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DETERMINANTS OF CREDIT GROWTH: MACROPRUDENTIAL POLICY AND INFLATION[1]

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ABSTRACT

The aim of the paper is to examine the relation between the domestic credit instability and the rate of inflation. Using random-effects panel logistic regression on annual data for a sample of around 160 countries over up to four decades we show that low inflation makes sizable deviations of the credit-to-GDP ratio from the trend more likely, thereby posing a dilemma for the central bank's choice of policy goals. We find that macroprudential policies are counterproductive as they do not reduce the probability of surpassing the credit-to-GDP gap threshold of 2 and increase the probability of hitting the upper threshold of 10 in advanced economies. The use of financial institutions-targeted instruments seems to tighten the link between credit and output gaps in advanced economies.

Keywords: central bank, credit cycle.

JEL Classification: E44, E58.

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1. INTRODUCTION

In the wake of the global financial crisis, mandate of many central banks has been extended to include macroprudential policy. Monitoring of asset prices dynamics – suggested already by Fisher (1911) to help predict prices of consumer goods – has been supplemented with careful attention to credit growth. Excessive credit growth began to be considered as a warning indicator of building up risk in the banking sector.

The global regulatory framework known as Basel III under the auspices of the Basel Committee on Banking Supervision (BCBS) promotes the countercyclical capital buffer regime to protect the banking sector from the credit cycle. The countercyclical capital buffer imposes additional capital requirements on the banking sector. To guide monetary authorities, the Committee recommends to use the aggregate private sector credit-to-GDP gap in taking buffer decisions.

The credit-to-GDP gap was found by Drehman et al. (2010) to be the best performing conditioning variable which could guide the build-up and release of capital. BCBS (2010) transformed the credit-to-GDP gap into the guide buffer add-on. Its size is zero when the gap is below the lower threshold of 2 percent and reaches its maximum when the gap exceeds the upper threshold of 10 percent. The threshold values are based on historical analysis of systemic banking crises occurrence.

The aim of this paper is to investigate the determinants of the probability of the credit-to-GDP gap exceeding the lower and the upper threshold of the BCBS's guide buffer add-on. The focus is twofold. First, we shed light on the tradeoffs between central bank objectives by looking at the impact of price stability on credit growth. Second, we analyze the role of macroprudential policies in curbing excessive credit growth and the latter's correlation with output growth.

Using annual data for a global sample of countries over up to four decades, we fit a random-effects panel logistic regression model. The estimation results show that low inflation is concomitant with excessive credit growth and therefore the primary central bank's objective is in conflict with the tasks in field of financial stability. We also find evidence that macroprudential policies are ineffective or even counterproductive as they are not reducing the probability of surpassing the credit-to-GDP gap threshold of 2 percent, and increasing the probability of hitting the upper threshold of 10 percent in advanced economies. Moreover, the use of financial institutions-targeted instruments of macroprudential policies seems to tighten the link between credit and output gaps in advanced economies.

The paper is structured as follows. In the next section we review the related literature and put forward the hypotheses. The methodology and data used in the paper are discussed in section 3. The results are presented in section 4, followed by conclusions in section 5.

2. RELATED LITERATURE AND THE HYPOTHESES

This section is devoted to a brief review of two strands of research. The first deals with the importance of financial stability in general, and credit growth in particular, for monetary policy. The second examines the effects of macroprudential policies. Both strands are intertwined and it is usually difficult to strictly categorize a paper as belonging to one of them.

The debate on implications of financial stability consideration for monetary policy has been lucidly systematized by Smets (2014), who distinguishes three views on this issue. According to a modified "Jackson Hole consensus," monetary policy and financial stability tasks should be assigned to two separate authorities and the central bank should not be concerned with financial market developments until they threaten price stability. According to Adrian et al. (2015), financial stabilization considerations could indirectly enter into monetary policy decisions to the extent that risk-taking behavior of financial institutions changes the expected outlook for inflation or real activity. Fischer (2016) suggests that monetary policymakers will search for macroprudential tools only if traditional macro objectives and financial stability objectives call for different policy actions. This happens, for instance, when some financial assets appear to be overvalued while the economy is not overheating and inflation remains low. Even when employment and inflation objectives and financial stability objectives call for the same policy action, it cannot be taken for granted that adjustment in the policy rate can enhance financial stability.

The second view vindicates the "leaning against the wind" strategy and argues that, on the one hand, monetary policy affects risk taking by financial intermediaries and, on the other, monetary transmission process and inflation depend on the behavior of financial intermediaries. Thus financial stability objectives should be included among the secondary objectives of central banks and concerted efforts of monetary and macroprudential policymakers are needed to tackle the financial cycle. This reasoning led Woodford (2012) to reject the argument that because financial crises are not predictable, "leaning against" developing financial sector risks is infeasible for monetary authorities. In a modified New Keynesian model he shows that a central bank should strike a balance between, on the one hand, output and inflation stabilization objectives and, on the other, the marginal crisis risks which he defines as the rate at which the expected loss from the occurrence of a financial crisis increases per unit increase in leverage (or financial risk-taking more generally).

In a related stream of research on the interaction between monetary policy and asset price volatility, Christiano et al. (2010) address the question of whether or not monetary policy is partially responsible for stock market booms. The conventional wisdom is that stock markets booms represent a surge in demand and are accompanied by a rise in inflation. Hence, there is no conflict between central bank's objectives given that the policy of inflation forecast targeting should also

help to avoid the stock market booms. The findings for the US and Japan contradict the conventional wisdom because inflation was relatively low (and slowing sharply in Japan) during the stock market boom episodes. Since low rate of growth of prices calls for interest rates reduction, monetary policy geared towards price stability can fuel stock market booms.

