{t+1})}{\partial K_{t+1}}\}$$

where λ_t is the shadow value of an additional unit of installed capital in period t. Expression $\beta\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}$ is a stochastic time-varying discount factor which is equal to β if we do not have financial constraints ($\lambda_{t+1} = \lambda_t$).

The first order conditions for borrowing, B_{t+1} and lending,L_{t+1} give us

$$1 = \beta E_t\{\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}(1 + r^B_{t+1}(B_{t+1}) + B_{t+1}\frac{\partial r^B_{t+1}}{\partial B_{t+1}})\} \tag{7}$$

$$1 = \beta E_t\{a(\nu_{t+1})\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}(1 + r^L_{t+1}(L_{t+1}) + L_{t+1}\frac{\partial r^L_{t+1}}{\partial L_{t+1}})\} \tag{8}$$

Combining equations (7) and (8), we get the expression for the optimal level of loans by bank

$$L_{t+1} = \left[-\frac{\partial r^L_{t+1}}{\partial L_{t+1}}\right]^{-1}\left(1 + r^L_{t+1} - \left[1 + r^B_{t+1} + B_{t+1}\frac{\partial r^B_{t+1}}{\partial B_{t+1}}\right] E\left[\Lambda_t\right]\right) \tag{9}$$

where $E\left[\Lambda_{t+1}\right] = \frac{E_t\{\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}_t\}}{E_t\{a(\nu_{t+1})\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}\}+cov(a(\nu_{t+1}),\frac{(1+\lambda_{t+1})}{(1+\lambda_t)})}$ is a measure of bank's financing constraints and macroeconomic uncertainty as well.[6] Note, if $a(\nu_{t+1}) = 1$ which means that all credits are returned, then $cov(1, \frac{(1+\lambda_{t+1})}{(1+\lambda_t)})$ and $E\left[\Lambda_{t+1}\right] = 1$. Similarly, if the bank faces no financing constraints, $\lambda_t = \lambda_{t+1}$ then $E\left[\Lambda_{t+1}\right] = 1$ as well.

Equation (9) is not linear in B_{t+1} and Λ_t, so we linearize it around a steady state.[7]

$$\widehat{\frac{L}{K}}_{t+1} = \frac{\eta^B r^B}{\eta^L r^L}\Lambda\widehat{\frac{B}{K}}_{t+1} + \frac{\left[1 + r^B + \eta^B r^B\right] r^L \Lambda}{\eta^L}\widehat{\Lambda}_{t+1} + \left(\frac{\eta^B r^B}{\eta^L r^L}\Lambda + 1\right)\widehat{K}_{t+1}$$

where we assume that $\eta^B = \frac{\partial r^B}{\partial B}\frac{B}{r^B} > 0$ and $\eta^L = \frac{\partial r^L}{\partial L}\frac{L}{r^L} < 0$. The elasticity of deposits supply with respect to deposit interest rate is positive. If the bank wants to attract more funds from firms and individuals, it has to increase the deposit interest rate. The elasticity of loans demand with respect with credit interest rate is negative. Business agents are expected to decrease demand for external financing when its price increases.

We parameterize the expression for $\widehat{\Lambda}_{t+1}$ as a function of profit to capital ratio in the current period, macroeconomic uncertainty and loans to total capital ratio in the previous period:

$$\widehat{\Lambda}_{t+1} = \alpha_0 + \alpha_1\widehat{\frac{L}{K}}_t + \alpha_2\widehat{\frac{\Pi}{K}}_{t+1} + \alpha_3\tau_t + f_i + e_{it}$$

[6]In the model macroeconomic uncertainty enters into the model through the default channel. We assume that the defaults are more costly when uncertainty is higher. However, there are other channels (e.g. lending or borrowing interest rates), not incorporated into the model.

