MONETARY POLICY TRANSMISSION DISTURBANCES DURING THE FINANCIAL CRISIS: A CASE OF AN EMERGING MARKET ECONOMY

PRELIMINARY, COMMENTS WELCOME

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Abstract

The aim of this paper is to show implications of the current financial crisis for the monetary transmission mechanism (MTM) and its effectiveness in Poland, which is an inflation targeting emerging market economy. MTM depends on the monetary policy, but also on structural features of the economy. Financial crisis could affect both. Our results based on the Polish data suggest a change in the monetary policy rule and a significant drop in the overall monetary policy effectiveness. Unlike disturbances in the interest rate pass-through, which reflect increased perception of risk and result from the financial crisis, the more pronounced role of credit market imperfections and the weakening of the exchange rate channel can be viewed as typical phenomena in the current phase of the business cycle. However, the magnitude of the crisis, the likely changes in the regulatory framework and adjustments in macroeconomic policies can result in the deeper evolution of the MTM.

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1. Introduction

Monetary transmission has recently gained a new wave of interest (e.g. Boivin et al. (2010), Cecioni and Neri (2010)), but papers addressing a question of a potential impact of the current financial crisis are scant, especially for emerging market economies. We would like to partially fill this gap – the aim of this paper is to show implications of the current financial crisis for the monetary transmission mechanism and its effectiveness in Poland, which is inflation targeting emerging market economy. Poland has both standard and non standard features of such economy. Emerging markets are usually open economies with less developed financial sector, but on the other hand, they depend heavily on foreign capital. Poland is less financial and trade opened than other European emerging markets; also, it is a significant recipient of funds related to the European Union's Cohesion Policy. Therefore, financial crisis in Poland may manifest itself in a different way and can have different outcomes than in developed economies, but also to some extent, than in other emerging market economies.

The transmission mechanism crucially depends on the monetary policy. In the sharp phase of the financial crisis – after the Lehman Brothers default, many central banks changed monetary policy from the short-term interest rate control to liquidity management and more pronounced role of output stabilization. Higher liquidity preference of banks resulting from a sharp increase of uncertainty brought about problems with transmission from the monetary policy instrument to the money market rates and retail rates.

Owing to the openness of emerging economies, exchange rate usually plays a significant role in the transmission mechanism. During financial crisis, increased global uncertainty caused massive capital outflows and these in turn led to a rapid depreciation of domestic currencies. The impact of depreciation can be twofold: on one hand, increasing competitiveness it can stimulate output, but on the other – dampen real sector activity via credit channel. Depreciations lead to a deterioration in borrowers' balance sheets, especially

in dollarized economies and when central bank credibility is low (Caballero and Krishnamurthy (2004)). Tornell and Westermann (2002) stress that in the middle income countries, the balance sheet effect and depreciations mostly affect non-tradable sector, which is more bank dependant than the tradable sector. In Poland, the exchange rate depreciation rather sustained than depressed domestic demand. There are at least three underlying reasons: (i) the share of corporate sector debt denominated in foreign currencies is relatively low – it amounts to 25%. Balance sheets of the corporate sector, though affected by exchange rate impact on loans, seemed to suffer more from firms' involvement in speculations on further exchange rate appreciation (options); (ii) the aforementioned broader indicator, i.e. the level of financial openness of Poland, measured as gross stocks of foreign assets and liabilities to GDP, which in 2008 reached the level of 116.6%, remains relatively low comparing to either Czech Republic (147.4%) or Hungary (173.5%), let alone the euro area (264.5%); (iii) central bank credibility, though not very high, increases steadily. Inflation targets, though not credible for consumers, are credible for commercial banks. Moreover, the probability of future inflation being within the NBP target is characterized by a positive trend both in the case of banks and consumers (Łyziak et al. (2007)).

Financial crisis and exogenous negative demand shock led to an exceptionally deep contraction in the real sector in many emerging markets. Poland did not experience a formal recession – GDP growth remained low but positive. Nonetheless, various measures of output gap were negative and big in absolute terms. As suggested by Adrian et al. (2010), the role of the interest rate spread or output gap may vary across different phases of the business cycle; the same applies to the exchange rate pass through (e.g. Correa and Minella (2006)). While during recessions the relationship between inflation and demand is close to linear as labour market is relatively competitive, during expansions capacities are utilized at high levels and increasing them is costly (constraint capacity models). Thus, inflation becomes more sensitive

to demand pressure. We try to shed some light on the role of cyclical factors in the monetary transmission disturbances observed during financial crisis.