Blanchard et al. (2010) are not blaming monetary policymakers for causing asset price booms. They rather point to the fact that in the precrisis 2000s the behavior of asset prices and credit aggregates was undesirable despite the stability of inflation and output gap. They conclude that stable inflation is not a sufficient condition for financial stability.

The third view identifies financial stability with price stability. The I-theory of money of Brunnermeier and Sunnikov (2016) provides a framework for analyzing the interaction between price stability and financial stability. Monetary policy which works through wealth effects has to mitigate financial frictions in order to achieve price stability objectives. The authors consider an adverse productivity shock to borrowers which leads to fire sales and a price decline of physical capital thereby eroding financial intermediaries' net worth. Consequently, financial intermediaries finance fewer risky household projects, creating less inside money and increasing households' risk exposure. Intermediaries' stake reduction in household risky project is a stimulus to money demand, whereas inside money creation and money supply shrink. These two effects trigger disinflation which monetary policy can work against by affecting the price of assets and avoiding the fall in the price of physical capital and intermediaries' net worth. Thus, by boosting the price of assets, monetary policy helps the financial sector to recover and reverses the disinflationary pressure.

Leeper and Nason (2014) discuss the integration of monetary policy with financial stability within the framework of dynamic stochastic general equilibrium models. They argue that the appropriate definition of the natural interest rate is still missing. While defining the natural rate of interest as arising in the absence of nominal rigidities is based on a plausible assumption of complete wage and price adjustments in the long run, the same cannot be true for financial frictions. Imperfect information in incomplete financial markets and the resulting imperfections in risk sharing would never be removed. A breakdown in risk sharing arrangements in financial markets is important for policymakers because it has a negative effect on real economic activity. Nevertheless, the authors conclude that directing policy toward a frictionless ideal may have unintended negative consequences for financial and macroeconomic stability.

The new approach to the modern central bank's mandate is well illustrated by Georgsson et al. (2015), where financial stability is listed first among the central bank's fundamental tasks, before monetary policy and price stability. Although the authors define the objective for financial stability as a stable and efficient infrastructure to make payments and regard the assignment of responsibility for macroprudential policy to central banks as disputable, a shift in the

hierarchy of the central bank's goals after the global financial crisis is remarkable.

All three views summarized above recognize an interaction, with varying degrees of pervasiveness, between monetary policy and financial stability. This interaction may involve conflict if central bank's pursuit of financial stability undermines the credibility of its pursuit of price stability. Smets (2014) shows that central bank's responsibility for debt overhang resolution following a financial crisis may require high inflation rates thereby creating time-inconsistency problem for monetary policy. However, the ineffectiveness of macroprudential policy in addressing the financial cycle may provide rationale for central bank's pursuit of financial stability objective.

There are also studies on the relationship between commercial banks' lending behavior and monetary policy which have not been fostered by the ongoing debate on the interplay between price stability and financial stability. Since we focus on the central bank's objectives rather than instruments, the relation between the official interest rate and bank loan supply is beyond the scope of this paper. We are more interested in the link between the rate of inflation and credit supply.

Guo and Stepanyan (2011) study the impact of inflation on credit in a large sample spanning the first decade of the 21st century and covering 38 emerging economies. The rate of growth of nominal credit to the private sector is regressed, inter alia, on the rate of inflation. The estimated coefficient is positive and lower than one, equal to around one third, pointing to the fact that lower rates of inflation are conducive of real credit growth. This results is not robust, however, to the inclusion of time dummies in the set of regressors. Similar conclusions can be drawn from Hempell and Sørensen (2010) who used data from the bank lending survey in the Euro Area countries over the 2002-2009 period. Their analysis reveals that the estimated coefficient of inflation is smaller than one third but loses its statistical significance when bank balance sheet constraints are among regressors. A negative impact of inflation on the ratio of bank credit to the private sector to GDP was also detected in the group of MENA countries observed over the period 1960-2006 (Naceur et al. 2014).

It is widely believed that the devastating effects of inflation become more severe when it reaches high levels. The relationship between bank lending activity and inflation seems to be nonlinear, too. In an overlapping generations monetary growth model of Huybens and Smith (1999) there are two or more steady state equilibria differentiated by their capital stocks, levels of real activity and level of activity in their financial markets. Higher steady state inflation leads to lower levels of real activity in the high-capital-stock steady state and, consequently, diminished bank lending activity. Once the steady state rate of inflation reaches some critical level, the high-capital-stock steady state is transformed to the low-capital-stock steady state and the economy experiences a sharp decrease in real activity. The level of financial intermediation shrinks and further increases in the rate of money growth have no additional effect on it.

The notion that bank lending and inflation are linked in a non-linear way finds support in the empirical work of Boyd et al. (2001). Low rates of inflation do not distort the flow of information in the credit market whereas informational frictions become more pronounced when inflation exceeds a critical rate. Examination of the data for up to 100 countries over the period 1960–1995 reveals that at low-to moderate rates of inflation there is a strong negative association between inflation and lending of the financial sector to the private sector. Once inflation exceeds 15 percent, financial sector performance drops precipitously.

The reviewed literature on monetary policy and financial stability objectives and the influence of inflation on bank lending lays ground for the first hypothesis. It concerns the relation between the rate of growth of prices and the probability that the credit-to-GDP gap would take the values of the BCBS's guide buffer add-on.

