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The credit channel of monetary policy transmission: issues of quantitative measurement

Abstract. The article revises existing channels of monetary policy transmission due to obvious changes in the macroeconomic environment, as well as in the patterns and efficiency of conventional channels. Under the present conditions in Russia, the widely used interest rate channel is being replaced by the credit channel, which is thought to be more effective in facilitating or slowing down the economy. Yet, the credit channel is understudied, also because it is a relatively new phenomenon for those who study the Russian economy. The paper introduces the concept of credit channel breadth (a term is proposed by the authors) measured as a relative extent of credit availability and affordability to the real sector enterprises. It provides quantitative measuring of the dependence of the credit channel breadth on changes in monetary policy due to which appropriate models are derived. The application of distributed lag and vector autoregression models on the basis of annual (1998 through 2016) and monthly (April 2009 through April 2017) statistical data established that changes in monetary policies affecting the money supply (M2) have a positive impact on the volumes of loans issued to enterprises, as well as on the net change of flows and transfers on debt. The most sufficient were 2-month and 10-month lags after quantitative easing or the so called credit squeeze when the credit channel breadth increased or decreased, respectively.
Keywords: Monetary Policy; Transmission Mechanism; Credit Channel; VAR model
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Кредитний канал трансмісії грошово-кредитної політики: проблеми кількісного виміру

Анотація. Очевидні зміни в макроекономічному оточенні зумовили перегляд підходів до дослідження каналів трансмісії грошово-кредитної політики й оцінки їх ефективності. Процентний канал, що широко використовується в російських реаліях, заміщається кредитним каналом, який вважається ефективним з огляду на його вплив на прискорення або сповільнення темпів економічного зростання. У роботі представлено концепцію ширини кредитного каналу, яка визначає рівень відносної доступності кредиту підприємствам реального сектора, а також виконано моделювання й кількісне вимірювання залежності ширини кредитного каналу від змін грошово-кредитної політики, у тому числі з урахуванням можливого відкладеного впливу. Застосування моделей розподілених лагів і моделей векторної авторегресії дозволило зробити висновки, що зміни грошово-кредитної політики, що виражаються в змінах грошової маси М2, позитивно впливають на обсяги видаваних підприємствам кредитів, а також на чисту зміну їхньої заборгованості за банківськими кредитами. Найбільш істотний вплив мають лаги у 2 та 10 місяців після кількісних пом'якшень або стиснення ліквідності, коли кредитний канал відповідно розширювався або звужувався.
Ключові слова: грошово-кредитна політика; трансмісійний механізм; кредитний канал; VAR модель.

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Кредитный канал трансмиссии денежно-кредитной политики: проблемы количественного измерения

Аннотация. Очевидные изменения в макроэкономическом окружении и в традиционных паттернах функционирования каналов трансмиссии денежно-кредитной политики обусловили наше обращение к пересмотру теоретических и практических достижений в области исследования каналов трансмиссии денежно-кредитной политики и оценки их эффективности. Широко используемый процентный канал в российских реалиях замещается кредитным каналом, который считается более эффективным с точки зрения его влияния на ускорение или замедление темпов экономического роста. При этом кредитный канал исследован недостаточно глубоко, в том числе и потому, что данная задача является относительно новой для исследователей российской экономики. В работе представлена концепция ширины кредитного канала как меры относительной доступности кредита предприятиям реального сектора, а также выполнено моделирование и количественное измерение зависимости ширины кредитного канала от изменений денежно-кредитной политики, в том числе с учетом возможного отложенного воздействия. Применение моделей распределённых лагов и моделей векторной авторегрессии на статистических данных в годовом (1998-2016 гг.) и помесячном (апрель 2009 г. – апрель 2017 г.) представлении позволило установить, что изменения денежно-кредитной политики, выражающиеся в изменениях денежной массы М2, оказывают положительное воздействие на объемы выдаваемых предприятиям кредитов и на чистое изменение их задолженности по банковским кредитам. Наиболее значимое воздействие было отмечено с лагом в 2 месяца и 10 месяцев после количественных смягчений или сжатия ликвидности, когда кредитный канал соответственно расширялся или сужался.

Ключевые слова: денежно-кредитная политика; трансмиссионный механизм; кредитный канал; VAR модель.