The paper is structured as follows. We start with a description of stylized facts: to pin down the analysis we present the main characteristics of the Polish economy, stressing these which have the largest impact on the way the crisis manifests itself – e.g. openness, the role of financial sector, degree of euroization of private sector debt and exposition of the economy to sudden stops. Then we present data and the estimation method. The next section provides empirical results, and the last one concludes. Graphs and tables are displayed in the Appendix.

2. Stylized facts. Monetary and other policies during financial crisis

Poland is a small open economy with a floating exchange rate regime pursuing inflation targeting. This gives an important role for the exchange rate channel in the monetary transmission mechanism, which is also characteristic for many emerging market economies (Mohanty and Turner, 2008). Still, Poland remains less open in terms of trade and financial linkages than countries of the region[1].

Despite a steady growth, Poland is characterized by a relatively low level of financial intermediation and banking sector development. In 2008 the relation of bank assets to GDP reached 82%, while the share of bank loans (deposits) to (from) non-financial sector in GDP amounted to 47% (39%)[2].

Bank loans remain the most important source of external financing for firms. Access to alternative sources of funds is limited – capitalization of the stock market is relatively low

[1] The degree of trade openness of the Polish economy is similar to that of the euro area, but two times smaller than of the Czech Republic and Hungary. Financial openness is more than two times lower than that of the euro area, and significantly lower than of the Czech Republic and Hungary (Mohanty and Turner (2008)).

[2] In the euro area, the Czech Republic and Hungary bank assets to GDP amounted to 346%, 109% and 110%, share of bank loans to non-financial sector: 106%, 55%, 54%, and share of bank deposits from non-financial sector: 75%, 62% and 36%, respectively (Financial system development in 2008, NBP).

(21% of GDP as of 2008) and commercial papers market is weak[3]. Large firms, which have relatively easier access to the capital market, finance their investments mainly from internal sources and only about 10% of funds comes from the domestic bank loans.

The concentration level of the Polish banking sector is low and decreasing since 2002 as a result of a rapid development of small and medium-size entities. As in other Central and East European countries, the share of foreign investments in this sector is large[4].

There are some mismatches in the banking sector. High growth rate of loans to the non-financial sector[5] and dynamic development of non-bank financial institutions which absorbed households' savings, has led to accruing of a funding gap, with relation of loans to the non-financial sector to its deposits at the level of 108% in 2008, which, however, is still fairly low, close to the euro area average (111%)[6]. The maturity mismatch has been driven by two opposite tendencies: an increase in the share of short-term deposits in total deposits of households (reaching 94% in 2009), as households moved their longer-term savings to investment funds and insurance companies, as well as lengthening of the average maturity of loans, mainly due to a dynamic rise of demand for loans for housing and increased firms' borrowing for investment and real property during 2004-2008[7]. The maturity mismatch halted at the beginning of 2009, once the banks, concerned about the economic prospects, tightened credit conditions while non-financial sector reduced its demand.

Another feature of the Polish banking sector is a significant role of loans denominated in foreign currencies[8]. In the case of firms, their share has been decreasing since 2003 together with a narrowing interest rate disparity between WIBOR and EURIBOR. In contrast, the

[3] Outstanding amount of long- and short-term debt securities issued by non-financial firms in 2008 amounted to 2.2% of GDP vs. 20.5% in the euro area.
[4] The ownership structure is stable with about 20% of total assets being controlled by the state, 5% - by domestic and 70% - by foreign investors; 5% of assets is attributed to cooperative banks (Financial system development in 2008, NBP).
[5] Indebtedness of households reached 48% of the disposable income (2009), but is much lower than in the euro area (81%).
[6] Financial system development in 2008, NBP.
[7] The share of short term-loans in total loans decreased form 32% in 2002 to 12% in 2009 in the case of households and from 30% to 25% in the case of firms.
[8] In 2009 foreign currency loans amounted to 40% of total households loans and 25% of firms loans.

fraction of households' loans denominated in foreign currencies has been constantly growing, mainly as a result of a high demand for long-term loans for housing. The household sector seemed to play on euro adoption and long-term zloty appreciation. Also, households downplayed exchange rate volatility and considered mostly interest rate disparity. The process slowed down in 2006, when central bank introduced a regulation tightening conditions for this type of loans. Also, banks changed their credit policy in the aftermath of the financial crisis.