Hypothesis 1: *Central bank's pursuit of the goal of price stability provokes excessive credit growth. Monetary and macroprudential policies should be brought under one central bank roof and monetary authorities should strike a balance between the competing objectives of low inflation and financial stability*.

Acknowledging the need for coordination of monetary and macroprudential policies revives the debate on the choice of instruments used to contain excessive credit growth. The up-to-date experience with the implementation of macroprudential policies raises some doubts about their effectiveness.

A preliminary judgment of the efficacy of marcroprudential tools in 18 countries, based on the authorities' own assessment, was positive (Borio and Shim, 2007). The aim of a reduction in bank lending growth was achieved in seven countries, while three countries (Estonia, Latvia and Thailand) reported a failure or only modest moderating effect of macroprudential policy. Similarly, the measures against asset price bubbles were met with limited success but improved the resilience of the banking sector to asset market crashes.

A more comprehensive empirical study of the effectiveness of macroprudential instruments was conducted by Lim et al. (2011). Using data form 49 countries over the 2000-2010 period, they show that credit-related (caps on loan-to-value ratio, caps on debt-to-income ratio, ceilings on credit growth) and some liquidity-related (reserve requirements) and capital-related (dynamic provisioning) prudential instruments reduce the pro-cyclicality of credit. It should be noted, however, that these results may suffer from omitted variables bias. In the model seeking to explain quarterly growth rate of credit, the set of explanatory variables comprised the rate of growth of GDP and its interaction with the dummies capturing the use of macroprudential instrument. The dummies not interacted with the GDP growth rate are missing in the specification. In this paper we pay attention to a proper specification of the regression model with interaction effects.

More recently, Cerutti et al. (2015) have expanded on previous studies and investigated the use and effectiveness of 12 macroprudential instruments in 119 countries over the 2000–2013 period. They find that policies help to reduce the

rate of credit growth , their effect is large, especially for emerging and developing countries, what can be attributed to their less developed financial systems. Moreover, the effectiveness was greater for relatively closed economies. The authors distinguish between borrower-targeted and financial institutions-targeted instruments. The former category encompasses measures aimed at borrowers' leverage and financial positions (loan-to value ratio and debt-to-income ratio) and the latter contains measures aimed at financial institutions' assets or liabilities (dynamic provisioning, countercyclical capital buffer, leverage ratio, capital surges on systematically important financial institutions, limits on interbank exposures, limits on foreign currency loans, reserve requirement ratios, limits on domestic currency loans, tax on financial institutions). Both borrower-based and financial institutions-based measures are generally negatively related to credit growth, especially in emerging economies.

From the perspective of excessive credit growth, which is of main interest here, it is worthwhile to refer to Della'Ariccia et al. (2012). They discuss the triggers of 175 credit boom episodes in a sample of 170 countries and the interventions implemented to curb credit growth. The authors are unable to provide empirical evidence that tighter monetary policy conditions are linked to a lower frequency of credit booms. Macroprudential policy tools have been found to perform better in avoiding bad outcomes following credit booms than in preventing them altogether. Only asset concentration and credit growth limits had some success in slowing down the pace of credit but often contributed to the build-up of systemic risk in the financial sector.

In this paper we deviate from the trodden path and investigate whether the effectiveness of macroprudential instruments can be weakened by their frequent use. We conjecture that financial stability can be undermined by repeated macroprudential interventions because the financial markets can learn to circumvent the restrictions imposed by the authorities. A frequent use of macroprudential policies may trigger financial intermediaries' efforts to avoid its consequences and, paradoxically, undermine financial stability. The sum of macroprudential interventions can have more pronounced effects in advanced countries where more developed and liberalized financial markets offer various alternative sources of finance and scope for avoidance (Cerutti et al., 2015). This reasoning leads to the second hypothesis.

Hypothesis 2: *Frequent use of macroprudential policy impedes its efficiency. The cumulative effects of borrower-targeted and financial institutions-targeted instruments on the probability of excessive credit growth and its pro-cyclicality is different in emerging and advanced economies.*

In summary, the hypotheses put forward in this paper concern the determinants of the probability that the growth rate of credit-to-GDP gap outstrips the safety thresholds of 2 and 10 percent. We presume that price stability and credit stability goals are mutually exclusive. The authorities should refrain from frequent use of macroprudential instruments to avert excessive credit growth.

3. DATA AND METHODOLOGY

In this paper the dependent variable is discrete, indicating the probability of excessive credit growth. We construct two dependent variables which are dummies coded as one ($y_{it} = 1$) if the value of credit-to-GDP gap is larger than, respectively, 2 and 10 percentage points and zero otherwise. Let's p_{it} denote the probability that the credit gap exceeds the threshold value in country i in year t. This probability is equal to the expected value of the binary variable y_{it} and it modeled as a function of explanatory variables x_{it}:

$$\Pr[y_{it} = 1] = (x_{it}\beta + v_i)$$

where F is the cumulative distribution function constrained to the range between zero and one, β stands for the coefficient vector, and v_i are independent and identically distributed country effects. We used the logistic density function describing F and fitted via maximum likelihood the random effects panel logistic models. This section contains the description of construction of the dependent variable y_{it} and the vector of independent variables x_{it}.