[7]See Gilchrist and Himmelberg (1998) for a similar linearization approach.

where α_0 is a bank–specific level of financing constraints, which enters into fixed effects, $\widehat{\frac{L}{K}}_t$ is the bank's loans to capital ratio, $\widehat{\frac{\Pi}{K}}_{t+1}$ is the bank's profit to capital ratio, and τ denotes volatility at macrolevel. The sensitivity of bank's lending to macroeconomic uncertainty, measured by the parameter α_3, is the main focus of this paper. Moreover, the negative sign of α_2 and positive sign of α_1 are expected. The higher leverage ratio in the previous period imposes additional financial constraints, while increase in profits releases them.

2.2 Empirical model

After rewriting our model one lag back and plugging our parametrization equation into the equation for optimal $\widehat{\frac{L}{K}}_{t+1}$, we receive econometric specification for bank i:

$$\widehat{\frac{L}{K}}_{it} = \gamma_0 + \gamma_1 \widehat{\frac{B}{K}}_{it} + \gamma_2 \widehat{\frac{L}{K}}_{it-1} + \gamma_3 \widehat{\frac{\Pi}{K}}_{t} + \gamma_4 \widehat{K}_t + \gamma_5 \tau_{t-1} + f_i' + \varepsilon_{it} \tag{10}$$

where

$\widehat{\frac{L}{K}}_{it}$ = loans to capital ratio of bank i at time t

$\widehat{\frac{B}{K}}_{it}$ = bank's borrowing to capital ratio of bank i at time t

$\widehat{K}_t$ = the natural logarithm of own capital of bank i at time t

τ_{t-1} = macroeconomic uncertainty measures at time $t-1$. It is described in the next subsection.

With respect to the coefficient in equation (10), the main hypothesis of this paper is formulated as:

$$H0 : \gamma_5 = \frac{\alpha_3 r^L \Lambda \left[1 + r^B + \eta^B r^B\right]}{\eta^L} < 0 \tag{11}$$

The nominator of the expression in inequality (11) is positive because of elasticity of deposit supply with respect to interest rate, η^B, expectation of model distortion, Λ, and positive sensitivity of distortion with respect to macroeconomic uncertainty, α_3. The denominator of the expression is negative because of negative elasticity of credits demand with respect to credit interest rate.

2.3 Identifying Macroeconomic Uncertainty

The literature points out good candidates for macroeconomic uncertainty proxies such as moving standard deviation (see Ghosal and Loungani (2000)), standard deviation across

12 forecasting terms of the output growth and inflation rate in the next 12 months (see Driver and Moreton (1991)).

However, as in Driver, Temple and Urga (2005) and Byrne and Davis (2002), we use a GARCH model for measuring our first proxy of macroeconomic uncertainty. We argue that this approach suits better in our case because disagreement among forecasters may not be a valid uncertainty measure and it may contain measurement errors. Finally, conditional variance is a better candidate for uncertainty comparing to unconditional variance, because it is obtained using the previous period's information set. This macroeconomic uncertainty identification approach resembles the one used by Baum, Caglayan, Ozkan and Talavera (2006). Banks determine the optimal loan to total capital ratio in anticipation of future macroeconomic shocks.[8] The difficulty of evaluating the optimal amount of lending increases with the level of macroeconomic uncertainty.

We draw our series for measuring macroeconomic uncertainty from monthly monetary aggregates M1 and M2[9] as well as consumer price index (CPI) and producer price index series. The first two series are available on a monthly basis from the National bank of Ukraine. The price indices are produced by the State Statistics Office. We build a generalized ARCH (GARCH(1,1)) model for all these series, where the mean equation is an autoregression. We use not only lagged but also weighted conditional variances of variable. The introduction of arithmetic lags proxies allows us to capture the combined effects of contemporaneous and lagged levels of uncertainty.[10]

We use daily PFTS index returns to compute the uncertainty proxy using two methods. The first method is based on Merton (1980).[11] This approach avoids potential model specification problems as in the GARCH. In order to employ the Merton (1980) methodology we first take the squared first difference of the daily changes in returns, divided by the square root of the number of trading days. This difference is defined as the daily contribution to annual volatility. This approach provides a more representative

[8] While in the existing literature loans to assets ratio is more widely used, different normalization does not changes the results notably because capital-to-assets ratio usually changes in a very narrow band.