Financial crisis induced a transitory change in the monetary policy. Facing a sharp increase in uncertainty and turbulences in foreign and domestic financial markets, and a significant increase in cash holdings of households, central bank which prior to the crisis focused on controlling the overnight money market interest rate (POLONIA), put into place various measures aimed at liquidity management. The crisis brought uncertainty about financial soundness due to massive write-downs and losses of the banking sector in both the US and the euro area and led to a fall in the unsecured transactions. In Poland, banks reduced limits on such transactions (Figure 1 shows the volume of overnight transactions). It should be stressed however, that as in many emerging markets, Poland's banking sector exhibits structural excess liquidity. During financial crisis it alleviated negative effects of the confidence loss. As shown in Fig. 1, there is a clear-cut fall in the overnight transactions in October 2008. Transactions remained subdued throughout 2009 in spite of a significant increase in the free reserves of banks; they started to rebuild only in 2010. A downward trend in the overnight transactions started in the first half of 2008, well before the Lehman Brothers collapse. Then, the central bank tightened monetary policy owing to inflation exceeding the targeted level of 2.5%. It is therefore understandable that lower free reserves led to a lower level of interbank transactions. Starting from November 2008 NBP gradually lowered its interest rate from 6% to 3.5% in June 2009.

Slightly before, in mid-October 2008, NBP introduced Confidence Package, i.e. a set of measures aimed at providing banks with liquidity in domestic and foreign currencies and at expanding possibilities for banks to obtain liquidity by broadening collateral in operations with the NBP. The central bank started repo and swap operations (due to surplus liquidity before financial crisis it conducted only absorbing operations). Through repo it added liquidity for maturities up to 6 months, whereas through swap operations, NBP provided banking sector with Swiss francs, US dollars and euros. The latter operations were mostly used by domestically-owned banks which found it difficult to finance themselves in foreign markets, opposite to these which could be financed by their mother-institutions.

In addition, in January 2009, NBP pursued an earlier redemption of its 10-year bond, issued in 2002 to absorb structural surplus liquidity. Finally, in May 2009 central bank reduced the reserve requirement ratio from 3.5% to 3%.

The provision of liquidity drove short-term rates in the unsecured market to the levels below the NBP's policy rate, i.e. the reference rate (Fig. 2). On the other hand, it helped reappearing of transactions, but mainly for maturities up to one week. This is well illustrated by spread behaviour. Spreads between interest rates of various maturities and POLONIA rocketed first at the end of 2007 reflecting disturbances in the world markets due to the first stage of the subprime crisis. This was a transitory phenomenon and then spreads went down. They increased sharply once again after the Lehman Brothers failure. Their increased level persisted in 2009, but while this between WIBOR1W and POLONIA stabilised, those between POLONIA and longer rates got even larger. This is especially visible in the case of WIBOR3M, even though this rate to some extent is impacted by the central bank's repo operations.

Government policies addressed to tackle disturbances the financial crisis brought about, involved four groups of measures. The first one was supposed to stabilise the banking sector through extension of household deposit guarantees and a possibility of getting a

transitory state aid in mortgage debt repayment for those who got unemployed due to the financial crisis. The second group was aimed at exchange rate stabilisation, which was depreciating, driven by contagion effects. Thus, the government exchanged the inflowing EU related funds in the foreign exchange market, instead of doing it at the central bank window. Moreover, the government and the central bank arranged an access to the Flexible Credit Line (FCL) offered by the IMF. Foreign investors treated the credit line as an additional insurance of macroeconomic stability or the country collateral. Thus, the FCL reduced credit constraints, which in the case of emerging markets exist on both firm and country levels (Caballero and Krishnamurthy (2004)) and made the credit channel operation closer to the way characteristic for developed economies. The third group was to sustain domestic demand and involved a faster use of EU funds, loans from the EIB and the World Bank. Also, small and medium size enterprises were offered credit guarantees. Finally, the last group was supposed to increase flexibility of the economy, and labour market in particular. Under auspices of the government, employers and trade unions agreed to enhance flexibility of working time and, by the same token, diminish lay-offs during periods of lower demand.

Data and estimation method

We use monthly data in the estimations showing stylized facts and interest rate channel operation through the lens of VAR and simple EC models, and quarterly data for the structural model. The sample starts in 1998 with the adoption of inflation targeting by the central bank and ends in May 2010.

To account for a possible regime shift and the resulting parameter instability, we use a dummy which is zero in the period before the Lehman Brothers collapse and 1 thereafter[9]. The results are presented both with and without the dummy, since it seems that it captures not only effects of the financial crisis, but also these of the business cycle. Interestingly, it was

[9] We checked whether the regime shift started before Lehman Brothers collapse, i.e. at the end of 2007, but such dummy was insignificant.

insignificant in the case of all credit variables but loans in foreign currencies to the corporate sector. Relatively high variability of loans in Poland since 1999 seems to be the underlying reason (see Fig. 3), therefore reactions of loans denominated in the domestic currency are displayed only for the specification excluding the dummy.