The credit-to-GDP gap has been calculated as the difference between the actual value of the credit to the private sector in percent of GDP and its trend value. Provided that the duration of the financial cycle is at least twice as long as the business cycle (Drehmann et al., 2012), the trend should be extracted by using the Hodrick-Prescott filter with the lambda parameter equal to 125 000 for quarterly data (Drehmann et al. 2010). Following the Ravn and Uhlig (2002) rule, the value of the lambda parameter for annual data which we use is 488.

Obviously, the probability that the credit gap would exceed the threshold value of 2 or 10 percent is higher during the upward phase of the financial cycle. The one year lagged value of credit gap, *credit_gap*, is intended to reflect the persistence of credit-to-GDP ratio deviation from trend.

To verify Hypothesis 1 we include two measures of price stability in the set of independent variables. The first, denoted *monet_qual*, is the quality of monetary policy index (IMF, 2007). This measure is defined as exp[–0.005·(inflation – 2 percent)^2] and it rapidly deteriorates once inflation rises above 10 percent. The index will allow to capture the non-linear impact of inflation on credit-to-GDP gap. The second measure of price stability is simply the rate of inflation, *inflation*. To lessen the concern about endogeneity, we use the lagged values of *monet_qual* and *infl* in the regression models.

To validate Hypothesis 2 we employ the Cerutti et al. (2015) macroprudential policy indices. As described above, the instruments have been gathered into two groups: borrower-targeted and financial institutions-targeted. To detect the postulated effect of repeated macroprudential interventions we calculate the running totals of the values of borrower-targeted, *mpi_borr*, and financial institutions-targeted, *mpi_fin*, indices. To address the reverse-causality problem, the lagged values of *mpi_borr* and *mpi_fin* are used, that is the running totals stop in the year preceding the episode of excessive credit growth. It has to be empha-

sized that none of the macroprudential policy indices were found significant when the simple lagged values instead of running totals were used.

The effectiveness of macroprudential policy can be different in advanced and developing countries. To test this prediction, we decomposed each of the running totals *mpi_borr* and *mpi_fin* into two variables, one taking on the value of the running total for advanced countries and zero otherwise, and the other taking on the value of the running total for developing countries, and zero otherwise. For instance, *mpi_borr_adv* and *mpi_borr_dev* are equal to *mpi_borr* when a country belongs to the group of, respectively, advanced and developing countries, and zero otherwise. The list of advanced and developing countries is in the Appendix.

A co-movement of cycles in credit and GDP is a well-established fact. The value of output gap in percent of potential GDP, labeled *gdp_gap*, is the key control variable. The level of potential GDP has been obtained by using the Hodrick-Prescott filter with the standard lambda parameter equal to 6.25. To assess the efficiency of macroprudential policies in curbing credit pro-cyclicality, we constructed interaction terms of output gap with the running totals of the uses of borrower-targeted and financial institutions-targeted instruments, *gdp_gap*×*mpi_borr* and *gdp_gap*×*mpi_fin*. As demonstrated in Balli and Sørensen (2013), in a panel data regression there is a risk of estimated interaction terms spuriously capturing country-varying slopes. The guidance, which we follow, is to subtract the country-specific means from each variable in the interaction. All variables described in this paragraph enter with a one-year lag. Each of the interaction terms has been split into the advanced and developing countries variables using the method described above for the *mpi_borr* and *mpi_fin* indices.

Besides inflation, we include in the model another central bank-related regressor. Central bank independence and the relative weight it attaches to price stability objective may matter for excessive credit growth. For instance, Berger and Kißmer (2013) find that the more independent central bankers are, the more likely it is that they refrain from implementing preemptive monetary tightening to maintain financial stability. We employ the governor's turnover which is a *de facto* measure of central bank independence. More precisely, *irreg_turn* is the number of irregular turnovers since 1970 which comes from the updated version of the Dreher et al. (2010) database. We check whether central bank independence plays a different role in advanced and developing countries. To that end we construct *irreg_turn_adv* and *irreg_turn_dev* which equal *irreg_turn* for, respectively, advanced and developing countries, and zero otherwise.

It is well documented that credit booms are often followed by financial crises (Claessens and Kose, 2013). We apply the logic of the "institutional memory" problem of Berger and Udell (2004) and argue that bank loan officers who experienced a systemic bank crisis are able to recognize potential risks associated with an excessive credit growth. The banking sector that underwent many episodes of financial turmoil may be less prone to engage in an immoderate

lending activity. Shortly, the institutional memory of banking crises disciplines banks not to extend too much credit. The variable *crises* is the running total of systemic bank crises episodes. We also created *crises_adv* and *crises_dev* which take on the value of *crises* for, respectively, advanced and developing countries, and zero otherwise.

The length and amplitude of the financial cycle in general, and credit cycle in particular, depend on policy regimes (Borio, 2014). Three factors were found to be crucial: the monetary regime, the financial regime and the real-economy regime. The monetary regime is comprehensively represented by inflation and central bank-related variables. Financial development and liberalization weaken borrowing constraints, potentially contributing to credit growth. Two variables are intended to capture this effect: financial institutions efficiency, *fie*, and the financial account balance in percent of GDP, that is capital inflows, *inflows*. Regarding the latter variable, it should be noted that domestic credit growth is strongly related to capital inflows (Arena et al. 2015), especially net debt inflows during credit-boom periods (Lane and McQuade, 2014). The former variable is extracted from the Svirydzenka (2016) database and relies on the efficiency in intermediating savings to investment, operational efficiency measures and profitability measures. The real-economy regime is associated with credit growth through a variety of channels, including globalization that raises growth potential without fueling inflation. We use the most popular measure of globalization, that trade openness index, labeled *trade*, defined as the ratio of the sum of exports and imports to GDP.