[9] In the econometric specification we actually used not only these aggregates, but their derivatives as well, namely demand deposits in UAH *(M1-M0)*, time deposits in all currencies *(M2-M1)*.

[10] Some caveats should be noted in the approach described above. The choice of a particular proxy for generating macroeconomic uncertainty might be dependent upon the choice of the model and exhibit significant variability over specifications.

[11] The daily returns series are taken from the PFTS website, http://www.pfts.com.ua.

measure of the perceived volatility while avoiding potential problems, such as the high persistence of shocks. Furthermore, using absolute returns we use the bipower variation measure of uncertainty described in Ghysels, Santa Clara and Valkanov (2004).

As can be seen from Table 2, there are three distinct groups of uncertainty proxies: monetary (M1, M2, demand deposits, time deposits), price indices (PPI, CPI) and stock indices. Correlation within each group is high but correlation between proxies from different groups is low, which is hardly surprising, bearing in mind the nature of these series. Therefore we can use them for composition of complimentary proxies, which should demonstrate the robustness of our results.

Ideally, other proxies could also be used for uncertainty measurement (e.g. industrial production or gross domestic product). However, most of these series are either too short or unreliable. For example, in the case of the real GDP or industrial production series, even the State Statistics Office's own publications inform that monthly series are calculated unsatisfactory and, therefore, cannot be used in an econometric analysis. More reliable data are available only on a quarterly and annual basis, which is not satisfactory for a GARCH estimation.

3 Empirical Implementation

3.1 Data set

In order to construct bank-specific variables, we utilize the data items loans, profits, capital and total assets. We use quarterly data on all Ukrainian banks' balance sheets, which are published in the official NBU's monthly *'Visnyk NBU'*.[12]

The NBU data set has 1,578 observations on each variable from 2001q1 to 2005q3.[13] After exclusion of newly arrived and closed banks we received 131 banks. In order to alleviate the influence of extreme observations, bank level variables are winsorized at the most extreme (top and bottom) one percent level of the distribution on an annual basis. In order to work only with long time series for an individual bank, we exclude all banks,

[12] Referred henceforth in the paper as the NBU data set.

[13] Variables include in-depth data on structure of bank's assets, liabilities and capital. Some series contain only 799 observations. This is due to the fact that several variables were introduced only since2004q2.

which have less than half time points.[14] While even the larger sample gives satisfactory results, it is better to "clean-up" the data before starting empirical investigations. This reduced the number of available observations to 1,171.

For investigation of the effects of macroeconomic uncertainty on groups of banks having similar characteristics we firstly divide the bank data into small and large banks. A bank is defined as *SMALL* if its average yearly assets are below the median, otherwise it is considered as *LARGE*. Second, we categorize banks as most profitable and least profitable or non-profitable. A bank is defined as *MOST PROFITABLE* if its average over the years net profits are above the median, otherwise it is considered as *LEAST PROFITABLE*.

The basic descriptive statistics of the data are available it Table 1. For credit or lending we use *Credits and accounts receivable* items of balance sheets; for capital – *Total own capital* items. For profits we use *Benefit/loss in accounting period to be confirmed* and for borrowing – *Clients assets*.

3.2 Results for All Banks

In this section we investigate the extent to which lending behavior responds to volatility in macroeconomic environment. We start our analysis evaluating the full sample of Ukrainian banks using the NBU data set. We later look at how results differ across sub-samples where data are split based on banks' capital measures.[15]

Estimates of the optimal bank capital structure measures usually suffer from endogeneity problems, and the use of instrumental variables may be considered as a possible solution. We estimate our econometric models using two-step GMM–SYSTEM dynamic panel data estimator. The GMM-SYSTEM, unlike the usual GMM, uses not only transformed equations but combines transformed equations with level equations (see Blundell and Bond (1998)). Lagged levels are used as instruments for transformed equations and lagged differences are used as instruments for level equations. The models are estimated using a first difference transformation to remove the individual bank effect.

The reliability of our econometric methodology depends crucially on the validity of

[14] Series can have a maximum of ten time points. All banks that have less than five time points are newly-entered banks.