While the sample is homogenous in terms of monetary policy framework, the EU entry in May 2004 was as a factor inducing greater mobility of the labour force. The number of persons staying temporarily in other European countries increased from 726 thousand at the end of 2002 to 2 210 thousand at the end of 2008 (the number of employed persons at the end of 2008 totalled 8 270 thousand, GUS Information, 2009 August, and Statistical Bulletin, April 2010). To capture the possible structural changes in the labour market due to migrations, we use a dummy equal zero before the Poland's EU entry and 1 thereafter in the VAR which includes a labour market variable.

First we analyze developments in the financial markets – i.e. interest rate pass-through from money market to retail rates. To check whether it underwent changes resulting from the financial crisis, we use a following model:

$$\Delta r_t = \alpha_0 + \alpha_1 \Delta mr_t + \beta_1 \left(r_{t-1} - \beta_2 mr_{t-1} \right) + \varepsilon_t$$

where r_t is a respective retail deposit or loan rate, mr_t stands for a money market rate (either 1- or 3-month WIBOR), Δ is a first difference of a variable, whereas α_0, α_1, β_1, β_2 are parameters, and $\beta_1<0$. Coefficient α_1 shows the instantaneous adjustment of the retail rate to the money market rate, while β_2 measures the long-term adjustment. Using the estimated parameter values we asses the speed of adjustment, which can be expressed as $(1 - \alpha_1) / \beta_1$. We employ data on both outstanding amounts (stocks) and new

deposits/loans (flows[10]). In this case, due to a change in the method of retail rates calculation, the sample is much shorter. It covers the period 2005.01-2010.05 only.

Next stages of the monetary transmission are examined with a suite of structural VAR models in the spirit of Peersman and Smets (2003). In the benchmark model we use four macroeconomic variables – prices (CPI), industrial output as a proxy for the real sector activity, short-term interest rate (1-month money market interest rate, WIBOR1M – serving as a proxy for the policy rate), and the nominal effective exchange rate. Foreign interest rate (EURIBOR) is plugged exogenously. To extract monetary policy shock we employ a recursive (Choleski) factorization. The variables are ordered in a way reflecting the assumption of a lag between monetary policy shock and the reaction of the real sector and prices. The specification reflects also monetary policy rule: central bank sets the level of its instrument (interest rate) observing current developments in inflation and the real sector. We allow the exchange rate to react contemporaneously to the interest rate developments, but interest rate does not respond contemporaneously to the exchange rate[11]. Information on disturbances and lags in the interest rate pass-through, obtained from the error correction models, makes it possible to conclude in a more robust way on the underlying reasons of potential disturbances in the further stages of the transmission.

To gain more insights from the VAR analysis, we add to the benchmark specification various credit aggregates, including these denominated in foreign currencies. This brings more evidence whether – as in developed economies – credit played a significant role in the propagation of financial crisis. We also plug in two variables characterizing the real sector – retail sales and unemployment rate. The variables are added one by one to reduce the problem of a small number of degrees of freedom.

[10] In the statistics they are dubbed "new businesses".
[11] It is an obvious shortcoming, so to check the robustness of result we have used Kim and Roubini (1995) decomposition. The results do not exhibit significant differences and are not reported.

The benchmark model includes four lags; more lags are usually used for the specification containing additional variables. The number of lags is determined taking into account information criteria, but also model stability and serial correlation of residuals. All variables except the interest rates are in natural logarithms and are seasonally adjusted. If necessary, we also use centred seasonal dummies to eliminate the remaining seasonality and autocorrelation of residuals. The VAR models are estimated in levels to allow for the long-run relationships between variables. The key variables are reproduced in Fig 1 and Fig. 3.

Basing on our VAR models with determined optimal lags, we calculate monetary transmission effectiveness (MTE), understood as a standardized elasticity ($e_{y2/y1,yA}$) between instrumental (y_1) and target (y_2) variables with intermediation of the y_A variable from the transmission chain:

$$MTE_{y_1 \to y_2, y_A} = (1 - pv_{A,1})(1 - pv_{2,A}) \frac{\left| e_{y_2 / y_1, y_A} \right|}{\left(1 + \left| e_{y_2 / y_1, y_A} \right| \right)} ,$$

where:

$$e_{y_2 / y_1, y_A} = e_{y_2 / y_A} \cdot e_{y_A / y_1}$$

if the parameters at respective variables are significant at the *pv* level and fulfil Wald restriction tests (for details see e.g. Bates and Vaugirard (2009)). MTE is a product of the elasticity $e_{y2/y1,yA}$ multiplied by the respective *pv*. To calculate the dynamic MTE, the former VAR models were reestimated for the optimal lag + 1. This overparameterization allows for using the OLS estimator (Harvey (1991)).

To account for the role of cyclical factors in disturbances of the monetary transmission, we conduct simulations on a small (structural) New Keynesian model augmented to include credit market imperfections.