It is unquestionable that credit booms can be associated with an economy overheating. It is therefore natural to investigate the contribution of fiscal policy to curbing fast credit growth. The evidence is mixed at best, pointing to either no impact of fiscal tightening on reduced incidence of credit booms or to a positive association between fiscal policy and credit growth in Central and Eastern Europe (Dell'Ariccia et al., 2012). The change in the public debt-to-GDP ratio, *Δdebt*, is used to quantify the stance of fiscal policy. The updated version of historical public debt database of Abbas et al. (2010) is the source of data for this variable.

Finally, we add to the set of independent variables the level of per capita GDP at constant prices, *income*, which can affect the probability of excessive credit growth through a number of channels. For instance, during crises rich countries can resort to bail out financial institutions, thereby alleviating the consequences of excessive lending. The level of income is also associated with institutional development (i.e. law enforcement) and the level of wealth which influence the lender-borrower relationship and banks' lending policy.

All variables, unless stated otherwise, have been extracted from the World Bank *World Development Indicators* database. The annual data span the 1970 to 2012 period and 167 countries (unbalanced panel). When macroprudential policy indicators *mpi_borr* and *mpi_fin* are included, the sample encompasses 110 coun-

tries and the 2000–2012 time period. The dependent variable is a binary choice variable coded as 1 if the level of credit gap exceeds the threshold value of 2 or 10 percentage points.

4. RESULTS

This section reports the estimation results of the probability that the credit-to-GDP gap exceeds 2 or 10 percentage points. First, the background models estimation results are presented (columns 1 and 3 in Tables 1 and 2), followed by the final models with significant variables retained (columns 2 and 4 in Tables 1 and 2). Since the data on macroprudential policy indices covers the period 2000–2012, we first estimate the model without these variables to test Hypothesis 1 based on a larger sample size. The results are reported in Table 1. The dependent variable is a dummy equal to 1 for the values of credit-to-GDP gap exceeding 2 (in columns 1 and 2) or 10 (in columns 3 and 4). The bottom part of the table reports the proportion of the total variance contributed by the panel-level variance component (*rho*) and a Wald test of the joint significance of all variables' parameters (*chi2*).

The hypothesis that low inflation raises the probability of excessive credit growth is corroborated in Table 1. The relation is non-linear, and linear for the probability that the credit-to-GDP gap is larger than 2 and 10, respectively. In columns (1) and (2) the index of monetary quality was found significant while it lost significance in columns (3) and (4) and was therefore replaced with the rate of inflation. Column (4) unveils that the negative impact of inflation on the probability of hitting the upper threshold is confined to the group of developing countries because only *infl_dev* is significant.

We identify four robust factors which make a large deviation of the credit-to-GDP ratio from trend more likely. The lagged value of credit gap, GDP gap, level of per capita income, the change in the public debt-to-GDP ratio are positively associated with the probability of excessive credit growth in all specifications. Surprisingly, capital inflows moderate the likelihood of credit gaps surpassing the threshold values. This result may seem at odds with the literature on capital inflows and credit booms but it should be stressed that the dependent variable in this paper is constructed using different methodology, the frequency of data is annual and the sample is wider than in other studies.

The impact of other variables on the probabilities of sizable credit deviations from trend is more subtle. The degree of central bank independence reduces the probability of excessive credit growth but mainly in developing countries (significant and positive association with *irreg_turn_dev* in column 2) and when the credit gap is not exceeding 10 percentage points. The banking sector institutional memory of crises dampens credit growth but is unrelated to the probability of exceeding the upper credit-to-GDP threshold in developing countries.

Table 1. Determinants of the probability of excessive credit growth

Variables	(1) probability (credit_gap>2)	(2) probability (credit_gap>2)	(3) probability (credit_gap>10)	(4) probability (credit_gap>10)
credit_gap	0.255[c] (0.0112)	0.255[c] (0.0112)	0.200[c] (0.0136)	0.201[c] (0.0136)
monet_qual	0.598[c] (0.173)	0.600[c] (0.174)	–	–
infl	–	–	–0.00366[b] (0.00177)	–
infl_dev	–	–	–	–0.00404[b] (0.00161)
gdp_gap	0.0736[c] (0.0174)	0.0735[c] (0.0174)	0.101[c] (0.0294)	0.103[c] (0.0294)
irreg_turn	0.0602[c] (0.0145)	–	–	–
irreg_turn_dev	–	0.0619[c] (0.0148)	–	–
crises	–0.0553[b] (0.0250)	–0.0571[b] (0.0253)	–0.103 (0.0692)	–
crises_adv	–	–	–	–0.223[a] (0.125)
fie	1.209[c] (0.314)	1.236[c] (0.316)	–	–
inflows	–3.140[c] (0.570)	–3.194[c] (0.572)	–5.264[c] (1.169)	–5.505[c] (1.173)
trade	–	–	0.00527[b] (0.00235)	0.00506[b] (0.00233)
$\Delta debt$	0.00453[a] (0.00252)	0.00458[a] (0.00258)	0.0192[c] (0.00580)	0.0205[c] (0.00568)
income	1.30e–05[c] (3.47e–06)	1.62e–05[c] (3.66e–06)	3.92e–05[c] (8.57e–06)	4.56e–05[c] (9.31e–06)
constant	–3.021[c] (0.317)	–3.058[c] (0.320)	–6.974[c] (0.831)	–7.051[c] (0.806)
Observations	3648	3648	3896	3896
rho	0.00636	0.00877	0.280	0.269
chi2 (*p*-value)	677.9 (0)	676.1 (0)	291.1 (0)	294.6 (0)