1. Introduction

Channels of monetary policy transmission need to be revised since the conventional understanding of the underlying processes require revision as well. The interest rate channel, which was thought to be the most influential in terms of delivering impacts of policy change to economy, developed sufficiently and obtained several modifications like the credit channel that makes it more precise and distinct in changing the corporate sector's balance-sheet position and performance through its specific contribution to the tradeoff between liquidity and profitability, as well as through fostering or slowing down capital expenditure. All the latter require a specific survey to determine if there is a plausible interrelation between the overall changes in monetary policy and the intensity of the credit channel, which is a relatively new research task, especially on the Russian market data.

Recent research shows that the credit channel in 2012-2016 was not the major channel to transmit the impacts of monetary policy change to the economy, but still it appears to obtain more evidence of weaknesses of other channels to deliver the signals properly due to several known disproportions of the structure of the Russian financial system and to the externalities exceeding the predicted boundaries. As we face the credit recovery (January-June 2017 gave 14% growth compared to the same period of 2016, according to the Bank of Russia), one might want to determine the contribution of monetary policy change and to distinguish it from other macroeconomic circumstances that influence credit affordability and availability. Although corporate loan interest rates are going down, we argue that the demand side of credit extension is also important, because non-financial enterprises tend to absorb growing liquidity gradually with respect to different sorts of expectations: lower interest rates can stimulate the demand for loans extended but they do not explain the propensity of companies to hold or to get rid of previously obtained debt, which is the prerogative of credit channel.

This paper brings the novelty of measuring the extent of monetary policy changes influence on credit availability and affordability that shape up the breadth of credit channel of monetary policy transmission. It provides comprehensive quantitative measures of the impact and, furthermore, the measures of the dependence of the credit channel on the money supply. To our knowledge, such a result is still subject to discussion, thus we are contributing sufficiently to the general knowledge of credit channel functioning.

The purpose of the research is to establish and measure the time-distributed interrelation between changes in the monetary policy and the breadth of the credit channel. The following research tasks facilitate the achievement of the following objectives:

- to determine the credit channel of monetary policy transmission and to distinguish it from the interest rate channel;
- to test several options of the model of monetary policy changes influence on the breadth of the credit channel;
- to derive conclusions and provide links to further research.

The research methodology is based on theoretical systematisation of recent and earlier papers on the issues of monetary policy transmission to the economy. Our theoretical assumptions get verified by the appropriate literature to eliminate any possible contradiction with the actual discourse and other researchers' results. Major sources of reference include both theory- and policy-oriented papers published in appropriate journals or books, including but not limited to the ones denoted in the literature review section.

Methods and techniques used for analytical purposes and modeling include multiple regression, polynomial distributed lag regression and vector autoregressive models. Prior to modelling, several statistical constraints were identified and tackled: all the time series employed were unit-root tested by using the Augmented Dickey-Fuller test and made stationary in the cases where it was necessary. The results of the models were verified both in levels and in stationary representation according to the earlier developed algorithm of deriving «Executive» models of data in levels and further testing them with «Authentic» models of stationary data. The approach description is available in [15].

The employed data sources include the Russian Federal State Statistics Service, the Bank of Russia, as well as some international organisations. Only public data sources were used.

The logic of the paper is the following:

- the literature review and methodology background section provides insight into the issues of evolution of monetary policy transmission channels, determines specific features of the credit channel and interrelates it to changes in monetary policy and describes the methodology of modelling the credit channel breadth;

- the results and discussion section contains the study of credit availability and affordability dependence on changes in the money supply, as well as the study prospects of the influence of credit channel breadth on the competitiveness of enterprises of the real sector.

2. Literature Review and Methodology Background

Evolution of monetary policy transmission channels

Monetary policy transmission is implemented through different channels, each being important in a given macroeconomic circumstance. This paper considers the breadth of credit channel of monetary policy transmission which is the extent of credit availability and affordability (further denoted as CAA) changes under the usage of appropriate monetary policy instruments that affect it: interest rate changes and minimum required reserve rate which means either an increase or decrease in liquidity available to banks. It stands in line with Mandel and Tomšík's point, who notice that «traditional interpretation of monetary policy is based on an assumption that central bank operates in conditions of «hunger» for liquidity and supplies liquidity to commercial banks through its monetary policy instruments» [10].