The open economy IS curve is:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 r^l_{t-1} + \alpha_3 \cdot \left(\Delta i^l_{t-1} - \Delta i_{t-1} \right) + \alpha_4 e_t + \alpha_5 y^{EUR}_{t+1} + \varepsilon^y_t \qquad (1)$$

where y is the output gap, r^l is the real and i^l is the nominal rate of interest on loans, i is the money market rate, e is the real effective exchange rate, and y^{EUR} is the GDP growth in the euro area, the main trading partner of Poland. Thus, in the model, a change of spread affects aggregate demand. Moreover, the spread is endogenised to account for its cyclical fluctuations and forward-lookingness. It depends on the future output gap, so the banks expecting deterioration in the economic activity perceive it as a risk and increase the spread.

The exchange rate equation is expressed in terms of the nominal effective exchange rate. It is a behavioural equation, although in the spirit of the UIP condition. The nominal effective exchange rate (s) depends on its lag and lead, the differential between domestic and foreign (i^f) short-term interest rates and the future output gap:

$$s_t = \beta_0 + \beta_1 s_{t-1} + \beta_2 s_{t+1} + \beta_3 \cdot \left(i_t - i_t^f\right) + \beta_4 y_{t+1} + \varepsilon_t^s \tag{2}$$

The Phillips curve (in terms of net inflation, π^n) is explained by inflation expectations (π^e), proxied by consumer survey-based measures, the output gap and the real effective exchange rate:

$$\pi_t^n = \lambda_0 + \lambda_1 \pi_t^e + \lambda_2 y_{t-3} + \lambda_3 e_{t-1} + \varepsilon_t^{\pi^n} \tag{3}$$

In the principal version of the model the relationship between the output gap and inflation is linear. For periods of prosperity we impose non-linearities in a way suggested by Alichi et al. (2009), i.e.:

$$\hat{y}_t = \frac{y^{\max}}{y^{\max} - y_t} y_t \qquad \text{for } y_t \succ 0$$

$$\hat{y}_t = y_t \qquad \text{for } y_t \leq 0$$

then

$$\pi_t^n = \gamma_0 + \gamma_1 \pi_t^e + \gamma_2 \hat{y}_{t-3} + \gamma_3 e_{t-1} + \upsilon_t^{\pi^n} \tag{4}$$

Such specification implies that the impact of the output gap on inflation is relatively stronger if the output gap is positive. The model is estimated and then partially calibrated to account

for a supposedly increased role of processes triggered by the financial crisis – e.g. the interest rate spread, stronger influence of economic fundamentals on the exchange rate, etc.

4. Empirical evidence

4.1. Interest rate pass-through

In line with the literature, we assume that banks are price takers in the money market and price setters in the case of retail rates – banks set retail rates with respect to the money market rates of corresponding maturities. Jobst and Kwapil (2008) point, however, that money market rates serve well as a proxy for the marginal cost in periods of calm, whereas in time of crisis this is not ensured. During the crisis banks had problems with fund raising in capital and money markets. And if they aim for a certain proportionality between the components when managing their liabilities, then diverging cost developments may result in marginal cost no longer being represented by money market rates alone. Moreover, retail rates can be affected by structural factors, like competition and development of the capital market. In this study we do not discuss the latter problem, since we suppose that structural factors do not differ much in the two samples we consider. Bearing in mind the scale of disturbances in the money market, we concentrate on the pure pass-through process.

Before financial crisis, loan and deposit rates moved broadly in line with the market rates[12]. There was some sluggishness in their adjustment to the market rates – notably in the case of loans for consumption, i.e. for loans which have poorer collateral than others. In many cases, the long-run adjustment to the money market rate was lower than one. The speed of adjustment varied from less than one month to about four months in the case of loans for households' consumption.

In the aftermath of the crisis, some long-run relationships between money market and retail rates broke down. In particular this is true for households' deposits (new businesses) of

[12] Graphs showing behaviour of deposit and loan rates are available upon request.

maturities longer than one month and up to six months. An increase in uncertainty and the aforementioned problems with fund raising led banks to offer deposit rates exceeding WIBOR3M, i.e. the rate treated as a benchmark for the retail rates (Table 1). This was most pronounced in the first quarter of 2009, when negative spread between WIBOR3M and deposit rates amounted to 1.4-1.5 percentage points; since then it gradually fell to 0.4-0.5 percentage points.

Rates on firms' deposits displayed fewer disturbances. A long-run relationship between rates on deposits of maturities up to 2 years (stock) persisted, however, the adjustment time got longer (from about a month and a half to above two months). As far as new deposits are concerned, the long-run relationship of these of maturities exceeding three months up to six months seem to disappear. From the point of view of the effectiveness of the monetary transmission process, this fact is of less importance, since firms tend to have deposits of maturities up to one month (Table 2).