Notes: Year fixed effects included in all specifications. Standard errors in parentheses; $^{c}p < 0.01$, $^{b}p < 0.05$, $^{a}p < 0.1$

Table 2. The impact of macroprudential policies on the probability of excessive credit growth

Variables	(1) probability (credit_gap>2)	(2) probability (credit_gap>2)	(3) probability (credit_gap>10)	(4) probability (credit_gap>10)
credit_gap	0.207[c] (0.0169)	0.208[c] (0.0169)	0.176[c] (0.0231)	0.174[c] (0.0230)
monet_qual	1.461[c] (0.520)	1.505[c] (0.522)	–	–
mpi_borr_adv	–0.00677 (0.0592)	–	0.185[b] (0.0878)	0.156[a] (0.0848)
mpi_borr_dev	0.0296 (0.0251)		0.0673 (0.0738)	–
mpi_fin_adv	–0.0317 (0.0232)	–0.0337 (0.0226)	–0.0463 (0.0535)	–0.0232 (0.0495)
mpi_fin_dev	–0.00316 (0.00987)	0.00144 (0.00899)	–0.0330 (0.0304)	–
gdp_gap	0.274[c] (0.0672)	0.274[c] (0.0661)	0.223[b] (0.108)	0.176[b] (0.0840)
gdp_gap× *mpi_borr_adv*	0.00363 (0.0310)	–	–0.0447 (0.0372)	–
gdp_gap× *mpi_borr_dev*	–0.00613 (0.0198)	–	0.0375 (0.0330)	–
gdp_gap× *mpi_fin_adv*	0.0389[b] (0.0178)	0.0399[b] (0.0170)	0.104[c] (0.0321)	0.0811[c] (0.0271)
gdp_gap× *mpi_fin_dev*	0.0117[b] (0.00486)	0.0115[b] (0.00475)	0.00229 (0.00914)	–
fie	1.285[a] (0.779)	1.431[a] (0.769)	4.669[b] (1.966)	5.506[c] (1.949)
inflows	–4.359[c] (0.891)	–4.342[c] (0.884)	–3.906[b] (1.974)	–4.085[b] (1.947)
trade	0.00332[a] (0.00177)	0.00314[b] (0.00159)	0.00737[a] (0.00399)	0.00771[a] (0.00404)
income	1.43e–05[b] (6.25e–06)	1.46e–05[b] (6.23e–06)	–	–
constant	–3.621[c] (0.623)	–3.721[c] (0.617)	–8.685[c] (1.669)	–9.286[c] (1.585)
Observations	1236	1236	1257	1257
rho	7.61e–07	7.78e–07	0.290	0.305
chi2 (*p*-value)	250.3 (0)	249.1 (0)	108.4 (0)	107.1 (0)

Notes: Year fixed effects included in all specifications. Standard errors in parentheses; $^{c}p < 0.01$, $^{b}p < 0.05$, $^{a}p < 0.1$.

Interestingly, financial sector efficiency augments and is irrelevant to the probability of the occurrence of credit gap larger than 2 and 10, respectively. Trade openness makes credit gaps above 10 more probable.

We now turn to the assessment of macroprudential policy, that is to the validation of Hypothesis 2. The results presented in Table 2 are not directly comparable with those previously discussed because of different estimation sample sizes (fewer countries and shorter period). The set of regressors has been extended to include the macroprudential policy-related variables and some of the variables used in the larger sample (*crises*, *irreg_turn*, *Δdebt*) were dropped from the models presented in Table 2 because of statistical insignificance. The Wald test χ^2 statistics (chi2) shows that the goodness of fit of the models is satisfactory.

Table 2 shows that in the 2000–2012 period the lagged value of credit gap, output gap, financial sector efficiency and trade openness exerted a positive influence on the probability of the occurrence of large credit-to-GDP gaps, while the ratio of financial account to GDP had a negative effect. Income level and the quality of monetary policy index were found to be positively associated only with the probability that credit gap exceeds 2 (columns 1 and 2 in Table 2). The latter result undermines the strong conclusions on Hypothesis 1 drawn from Table 1, which are, however, more reliable because of the larger size of the sample used for estimations.

Regarding the main goal of the regression analysis presented in Table 2, which is an assessment of macroprudential policy efficiency, it is noticeable that most of *mpi*-related variables are insignificant. An examination of the baseline specification in column 1 reveals that, in both advanced and developing countries, neither borrower-targeted nor financial institutions-targeted instruments reduce the probability of credit gap expansion above 2 percentage points. Moreover, the estimated coefficients of the interaction terms of financial institutions-targeted instruments with output gap are positive demonstrating that a frequent use of macroprudential policy increased the pro-cyclicality of credit. This result is robust to the removal of borrower-targeted variables from the specification in column 2.

Columns 3 and 4 of Table 2 point to the fact that macroprudential policies have distinct effects in advanced and developing economies. In the latter group of countries the running total of macroprudential interventions leaves the probability of credit gap exceeding 10 percentage points and its pro-cyclicality unaffected. Conversely, the running total of borrower-targeted instruments significantly raises the aforementioned probability in advanced economies. Those countries also experience a rising degree of pro-cyclicality of credit as a result of periodic recourse to the financial institutions-targeted instruments.