The interest rate channel is ubiquitous because short-term interest rates, which seem to affect all four main transmission channels, are most responsive to changes in the monetary policy, even though the impact on some retail interest rates may be much slower, according to the Bank of England [1]. There are several reasons for this. Firstly, they affect the interest margin on new borrowings, thereby increasing transaction costs for real expenditure, for example, through the cost of capital. Secondly, they underlie average costs of settlements and, consequently, the price of holding accounts receivable and payable, thereby ensuring changes in income and cash flows, as well as reducing spending opportunities. Thirdly, changes in interest rates affect the value of assets, resulting into changes in creditworthiness and in the willingness to lend. Finally, interest rates are linked to the exchange rate of the national currency, thereby providing benefits for importers or exporters. Thus, the interest channel of monetary policy transmission is widely employed in many economies. Evidence comes from the USA (Chang, Wang, Chang, & Liu, 2015) [4], India (Bhoi, Mitra, Singh, & Sivaramakrishnan, 2017) [2], the United Kingdom (Bank of England, 2000) [2] and several other countries showing the interest rate channel to be the most important one.

The interest rate and the minimum required reserve rate have both a direct and indirect impact on liquidity. Primarily, they determine the dynamics of inter-bank rates, as well as the prospect attitude of commercial banks towards liquidity and loan supply (the matter of choosing the type of an asset to invest). The latter is more important in terms of interrelation between monetary policy and economic policy, as shown in [13], since monetary policy is thought to be subordinate to economic policy. This subordination means that changes in CAA through monetary policy instruments, i.e. changes in banks' willingness to extend credit and their pricing policies affect the non-financial sector in a multivariate manner which is subject to further investigation.

Since commercial banks conduct the impulses of monetary policy to the real sector through the credit shrink or expansion, such an intermediation is not purely adherent to the interest rate channel, which makes it reasonable to introduce the credit channel, also denoted as the bank lending channel. The discussion is being shifted from the matters of delimitation between the interest rate channel and the credit channel to the issues of the efficiency of channels in fostering economic growth or increasing competitiveness of the economic system as a whole or of separate industries or even enterprises. Proper theoretical background and empirical proof of the credit channel existence is provided by C. Tsatsaronis (1995). According to the researcher, it becomes obvious that «when a central bank reduces the amount of reserves in the system it is not only bank liabilities that are affected but also bank assets. A reduction in the quantity of bank loans supplied… will be reflected in a quantity constraint on intermediated credit to bank customers. A reduction in the total supply of external funds will have negative effects on their activity level. This mechanism represents a distinct channel because it entails a shift in the supply of bank credit in addition to any movements along the demand curve for loans induced by the higher level of interest rates» [15]. The quoted author modelled economic activity as a function of several predictors including money supply and loans extended. He concluded that the USA and the United Kingdom showed no evidence of the credit channel relative importance among all the other transmission mechanisms, however the case of Germany returned a positive test for credit channel importance in the functioning of an economy: monetary policy tightening caused economic slowdown neither immediately nor timely after the introduction of restrictive measures because commercial banks managed to buffer the negative impact and to maintain comfortable volume of credit extended to non-financial enterprises. Still, the USA, according to Endut et al., is a separate case since its monetary policy transmission mechanisms change dramatically (Endut, Morley, & Tien, 2017) [6]. More issues of state-dependent transmission practices are provided in (Rüth, 2017) [14].

Hence, the credit channel of transmission is actual for the countries where monetary policy is closely related to CAA and where an increase in interest rates results in a credit extension slowdown at all levels of the banking system, which ultimately causes a reduction in the demand and supply of loans to enterprises of the real sector:

- An increase in interest rates reduces the demand for loans, making them relatively less affordable, hence pushing forward the liquidity deficit followed by the growth of accounts payable and receivable, increasing the length of their turnover. The next step is a change of companies' working capital structure and growth of interest expenses (the interest coverage ratio going down).
- An increase in interest rates reduces the supply of credit, as banks revise their attitude to risk, and are also forced to respond to increases in unitary fixed costs because of lower demand for loans, making them more expensive. As Mandel and Tomšík declare, «a characteristic feature of an oligopoly is a partial transmission of costs imposed on banks by the central bank to customers through a higher interest margin» [10].
- A decrease in interest rates may lead to a reluctant extension of new credit to the current borrowers, due to earlier disproportions in the structure of balance sheets.