Interest rate pass-through from money market to retail loan rates for households and firms has also displayed disturbances. Although many long-term relationships persisted, the time of adjustment lengthened, in particular this for already existing contracts (stocks). Moreover, the long-run relationship between the rate on loans for house purchases (new businesses) broke down. Another example of the broken long-run relationship is that between money market rate and the rate on loans for sole proprietors (i.e. the owners of small firms) and consumption. In the case of loans for housing, it seems that risk management in the banking sector tended to reflect conditions in the country of bank's parent company rather than her Polish subsidiary.

Interest rate pass-through to rates on loans to firms (both stocks and flows) displays less changes. As a rule, the long-term relationships still operate. The speed of adjustment of the average rate on all new loans got lower. Interestingly, the long-term magnitude of

adjustment (i.e. the coefficient β_2) does not exhibit more pronounced changes as compared with the period before the financial crisis (Table 3 and 4). This leads us to a conclusion, that apart from the housing sector, which to some extent suffered from constraints transferred from the foreign parent company to their Polish subsidiaries, the interest rate on loans for other sectors, albeit in a more sluggish way, followed money market rates.

4.2. Further stages of the monetary transmission

Assuming that there was a regime change, central bank's reaction function (monetary policy rule) obtained from our VAR model is – at first sight – similar in both samples. The reaction to the domestic demand shock is slightly bigger in the long sample than in the short one, whereas the reaction to the price shock does not display any change (Fig. 4, Fig. 6 upper panel shows the response of the interest rate to the domestic demand shock). Dropping this assumption we obtain a considerably bigger response to both shocks. However, while before the crisis the reactions of the interest rate to the domestic demand shock were statistically insignificant, in the sample including data after Lehman Brothers collapse, they are significant. Our tentative explanation is that facing a risk of a severe output decline and disturbances in the interest rate pass-through and credit channel operation, central bank reacted to inflation and output shocks more than in the past. Other empirical results (Fig. 5 and Fig. 6) show that the monetary transmission is somewhat slower – assuming the regime shift – the maximum reaction of prices to the interest rate shock appears 3 months later than in the past, but the magnitude of the reaction is very similar. As expected, reactions obtained without the dummy exhibit longer lags. The reaction of prices to the exchange rate shock under the assumption of a regime shift tends to be more prolonged than before the crisis. If, once again, we drop this assumption, the pass-through is smaller and faster. The difference between the two responses can be due to cyclical factors. Przystupa and Wróbel (2010) show that exchange rate pass-through is asymmetric over the business cycle and tends to be the

smallest during early recessions. Thus, the dummy effect may encompass not only the increased uncertainty and changes in the monetary policy, but also cyclical fluctuations.

Prices seem to be more flexible with respect to the domestic demand than before the crisis. With the dummy the effect is small, whereas much bigger without it. Bearing in mind the global character of the crisis and the scale of output drop in the EU and the US, we argue that facing adverse conditions, producers were slightly more than usually willing to adjust their prices to a fall in demand. Also, the reaction of the nominal effective exchange rate to the shock in output, which can be interpreted as a positive shock to the economic fundamentals, brings about appreciation which is less persistent than in the past. Thus, it seems that the financial crisis induced more volatility into the foreign exchange market. The reaction of output to both the interest rate shock and exchange rate shock is slightly smaller than before the financial crisis. In this case the dummy does not change the responses.

A response of the unemployment rate to the interest rate shock tends to be larger and more volatile in the longer sample, what seems to be inconsistent with the respective reaction of industrial output. The maximum reaction in the longer sample occurs six months later than in the short one. The slower response can be due to reluctance of employers to quick lay-offs after a prolonged period of a tight labour market. The increased openness of labour market after the EU enlargement in 2004 adds volatility to its reactions. Thus, it seems that financial crisis triggered changes in the labour market initiated well before the EU entry.

The response of the unemployment rate to the exchange rate shock is somewhat puzzling. Both in the short and long sample it tends to fall after the unexpected appreciation, while one could expect rather some increase, owing to losses in competitiveness which in turn lead to a drop in output. But in the case of a country displaying high import intensity of exports (about 0.7 for manufacturing), such results seem plausible. Thus, they can be interpreted as the effect of improved competitiveness of the real sector due to cheaper

imports. The response in the sample covering financial crisis, which does not display any increase, is probably caused by a higher price competitiveness of exports after 30% depreciation offsetting increased cost of imports (Fig 6).

Interestingly, responses of main macroeconomic variables to the foreign demand shock have not changed much owing to the crisis. Therefore, we only briefly note that a positive demand shock induces exchange rate appreciation. This in turn leads to a downward movement in prices and a positive reaction of the real sector – industrial output increases and the unemployment rate goes down. Prices start to increase slightly only afterwards.