Overall, this paper is a step towards explaining the interplay between the traditional goals of central banks and the countercyclical capital buffer policy. We presented a convincing evidence in favor of the hypotheses put forth in this

paper. We showed that the probability of breaching the credit gap indicator's threshold values of 2 and 10 percent is negatively, probably non-linearly, associated with inflation rates. Moreover, recurrent macroprudential interventions not only failed to contain credit growth but contributed to its pro-cyclicality, especially in the advanced countries.

5. CONCLUSIONS

At least since the global financial crisis, the health of the banking sector has been seen as one of the priorities of macroeconomic policy. In search of the solution to the problem of credit boom and bust cycle, the Basel Committee on Banking Supervision advocates the countercyclical capital buffer requirement which should be activated if the credit-to-GDP gap exceeds 2 percentage points and should reach its maximum when the gap exceeds 10 percentage points. This paper shows that the central bank's goal of price stability interferes with the dynamics of credit gap calling for a careful consideration of the question which institution should carry out the tasks of financial stability. Moreover, the experience with the use of macroprudential policy instruments is not very reassuring as it seems that their frequent use raises the probability of excessive credit growth and its pro-cyclicality.

The analysis conducted in this paper reveals that the probability of the credit-to-GDP ratio exceeding its trend by more than 2 or 10 percentage points is negatively, and non-linearly for the first threshold value, related to inflation rate. Thus, the pursuit of price stability would force the central bank to make regular use of macroprudential policy. Unfortunately, a frequent use of borrower-targeted instruments is counterproductive, at least in the advanced countries where it raises the probability of excessive credit growth. The financial institutions-targeted instruments of macroprudential policy do not ease the fight against the occurrence of large credit gaps either. What is even more troubling is that, if frequently used, these instruments strengthen the association between output gaps and credit gaps.

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APPENDIX

The list of countries included in the sample (names with an asterisk, *, denote countries included in the regression analysis presented in both Tables A1 and A2).

Advanced:

Australia*, Austria*, Belgium*, Canada*, Denmark, Finland*, France*, Germany*, Greece, Hong Kong*, Iceland*, Ireland*, Israel*, Italy*, Japan*, Korea Rep.*, Luxembourg, Netherlands*, New Zealand*, Norway*, Portugal*, Singapore*, Spain*, Sweden*, Switzerland*, United States*.

Developing:

Albania*, Algeria*, Angola*, Antigua and Barbuda, Argentina*, Armenia*, Azerbaijan*, Bahamas The*, Bahrain*, Bangladesh*, Barbados, Belarus*, Belize*, Benin, Bhutan*, Bolivia, Botswana*, Brazil*, Brunei Darussalam*, Bulgaria*, Burkina Faso, Burundi*, Capo Verde*, Cambodia*, Cameroon, Central African Republic, Chad, Chile*, China*, Colombia*, Comoros, Congo Dem. Rep., Congo Rep., Costa Rica*, Cote d'Ivoire, Croatia*, Cyprus*, Czech Republic*, Djibouti, Dominica, Dominican Republic*, Ecuador*, Egypt Arab Rep., El Salvador*, Equatorial Guinea, Estonia*, Ethiopia, Fiji*, Gabon, Gambia The*, Georgia*, Ghana*, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana*, Haiti*, Honduras*, Hungary*, India*, Indonesia*, Iran Islamic Rep., Jamaica*, Jordan*, Kazakhstan*, Kenya*, Kuwait*, Kyrgyz Republic*, Lao PDR*, Latvia*, Lebanon*, Lesotho*, Liberia, Libya, Lithuania*, Macedonia FYR*, Madagascar, Malawi*, Malaysia*, Maldives, Mali, Malta*, Mauritania, Mauritius*, Mexico*, Moldova*, Mongolia*, Morocco*, Mozambique*, Namibia, Nepal*, Nicaragua, Niger, Nigeria, Oman, Pakistan*, Panama, Papua New Guinea, Paraguay*, Peru*, Philippines*, Poland*, Qatar, Romania*, Russian Federation*, Rwanda, Samoa, Sao Tome and Principe, Saudi Arabia*, Senegal, Serbia*, Seychelles, Sierra Leone, Slovak Republic*, Slovenia*, Solomon Islands*, South Africa*, Sri Lanka*, St. Kitts and Nevis*, St. Lucia, St. Vincent and the Grenadines, Sudan*, Suriname, Swaziland, Tajikistan*, Tanzania, Thailand*, Togo, Tonga*, Trinidad and Tobago*, Tunisia*, Turkey*, Uganda*, Ukraine*, Uruguay, Vanuatu, Venezuela RB, Vietnam, Yemen Rep., Zambia*.