[15] Similar estimates were made using the alternative data set from the AUB. The results were quite similar, thus we report only results on one data set to avoid confusion.

its instruments. We check it with Sargan's test of overidentifying restrictions, which is asymptotically distributed as χ^2 in the number of restrictions. The consistency of estimates also depends on the serial correlation in the error terms. We present test statistics for first-order and second-order serial correlation. The results are estimated using (Windmeijer, 2000) finite sample correction. We estimate different model specifications using XTABOND2 module for Stata package. The matrix of instruments includes for all firms estimation includes L/K_{t-3} to L/K_{t-6}, D/K_{t-2} to D/K_{t-5}, Π/K_{t-2} to Π/K_{t-5}, K_{t-2} to K_{t-5} and $\Delta L/K_{t-2}$ to $\Delta L/K_{t-5}$, $\Delta D/K_{t-1}$ to $\Delta D/K_{t-4}$, $\Delta\Pi/K_{t-1}$ to $\Delta\Pi/K_{t-4}$ and ΔK_{t-1} to ΔK_{t-4}.[16]

The results of estimating equation (10) for all banks are given in Tables 3 – 4. The columns of Table 3 represent the final result of two-step GMM System estimator with weighted conditional variance of four different monetary parameters: M1 monetary aggregate growth,[17] M2 monetary aggregate growth,[18] domestic currency demand deposits growth,[19] and time deposits.[20] The sign of all proxies is in line with theoretical expectations and three of them (M1, M2 and demand deposits) are significant at 1 percent level. However, the low significance of the measure based on time deposits can be explained by the fact these funds can not be as easily withdrawn compared to funds on demand deposits.

The estimation results suggest the existence of a significant negative relationship between a bank's behavior and macroeconomic uncertainty measured with proxies, based on monetary aggregates. The statistically significant coefficients vary from -170.1 to -28.8 for M2 and demand deposits measures, respectively. The difference is caused mainly by the different nature of the proxies and to the degree in which they can be managed by authorities. Elasticity of lending with respect to change in macroeconomic uncertainty is equal -0.022 for M1-based proxy, -0.020 for M2 and -0.056 for demand deposits-based proxy. This means that regardless of macroeconomic uncertainty, measured by the

[16]See help for XTABOND2 (Roodman, 2004) for matrix of instruments selection. In subsamples we use a shorter list of instruments, dated from $t-1$ to $t-2$.

[17]Currency and demand deposits in domestic currency, mn UAH end of period. This series is considered more volatile, because deposits can be withdrawn at any moment.

[18]M1 plus time deposits (both domestic and foreign currency). Preliminary withdrawal of time deposits is much harder than for demand deposits, often different sanctions apply, e.g. no interest payments. Therefore this aggregate is considered more inertial.

[19]M1 minus currency outside the banking system (M0 aggregate). In our tables it is denoted as $M1*$.

[20]M2-M1. In our tables it is denoted as $M2*$.

M1-based proxy increases twofold (100% growth), the lending ratio decreases by 2%. Interestingly, the larger the level of variable (demand deposits are parts of M1 and M1 is a part of M2), the smaller the relative change needed. Another important outcome is the persistence in the overall credits to capital ratio in period $t-1$, equal to 0.5–0.539, is also observed, which suggests that on a quarterly basis inertia can define only a half of bank's lending. The last statistically significant coefficient in all specifications – deposits to capital ratio is also close to one-half, ranging from 0.496 to 0.504. The Table 4 represents the result with the weighted conditional variance of consumer price index (CPI) producer price index (PPI), as well as two different possible proxies based on the stock index. As can be seen, price indices are highly significant, while either proxy based on the stock index is statistically insignificant. One of the stock index proxies has the theoretically unpredicted sign. This fact and insignificance of the stock indices can be caused by the underdeveloped stock market and the fact that less than 5 percent of all purchases/sales of shares is made through legal stock markets.