All the latter have a negative impact on liquidity or profitability of the non-financial sector. Still, as the money channel affected by interest rate changes appears to be more effective in delivering impacts of monetary policy change, it is reasonable to draw a causality line between the concepts in focus and to prove it is correct. We agree that monetary policy instruments in the Russian Federation aim to target inflation by regulating the money supply that is determinant to CAA. Consequently, M2 changes can be treated as an argument in CAA formalisation models that link monetary policy transmission mechanisms to the concept of corporate competitiveness.

Modelling the credit channel breadth methodology

We assume that changes in the monetary policy of the Bank of Russia has an impact on the availability and affordability of credit and on the reluctance of banks to extend credit or, conversely, to retain excess liquidity. The correlating indicators should be the dynamics of interest rates and the money supply (M2). Consequently, we introduce the two factors of corporate competitiveness: the volume of bank loans extended during a period (*Le*) and the net change of bank loans debt (*Dn*).

It is noteworthy that different channels of monetary policy transmission act asynchronously, as well as their efficiency depends on many exogenous factors, such as a stage of economic cycle or the dynamics of the major market-makers expectations. For example, T. Dahlhaus (2017) proved that sharp changes in monetary policy during periods of financial instability have a stronger and more stable impact on macroeconomic variables such as the volume of industrial output, general consumer consumption, gross investment, etc.,

compared to non-recessionary periods. The reasons for those differences, in her opinion, arise from the nonlinearity of each of the two components of the credit channel, namely the balance sheet channel and the bank lending channel.

Tab. 1: **Parameter estimates of *Le* dependence on M2 changes**

Dependent variable	Independent variable	Beta	B	Intercept	P-level	R^2
Loans extended per month	Absolute growth of M2, unadjusted	0.381	393	2160673	0.000	0.136
Total debt, end of month	M2 unadjusted	0.979	599.8	345731.1	0.000	0.958

Source: Authors' own research

3. Purpose of research

Given the inputs above, we assume that a change in credit extension or a change in enterprises' balance-sheet positions can occur with different lags that do not correspond to the usual ideas about patterns of dynamics of the economic variables in question. Thus, we are planning to prove the existence of the mentioned lags as well as the presence of causality relation between monetary policy changes and the credit channel breadth, which influences, presumably, corporate competitiveness.

4. Results and discussion

Study of CAA dependence on changes in the money supply

At the first stage of the empirical study, a simulation of relationship between the monthly data of bank loans extended to non-financial enterprises (*Le*) and the money supply (M2) was made to determine causality and to identify the time lags for mutual impact. That was required to prove the existence of a tangible impact of monetary policy instruments on the volume of bank lending to the non-financial sector. The time series employed were previously seasonally adjusted (the «SA» index at a variable) and made stationary, where necessary (the 1st order differences were used to eliminate the unit root - the «1od» index in the variable).

Having examined the data on the monthly amount of loans extended (*Le*), the total current debt at the end of the month (*D*) and their dependence on the monthly changes in M2 in the synchronous presentation, we can draw the following conclusions:

1. There is a strong correlation between the volumes of the total banks' portfolio of credits to the non-financial sector and the size of M2 aggregate in the synchronous representation (the determination coefficient is 0.958), whereas the correlation between the M2 changes and *Le* at the zero lag is not obvious (the determination coefficient is 0.136). Linear regression results and parameter estimates are shown in Table 1.

Judging from the values above, a billion rubles growth of M2 caused total debt to respond in 0.6 billion rubles growth, and vice versa, while the extended loans demonstrated almost no reaction (0.393 billion rubles per 1 billion growth of M2) considering the low percentage of the variance explained by the model.

Given the possible delayed impact of M2 changes on the extended loans, the corresponding hypothesis was tested to determine the existence of the deferred influence), in line with the methodology described in [16]. The instrument for such a study was the Almon polynomial model of distributed lags. We took the 2nd order model to estimate the most significant interval of influence - the lag between the M2 changes and the extended loans (*Le*). Since preliminary studies aimed at detection of reliable lags were not carried out, the above hypothesis was worked out with maximum lags of 6 months and 12 months (the non-discrete sequential lags in the intervals [0; 6] and [0; 12] months, respectively).