Table A1. Determinants of the probability of excessive credit growth

Variables	(1) probability (credit_gap>2)	(2) probability (credit_gap>2)	(3) probability (credit_gap>10)	(4) probability (credit_gap>10)
credit_gap	0.255[c] (0.0112)	0.255[c] (0.0112)	0.200[c] (0.0136)	0.201[c] (0.0136)
monet_qual	0.598[c] (0.173)	0.600[c] (0.174)	–	–
infl	–	–	–0.00366[b] (0.00177)	–
infl_dev	–	–	–	–0.00404[b] (0.00161)
gdp_gap	0.0736[c] (0.0174)	0.0735[c] (0.0174)	0.101[c] (0.0294)	0.103[c] (0.0294)
irreg_turn	0.0602[c] (0.0145)	–	–	–
irreg_turn_dev	–	0.0619[c] (0.0148)	–	–
crises	–0.0553[b] (0.0250)	–0.0571[b] (0.0253)	–0.103 (0.0692)	–
crises_adv	–	–	–	–0.223[a] (0.125)
fie	1.209[c] (0.314)	1.236[c] (0.316)	–	–
inflows	–3.140[c] (0.570)	–3.194[c] (0.572)	–5.264[c] (1.169)	–5.505[c] (1.173)
trade	–	–	0.00527[b] (0.00235)	0.00506[b] (0.00233)
Δdebt	0.00453[a] (0.00252)	0.00458[a] (0.00258)	0.0192[c] (0.00580)	0.0205[c] (0.00568)
income	1.30e–05[c] (3.47e–06)	1.62e–05[c] (3.66e–06)	3.92e–05[c] (8.57e–06)	4.56e–05[c] (9.31e–06)
constant	–3.021[c] (0.317)	–3.058[c] (0.320)	–6.974[c] (0.831)	–7.051[c] (0.806)
Observations	3648	3648	3896	3896
rho	0.00636	0.00877	0.280	0.269
chi2 (p-value)	677.9 (0)	676.1 (0)	291.1 (0)	294.6 (0)

Notes: Year fixed effects included in all specifications. Standard errors in parentheses; $^{c}p < 0.01$, $^{b}p < 0.05$, $^{a}p < 0.1$

Table A2. The impact of macroprudential policies on the probability of excessive credit growth

Variables	(1) probability (credit_gap>2)	(2) probability (credit_gap>2)	(3) probability (credit_gap>10)	(4) probability (credit_gap>10)
credit_gap	0.207[c] (0.0169)	0.208[c] (0.0169)	0.176[c] (0.0231)	0.174[c] (0.0230)
monet_qual	1.461[c] (0.520)	1.505[c] (0.522)	–	–
mpi_borr_adv	–0.00677 (0.0592)	–	0.185[b] (0.0878)	0.156[a] (0.0848)
mpi_borr_dev	0.0296 (0.0251)	–	0.0673 (0.0738)	–
mpi_fin_adv	–0.0317 (0.0232)	–0.0337 (0.0226)	–0.0463 (0.0535)	–0.0232 (0.0495)
mpi_fin_dev	–0.00316 (0.00987)	0.00144 (0.00899)	–0.0330 (0.0304)	–
gdp_gap	0.274[c] (0.0672)	0.274[c] (0.0661)	0.223[b] (0.108)	0.176[b] (0.0840)
gdp_gap× mpi_borr_adv	0.00363 (0.0310)	–	–0.0447 (0.0372)	–
gdp_gap× mpi_borr_dev	–0.00613 (0.0198)	–	0.0375 (0.0330)	–
gdp_gap× mpi_fin_adv	0.0389[b] (0.0178)	0.0399[b] (0.0170)	0.104[c] (0.0321)	0.0811[c] (0.0271)
gdp_gap× mpi_fin_dev	0.0117[b] (0.00486)	0.0115[b] (0.00475)	0.00229 (0.00914)	
fie	1.285[a] (0.779)	1.431[a] (0.769)	4.669[b] (1.966)	5.506[c] (1.949)
inflows	–4.359[c] (0.891)	–4.342[c] (0.884)	–3.906[b] (1.974)	–4.085[b] (1.947)
trade	0.00332[a] (0.00177)	0.00314[b] (0.00159)	0.00737[a] (0.00399)	0.00771[a] (0.00404)
income	1.43e–05[b] (6.25e–06)	1.46e–05[b] (6.23e–06)	–	–
constant	–3.621[c] (0.623)	–3.721[c] (0.617)	–8.685[c] (1.669)	–9.286[c] (1.585)
Observations	1236	1236	1257	1257
rho	7.61e-07	7.78e-07	0.290	0.305
chi2 (p-value)	250.3 (0)	249.1 (0)	108.4 (0)	107.1 (0)

Notes: Year fixed effects included in all specifications. Standard errors in parentheses; $^{c}p < 0.01$, $^{b}p < 0.05$, $^{a}p < 0.1$.

DETERMINANTY WZROSTU KREDYTU: POLITYKA MAKROOSTROŻNOŚCIOWA I INFLACJA

STRESZCZENIE

Celem artykułu jest zbadanie zależności między niestabilnością kredytu a stopą inflacji. Analiza modelu regresji logistycznej z efektami losowymi dla danych panelowych obejmujących ok. 160 krajów z czterech ostatnich dekad ujawnia, że niska inflacja zwiększa prawdopodobieństwo znaczącego odchylenia się od trendu stosunku kredytu do PKB, co utrudnia bankowi centralnemu właściwe sformułowanie celów polityki pieniężnej. Polityki makroostrożnościowe okazują się nieskuteczne, ponieważ nie zmniejszają prawdopodobieństwa przekroczenia przez odchylenie od trendu stosunku kredytu do PKB wartości progowej równej 2 i zwiększają prawdopodobieństwa osiągnięcia górnego progu wynoszącego 10. Wykorzystanie instrumentów polityki makroostrożnościowej regulujących funkcjonowanie instytucji finansowych zwiększa zależność cyklu kredytowego od cyklu koniunkturalnego w gospodarkach wysoko rozwiniętych.

Słowa kluczowe: bank centralny, cykl kredytowy.

Klasyfikacja JEL: E44, E58.