3.3 Results for Subsamples of Banks

Having established the presence of a negative role for macroeconomic uncertainty on bank's lending, we next investigate whether the strength of association varies across groups of banks with differing characteristics. There are interesting differences across the large and small banks categories. Results for large banks (Tables 5–6) are similar to results of all banks. The significance of monetary proxies is notably reduced, with only 3 proxies having the statistically significant coefficients (at 5% (for M1, M2) and 10% (for demand deposits) significance level). This can be caused by a small sample or by market-making position of large banks. Over 80% of all deposits are located in these banks. At the same time there is a highly–significant negative relationship between large bank lending behavior and macroeconomic uncertainty measured by either CPI or PPI. As in the case of all banks, the stock market volatility has no significant effect on large banks. The effect of inertia measured by the lagged autoregressive term decreased slightly, while importance of borrowing (deposits-to-capital) increased in the sub-sample.

For small banks (Tables 5–6) the results are opposite: we have revealed significant relationship between bank's lending behavior and macroeconomic uncertainty when uncertainty measure is based on M1 monetary aggregate and on the stock market index, unlike large banks. Time and demand deposits do not have a notable effect on lending behavior, while prices indices do indeed. This suggests that while some measures of uncertainty affect banks regardless of their size, others are clearly size–specific. This allows for a shift of lending from large to small banks or vice versa when only one measure of uncertainty has changed. Changes in monetary aggregates, which can be related to the macroeconomic policies are relatively more important for large banks than for the small counterparts. This result suggests that small banks are less able to change their behavior over time in response to changes in the monetary policy and their lending depends to a much greater extent on capital. Small banks' behavior heavily depends on their structure of existing assets. This can be explained by the fact that small banks in Ukraine are often referred to as "pocket banks" due to an extreme concentration of credits to one, (usually affiliated) entity. These points can be considered as hypotheses for the future research.

At the same time, lending behavior of small banks is notably affected by changes in inflation and stock market indices, while for large banks this influence is less significant. This maybe caused by the fact that only large are able (or willing) to credit industrial enterprizes, which products affect the producer price index the most. It is possible that this indirectly shows close relations of enterprizes and banks of the same financial and industrial groups.

The second grouping of banks, based on their profitability gave slightly different results (see Tables 5–6). First of all, for both groups of banks, only proxies based on price indices are statistically significant. At the same time, proxies based on monetary aggregates are highly significant at 1% level in the case of more profitable banks,[21] while in the case of less profitable banks they are not significant even at 10% level. Both PPI and CPI are more significant for more profitable banks (1% level) than for the less profitable ones (5% level). Stock exchange indices have very minor effect on any group, and in the case of more profitable even the sign is incorrect.

Thus, we receive empirical confirmation of our analytical hypothesis. An increase in the level of macroeconomic uncertainty leads to narrowing of bank lending. The result is robust, because different proxies yield the same theoretical outcome. We show the differences in behavior of small and large banks and of more and less profitable

[21] Except for time deposits that are not significant.

banks. Different groups of banks have different sensitivity to changes in macroeconomic environment as measured by different proxies. This can allow for a shift of lending from one group of banks to another when only one measure of the uncertainty has changed.

4 Conclusions

The paper investigates the link between the commercial banks lending and macroeconomic uncertainty. We develop a dynamic partial equilibrium model of a representative bank that maximizes its value, equal to a discounted stream of dividends. Based on theoretical predictions, we claim that higher uncertainty leads to lower lending due to the increased risks associated therewith.

We examine the empirical predictions of this model on the sample of Ukrainian banks. Using eight alternative measures of macroeconomic uncertainty, we find out that banks decrease their supply of credits when volatility of macroeconomic variables increases. Consistent with the value-maximizing model, we find significant evidence that banks increase credit supply when macroeconomic uncertainty decreases. This effect remains after controlling for size, profitability, and the deposits to capital ratio. We also find a distinct sensitivity of contrasted groups of banks with respect to different proxies for macroeconomic uncertainty. The result is achieved for groupings based on size and profitability of banks.