Retail sales, being in this study a proxy for private consumption, react negatively to the monetary tightening. The response obtained from the short sample is slightly smaller than this of the longer one. The dummy makes this difference even smaller. Thus, it seems that in spite of the increased uncertainty, consumption tends to be smoothed (Fig. 6).

In the wake of the financial crisis domestic currency loans for households display practically the same reaction to the interest rate shock as before (Fig. 7). In this group of loans, only these to sole proprietors seem to exhibit more downward movement in the longer sample. This could suggest that banks perceived loans for these small entities as relatively risky. The reaction of the corporate sector loans (Fig. 8) in the longer sample is unchanged over the period of first 15 months after the shock and only afterwards some differences begin to develop. Both overdraft and loans of maturity exceeding one year (serving here as a proxy for investment loans) exhibit initially slower and smaller (overdraft) reaction to the interest rate shock than before the crisis. This can reflect the fact that during financial crisis banks lengthened the interest rate adjustment period. The more rigid reaction of the overdraft to the interest rate shock can be also due to an increase in demand for such loans. On the other hand, tightening of loan conditions for small and medium size enterprises could have a negative impact. It is noteworthy that in the longer sample total amount of household and corporate

sector loans (up to 17-18 months after the shock) exhibits the reaction pattern similar to that before the collapse of Lehman Brothers. Thus, we conclude that banks simultaneously used in a more active way instruments other than interest rates to affect loan supply, setting tighter standards and conditions[13].

In the case of loans denominated in foreign currencies to households[14] and corporate sector, we discuss impulse responses to the (domestic) interest rate shock only. Exchange rate shock seems to induce mostly the accounting effect. After monetary tightening, both before and after the crisis corporate sector tends to increase its debt in foreign currencies (Fig. 9), since this in the domestic currency becomes relatively more expensive. The effect is somewhat bigger in the longer sample and is statistically significant. Loans in foreign currencies to private persons do not change in response to the monetary policy shock (thus we even do not reproduce them in the graph), whereas these to sole proprietors display a similar pattern as loans to the corporate sector. Thus, in the sample including financial crisis data, loans in foreign currencies to the corporate sector and sole proprietors seem to be more responsive to the monetary policy shocks. It should be stressed however, that in both samples they clearly weaken monetary transmission.

4.3. Effectiveness of the monetary transmission mechanism. Impact of cyclical factors

The efficiency of the monetary policy depends on its credibility and effectiveness of the monetary transmission mechanism. The effectiveness may change over time and tends to be

[13] Our setting of the VAR does not allow us to draw hard conclusions on credit channel operation, since we do not disentangle between loan supply and demand. Senior Loan Officer Opinion Surveys (SLOOS), conducted by the NBP on quarterly basis, involve questions on both demand and supply. SLOOS show that banks aimed at reducing loans for housing and consumption. As we discussed before, the former are mostly extended in foreign currencies. Also, loan officers report that demand for consumer loans was slightly falling in the first half of 2009 but then started to increase. In the case of loans extended to the corporate sector, banks report to tighten standards and conditions with respect to the supply of short-term (of maturity up to 1 year) and long-term loans (of maturity exceeding 1 year) in the same way. The standards and conditions were tightened more for small and medium size enterprises than for the big ones. On the other hand, loan officers reported a more pronounced fall in demand for long-term than for short-term loans, suggesting that firms abandoned investment plans, whereas they tried to find financing for the working capital, inventories and debt restructuring. Our results are broadly consistent with the SLOOS, with exception of loans to the corporate sector of maturity exceeding one year.

[14] Over the period 2004-2010 loans denominated in foreign currencies for sole proprietors accounted only for about 2.5-10% of the total amount of such loans extended to households.

impacted by both structural shocks and cyclical behaviour of the economy. The former may permanently affect the strength of a specific channel as well as the relative weight of channels, while the latter induces temporary fluctuations of the transmission.

We present indicators obtained for the period 2001.01-2010.05. Monetary policy effectiveness, defined as in Section 3, indicates that the exchange rate has been the most efficient channel among these included in our VAR model, i.e. interest rate, exchange rate, and credit channel (Fig. 10). However, its efficiency is decreasing in line with development of structural changes. A downward trend observable in 2001 results from a transition from managed to pure float. The EU accession induced fluctuations of the indicator but did not alter its average level. In the wake of the crisis, effectiveness dropped by one third. It is plausible that the effect is transitory – since July 2009 the effectiveness has been increasing

The effectiveness of the interest rate channel (Fig. 10) rose rapidly at the early stage of the inflation targeting, apparently resulting from a higher credibility of the central bank and increasing monetization. The level of the indicator, apart from its slight increase during the recovery triggered by Poland's accession to the EU, was stable until financial crisis. Between the third quarter of 2008 and the first quarter 2010, the effectiveness decreased by almost 20% and remains at a low level. It may reflect both a temporary change in the NBP's monetary policy: a shift from the interest rate control to the liquidity management and an effect of the economic slowdown with a fall of investment and credit use. Both suggest a transitory fall of the effectiveness.