The derived model has rather low explanatory power (R^2 = 0.19), regression coefficients (b) for all six lags indicate that the most significant absolute influence M2 growth on the volume of loans extended is found at the zero lag, although it is negative on all the verified lags and statistically insignificant. Yet, the results of PDLM simulation of the M2 change influence on *Dn* turned out to be somewhat different. Unlike *Le*, the *Dn* variable has a different pattern in terms of exposure to the influence monetary policy changes.

The model with the maximum lag of 6 months (R^2 = 11%) indicated a statistically insignificant positive effect of M2 change on *Dn* at the lag of 6 months (b = 11.6), while the zero-lag value of the regression coefficient was minimal (-88.8 with a gradual increase to the 6 lag). The cumulative impact of M2 changes on *Dn* scored (-267.8): it can be assumed that increasing the money supply causes total credit reduction.

The maximum lag set to 12 allowed obtaining a model that, with a probability of 22.4%, described the dependence of the considered variables to prove the existence of a positive deferred influence of the monetary M2 change on CAA and the companies' preference of liquidity (*Dn* grows along the increase of M2). Consequently, an increase in money supply provides a positive increase in the corporate loan debt 4 months past. The most significant impact (taken unweighted by statistical significance) is noted at the lag of 11 months, while on minimal lags the impact is negative. The cumulative effect of the M2 increase on the growth of corporate loans debt is measured by an indicator of 186.7 (million rubles per each billion rubles of money supply growth over the following 12 months).

In all the models above, a critically high value of an intercept indicates several other factors that are more significant in terms of their influence on the credit channel efficiency. To verify the PDLM results, a vector autoregressive model (VAR) for 6 and 12 lags was used.

Modelling $VAR(Le_{SA}; M2_{SA})$ derived a significant autoregression of Le_{SA} on the 1st and 2nd lags, as well as a statistically significant dependence of Le_{SA} on the changes in $M2_{SA}$ with a lag of 2 months (Table 2).

Tab. 2: **VAR(Le_{SA}; $M2_{SA}$) results**

Model with 6 lags			*Model with 12 lags (selected lags)*		
R- squared = 0.961	B	p- level	R- squared = 0.957	B	p- level
Intercept	20.013	0.8514			
Lesa_1	0.611	<0.0001 *	Lesa_1	0.622	0.003
Lesa_2	0.335	0.0155 *	Lesa_2	0.309	0.004
Lesa_3	-0.023	0.8672			
Lesa_4	-0.018	0.8999			
Lesa_5	-0.060	0.6502			
Lesa_6	0.133	0.2457			
M2sa_1od_1	0.045	0.4279			
M2sa_1od_2	0.121	0.0356 *	M2sa_1od_2	0.114	0.067
M2sa_1od_3	0.023	0.6982			
M2sa_1od_4	-0.042	0.4722			
M2sa_1od_5	0.057	0.3368			
M2sa_1od_6	0.028	0.6325			
M2sa_1od	-0.009	0.8685	M2sa_1od_10	0.117	0.065
Time	-0.014	0.9870	Time	0.490	0.663

Source: Authors' own research

It is notable that the lagged influence of M2 changes on the extended loans results in the total of 0.223 billion rubles growth per 1 billion rubles money supply advances, including two inhibitory factors at lags zero and four (negative values), yet statistically insignificant since p-values are close to random samples.

An inverse relationship between *Le* and M2 is not observed, which allows us to statistically confirm the causality relation between the changes in M2 (the cause) and the volumes of loans extended to the non-financial sector (effect). The model with 12 lags also confirmed this cause-effect relationship at the 2nd lag, as well as found it at the 10th lag.

Comparing the results of VAR with the results of PDLM, it is necessary to emphasise that the conclusion about the influence of M2 on Le at various lags, concerning the strength of this influence, is generally reproduced, as well as its extent given the comparable values of regression coefficients. The VAR model using time series without seasonal adjustment also indicates a negative impact of M2 changes on the supply of loans to the non-financial sector. Consequently,

seasonality is a significant factor explaining the direction of the cause-effect relationship between the M2 changes and extension of loans.