This evidence sheds light on three sets of questions. First, the estimated effects of macroeconomic uncertainty are consistent with the predictions from the dynamic model of bank value maximization. Moreover, some macroeconomic uncertainty proxies have marginal or no effects on some groups of banks. Second, our results contribute to the existing literature of a bank lending channel for monetary policy.[22] Through this channel banks affect bank–dependent borrower's ability to finance their investment projects. There is substantial evidence for effects of monetary policy on banks' balance sheets (see, e.g. Kashyap and Stein (1995)). If macroeconomic uncertainty increases then borrowers face the costs of switching from one bank to another. When a bank's financial situation reflects borrowers financial situation or switching costs are small, the effects of a bank lending channel on monetary policy is minimal (Hubbard, Kuttner and

[22]See Bernanke and Gertler (1995) and Bernanke and Blinder (1992) for detailed description of monetary policy channels.

Palia (2002)). Third, if there is a negative effect of macroeconomic uncertainty on bank's lending behavior, then we can find out how riskiness of the whole system changes. This should allow for a better banks supervision, thus minimizing the effect of external shock.

Bank lending to general overall sectors of the economy increased by solid 62 percent in 2005, while credits to households more than doubled.[23] However, this sharp growth, fueled by the present and expected future income growth was not strong enough to compensate less favorable terms of trade on foreign markets. Therefore, while the banking sector showed high expansion rates, the real output rate has slowed down notably. This slowing of the economy, which may be further amplified in 2006 by higher gas import prices, suggests that more attention should be directed toward the financial sector.

Our research has important policy implications. According to Nier and Zicchino (2005), a decrease in loan supply may reduce aggregate investment, therefore amplifying macroeconomic fluctuations. These consequences are not confined to particular countries and particular times. When banks curtail their lending, companies are unable to obtain funds and may be forced to default on their obligations. Moreover, scarcity of funds may lead, as shown by Dell, Detragiache and Rajan (2005), to early liquidation of long-term investments, which affects the long-term growth trend as well.

This research is the first attempt to study and test the effect of changes in macroeconomic uncertainty on bank lending in Ukraine. The results of this research cannot be considered a definitive answer to what is the appropriate policy for the NBU or other state agencies that supervise the financial sector, except to convey the general notion that they have to decrease the level of macroeconomic uncertainty whenever possible.

[23]The growth of loans to households is 126%. This is the largest increase since the hyperinflation period. Hard currency credits to persons increased even more significantly – by 145% even in spite of nominal and real appreciation of UAH.

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Table 1: Descriptive statistics

	Obs	Mean	Std. Dev.	Min	Max
L/K	1,439	3.379	2.167	0.091	9.885
Π/K	1,397	0.034	0.038	0.000	0.232
K	1,439	10.809	0.799	9.534	13.864
B/K	1,439	3.308	2.460	.0292	11.892

Note: This table reports descriptive statistics for Ukrainian banks. The time span is from 2001q1 to 2005q3. K is total own capital, L is credits and accounts receivable, B is clients assets, and Π is Profit/loss in accounting period to be confirmed.

Table 2: Correlation of macroeconomic uncertainty proxies

	τ_{M1}	τ_{M2}	τ_{M2*}	τ_{M1*}	τ_{CPI}	τ_{PPI}	ζ^{η}
τ_{M1}	1						
τ_{M2}	0.987	1					
τ_{M2*}	0.767	0.727	1				
τ_{M1*}	0.810	0.732	0.664	1			
τ_{CPI}	0.503	0.464	0.093	0.445	1		
τ_{PPI}	0.407	0.373	0.007	0.426	0.958	1	
$\zeta^{bipower}$	-0.141	-0.110	-0.279	-0.405	0.404	0.318	1
ζ^{η}	-0.161	-0.118	-0.215	-0.491	0.297	0.178	0.960

Note: τ^2 measures are derived from GARCH estimations using monthly data. ζ measures are calculated using daily data.

Table 3: Determinants of total credits to capital ratio: GMM-SYSTEM results, all banks, monetary proxies

	Dependent variable is L/K_t			
	(1)	(2)	(3)	(4)
L/K_{t-1}	0.5145***	0.5105***	0.5389***	0.5000***
	(0.0810)	(0.0810)	(0.0819)	(0.0770)
B/K_t	0.4633***	0.4682***	0.4372***	0.4739***
	(0.0801)	(0.0796)	(0.0801)	(0.0745)
Π/K_t	-1.1519	-1.1666	-1.3754	-1.5491
	(1.2125)	(1.2404)	(1.1391)	(1.3212)
K_t	0.0583	0.0441	0.0790	0.0355
	(0.1113)	(0.1108)	(0.1267)	(0.1149)
$\tau_{M1,t-1}$	-145.4792***			
	(36.1330)			
$\tau_{M2,t-1}$		-170.0774***		
		(44.5519)		
$\tau_{M1*,t-1}$			-28.8483***	
			(8.9230)	
$\tau_{M2*,t-1}$				-35.2782**
				(14.2860)
AR(1)	-3.928***	-3.936***	-3.831***	-3.929***
AR(2)	0.490	0.468	0.545	0.471
Sargan	0.468	0.409	0.297	0.304
N	1173	1173	1173	1173

Note: Every equation includes constant term. Asymptotic robust standard errors are reported in the brackets. Estimation using XTABOND2 module for STATA. "Sargan" is a Sargan–Hansen test of overidentifying restrictions (χ^2 value reported). "AR(k)" is the test for k-th order autoregression. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Determinants of total credits to capital ratio: GMM-SYSTEM results, all banks, non-monetary proxies

	Dependent variable is L/K_t			
	1	2	3	4
L/K_{t-1}	0.5646***	0.5502***	0.5117***	0.5238***
	(0.0829)	(0.0799)	(0.0820)	(0.0815)
B/K_t	0.4030***	0.4162***	0.4619***	0.4550***
	(0.0781)	(0.0748)	(0.0753)	(0.0760)
Π/K_t	-0.0994	-0.3563	-0.7867	-1.0764
	(0.8965)	(0.9470)	(1.3375)	(1.2803)
K_t	-0.0299	-0.0211	-0.0247	-0.0124
	(0.1119)	(0.1141)	(0.1208)	(0.1238)
$\tau_{CPI,t-1}$	-94.3938***			
	(23.1953)			
$\tau_{PPI,t-1}$		-20.1692***		
		(5.4605)		
$\zeta_{t-1}^{bipower}$			-2.3081	
			(3.2150)	
ζ_{t-1}^{η}				0.0100
				(0.0410)
AR(1)	-3.7792***	-3.819465***	-3.878595***	-3.875413***
AR(2)	0.568	0.567	0.400	0.393
Sargan	0.26	0.187	0.328	0.225
N	1173	1173	1173	1173

Note: Every equation includes constant term. Asymptotic robust standard errors are reported in the brackets. Estimation using XTABOND2 module for STATA. "Sargan" is a Sargan–Hansen test of overidentifying restrictions (χ^2 value reported). "AR(k)" is the test for k-th order autoregression. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Determinants of total credits to capital ratio: GMM-SYSTEM results, monetary proxies

Panel A: *LARGE banks, N = 599*

	$\tau_{M1,t-1}$	$\tau_{M2,t-1}$	$\tau_{M1*,t-1}$	$\tau_{M2*,t-1}$
Uncertainty measure	-183.7638**	-223.9894**	-42.2719*	-35.1096
	(79.7621)	(87.6819)	(22.0141)	(27.0864)
AR(1)	-3.033***	-3.036***	-2.979***	-2.976***
AR(2)	0.361	0.345	0.372	0.339
Sargan	0.864	0.886	0.892	0.864

Panel B: *SMALL banks, N = 574*

	$\tau_{M1,t-1}$	$\tau_{M2,t-1}$	$\tau_{M1*,t-1}$	$\tau_{M2*,t-1}$
Uncertainty measure	-78.7710**	-84.4384	-11.5386	-27.5206
	(43.2704)	(53.6464)	(10.7304)	(18.8825)
AR(1)	-3.382***	-3.393***	-3.348***	-3.336***
AR(2)	0.777	0.774	0.791	0.671
Sargan	0.775	0.778	0.802	0.832