Applying VAR to investigate the interdependence between changes of M2 and *Dn* confirmed the causality of M2 to *Dn* at the 4th lag (model with 6 lags maximum) and at the 9th-11th lags (model with a limit of 12 lags). The greatest positive impact of the M2 changes on the net increase of corporate loans debt is found at the lag of 11 months. See Table 3 for details.

The above results indicate a strong negative aggregate influence of the M2 changes on the net debt change - the total of all negative lags is minus 80 million rubles per 1 billion increase of M2. The positive lags are equipotent as negative ones: 82.3 million debt surplus in 3-4 months perspective in response to M2 growth.

Restyling the model to employ annualised data - M2 and *Dn* year-to-year change - within a range from 1998 to 2016 confirmed the existence of a positive relationship between M2 and *Dn* on the lag of one year, and the greater extent of the negative impact at the 4-year lag (Table 4).

One possible explanation for the negative interrelation between the debt net change and the M2 change in 3-4 years' perspective is the match of the average length of loans funded investment projects. Growing M2 fosters credit extension, capital expenditure loans are measured to have average duration of 3 years after which they are paid back, thus decreasing the net debt.

The models described above indicate that there exists a rational and reliable interrelation between the changes in monetary policy, which result in the money supply fluctuations, and the effects of the credit channel of its transmission. Given the specific features of the Russian economy, the reaction of the credit channel to M2 changes is rather ambiguous taken in different time intervals: it does affect the willingness of non-financial enterprises to raise more credit and to hold the credit until maturity, or, in contrast, to pay-off debts and get finance from operations by changing the payables and receivables policy.

Tab. 3: **VAR(M2_1od; Dn_1od) results**

Model with 6 lags			Model with 12 lags (selected lags)		
R2 = 0.276	Coefficient	p-value		Coefficient	p-value
Const	97284.50	0.15		122827.00	0.25
Dn_1od_1 *	0.22	0.08	M21od_1	-24.87	0.56
Dn_1od_2	0.21	0.10	M21od_2	-36.76	0.36
Dn_1od_3	0.08	0.55	M21od_3	-16.02	0.66
Dn_1od_4	0.01	0.95	M21od_4	21.10	0.53
Dn_1od_5	-0.10	0.39	M21od_5	-50.56	0.16
Dn_1od_6	0.11	0.32	M21od_6	-22.88	0.53
M21od_1	-33.41	0.23	M21od_7	22.67	0.54
M21od_2	-31.23	0.31	M21od_8	2.56	0.94
M21od_3	24.92	0.45	M21od_9 *	85.16	0.02
M21od_4 *	57.41	0.08	M21od_10 *	84.59	0.03
M21od_5	-12.74	0.70	M21od_11 *	120.56	0.01
M21od_6	-2.68	0.92	M21od_12 *	14.98	0.73
Time	-588.21	0.33	Time	-1493.03	0.06

Source: Authors' own research

Tab. 4: **Year-to-year VAR(M2; Dn) results**

R- squared = 0.991265	*Coefficient*	*p-value*	
Const	-1,723,800.00	0.079	*
M2_1od_1	508.19	0.001	***
M2_1od_2	465.19	0.106	
M2_1od_3	-276.37	0.351	
M2_1od_4	-1192.08	0.012	**
Dn_1od_1	0.05	0.817	
Dn_1od_2	-1.36	0.032	**
Dn_1od_3	2.60	0.010	***
Dn_1od_4	-1.22	0.007	***
Time	277,254.00	0.073	*

Source: Authors' own research

5. Conclusions

We managed to establish and measure the interrelation between changes in monetary policy and the breadth of the credit channel of its transmission, that turned out to be lagged with the greatest positive influence on credit supply 11-12 month past the M2 growth. As for the credit extended, it reacts positively 2 months past quantitative easing and, again, in the 10-month perspective. The influence patterns derived from modelling appear to be rigid and sustainable to time series prolongation: further testing of the models on longer time series (including data of May-August 2017) indicated no significant change in the values of coefficients, yet no drastic changes in monetary policy happened during the period.

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