Panel C: *MOST PROFITABLE banks, N = 601*

	$\tau_{M1,t-1}$	$\tau_{M2,t-1}$	$\tau_{M1*,t-1}$	$\tau_{M2*,t-1}$
Uncertainty measure	-167.1925***	-191.8726***	-44.0517***	-34.9542
	(60.6178)	(67.9704)	(12.9154)	(24.0111)
AR(1)	-3.944***	-3.9423***	-3.888***	-3.894***
AR(2)	-0.496	-0.495	-0.497	-0.480
Sargan	0.797	0.744	0.814	0.751

Panel D: *LEAST PROFITABLE banks , N = 572*

	$\tau_{M1,t-1}$	$\tau_{M2,t-1}$	$\tau_{M1*,t-1}$	$\tau_{M2*,t-1}$
Uncertainty measure	-49.3391	-58.3949	-4.8103	-16.8805
	(43.5557)	(51.3456)	(10.8322)	(15.5418)
AR(1)	-2.358**	-2.360**	-2.363**	-2.342**
AR(2)	0.735	0.729	0.730	0.713
Sargan	0.816	0.809	0.772	0.845

Note: Dependent variable is L/K_t. Every equation includes constant term, L/K_{t-1}, B/K_t, Π/K_t and K_t. Asymptotic robust standard errors are reported in the brackets. Estimation using XTABOND2 module for STATA. "Sargan" is a Sargan–Hansen test of overidentifying restrictions (χ^2 value reported). "AR(k)" is the test for k-th order autoregression. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Determinants of total credits to capital ratio: GMM-SYSTEM results, non-monetary proxies

Panel A: *LARGE banks, N = 599*

	$\tau_{CPI,t-1}$	$\tau_{PPI,t-1}$	$\zeta_{t-1}^{bipower}$	ζ_{t-1}^{η}
Uncertainty measure	-123.8410**	-29.8964***	8.0256	0.1268*
	(48.7568)	(10.9337)	(5.4589)	(0.0727)
AR(1)	-2.997***	-3.009***	-2.926***	-2.865***
AR(2)	0.415	0.391	0.119	0.100
Sargan	0.791	0.784	0.923	0.928

Panel B: *SMALL banks, N = 574*

	$\tau_{CPI,t-1}$	$\tau_{PPI,t-1}$	$\zeta_{t-1}^{bipower}$	ζ_{t-1}^{η}
Uncertainty measure	-83.5890***	-16.2792***	-11.0216***	-0.1218**
	(24.1094)	(5.4328)	(3.3133)	(0.0465)
AR(1)	-3.396***	-3.397***	-3.308***	-3.311***
AR(2)	0.977	1.013	0.901	0.798
Sargan	0.813	0.799	0.843	0.808

Panel C: *MOST PROFITABLE banks, N = 601*

	$\tau_{CPI,t-1}$	$\tau_{PPI,t-1}$	$\zeta_{t-1}^{bipower}$	ζ_{t-1}^{η}
Uncertainty measure	-148.0819***	-32.8758***	5.8827	0.1130
	(39.1671)	(8.6509)	(5.7790)	(0.0719)
AR(1)	-3.951***	-3.996***	-3.935***	-3.908***
AR(2)	-0.705	-0.708	-0.772	-0.799
Sargan	0.733	0.736	0.715	0.722

Panel D: *LEAST PROFITABLE banks , N = 572*

	$\tau_{CPI,t-1}$	$\tau_{PPI,t-1}$	$\zeta_{t-1}^{bipower}$	ζ_{t-1}^{η}
Uncertainty measure	-61.6238**	-12.3687**	-8.1613**	-0.0816
	(29.3367)	(6.2025)	(3.7035)	(0.0503)
AR(1)	-2.393**	-2.407**	-2.410**	-2.407**
AR(2)	0.821	0.825	0.733	0.713
Sargan	0.797	0.821	0.804	0.801

Note: Dependent variable is L/K_t. Every equation includes constant term, L/K_{t-1}, B/K_t, Π/K_t and K_t. Asymptotic robust standard errors are reported in the brackets. Estimation using XTABOND2 module for STATA. "Sargan" is a Sargan–Hansen test of overidentifying restrictions (χ^2 value reported). "AR(k)" is the test for k-th order autoregression. * significant at 10%; ** significant at 5%; *** significant at 1%.