Credit channel or more precisely, the bank lending channel, effectiveness (Fig. 10), changes in line with that of the interest rate. Both seem to reflect the cyclical behaviour of the economy. The level of the indicator is twice lower than this of the interest rate, but its reaction to the financial crisis is bigger, suggesting a significant squeeze of credit supply. Though in our setting it is impossible to disentangle credit supply and demand, we suspect that while the

first drop of the effectiveness was probably due to tightening of credit conditions, the second one, in mid-2009, is probably rather a result of a lower demand (see e.g. Del Giovane et al. (2010)).

To trace the cyclical features of the indicator, we compare it with the output gap[15] (a proxy for the business cycle). We find that the former tends to fall during recessions while remains stable during expansions. It may result from a low exchange rate pass-through to consumption prices in the early and middle stage of recession, when enterprises expecting lower profits cut costs (see Przystupa and Wróbel (2010) for details). Then, the slope of the Phillips curve becomes less steep (enterprises are more reluctant to raise prices than to lower them, see e.g. Filardo (1998)). In the early expansion, the convex Phillips curve is combined with a high pass-through effect. The same phenomenon, although due to the opposite reaction, can be observed in the late expansion, when the concave Phillips curve is combined with a lower pass-through. That is, during a recovery the effectiveness of the exchange rate channel may slightly increase or remain constant. Analytically this can be described by a two-leaf clover curve drawn by a segment moving in the rectangular coordinates along the horizontal coordinate (output gap) and the vertical one (inflation gap, i.e. difference between current and target inflation) – Fig. 10. The segment may be interpreted as a long-run path of the GDP growth rate expressed in nominal terms.

To develop the role of the business cycle phase for the effectiveness of the monetary transmission mechanism we used linear and non-linear versions of the structural model described in Section 3. In the non-linear model the estimated direct impact of the output gap on net inflation varies from 0.13 in the case of a non-negative output gap to 0.42 in the case of the output gap significantly positive (the highest value observed in the sample). In the linear version of the model the direct impact of the output gap on net inflation is 0.28 (Fig. 11). To

[15] De-trended industrial production.

analyse main features of the monetary transmission mechanism we analyse results of the simulations, in which the short-term interest rate is increased or decreased by 1 pp. for 4 quarters and then it returns to the baseline. Due to non-linear effects of the output gap on inflation simulations are conducted for different initial values of the output gap. Figure 12 presents the response of CPI y/y inflation to a positive, while Figure 13 – to a negative interest rate impulse. Table 5 summarizes the results.

Simulations based on the non-linear model support previous evidence of the impact of the business cycle on the monetary transmission mechanism. The maximum inflation response to the interest rate increase varies between -0.37 pp. in the case of non-positive output gaps to 0.59 pp. in the case of the actual output being 4.5% higher than the potential output. A reduction of interest rates leads to outcomes even more diversified: inflation increases by 0.37 pp. for a non-positive output gap and by 0.68 pp. for a highly positive output gap.

The operation of the monetary transmission mechanism is different in both versions of the model. Capturing non-linear effects in the monetary transmission mechanism makes inflation response to the interest rate impulse less persistent. For the initial levels of the output gap not sizeably higher than 0.03 the maximum inflation response in the linear model is stronger, although more delayed than in the non-linear one. In the periods of economic boom and the output gap approaching its highest observed value, the maximum response is significantly higher than in the linear version of the model and occurs with the same delay.

5. Conclusions

The paper shows implications of the current financial crisis for the monetary transmission mechanism in an emerging market economy. The transmission mechanism crucially depends on the monetary policy, but also on structural features of the economy. Financial crisis could potentially affect both. In its sharp phase, many central banks changed their monetary policy

from short-term interest rate control to liquidity management. In the case of Poland, we find support for the hypothesis of a change in the monetary policy rule. Facing a risk of a severe output decline central bank apparently took into account possible disturbances in the interest rate pass-through as well as in credit channel operation and increased its responsiveness to both inflation and output shocks. Reactions of inflation and industrial output to the interest rate and exchange rate shocks display minor changes. Contraction accompanying financial crisis triggered more volatile reactions of the labour market.

Increase of uncertainty brought about problems with transmission from the monetary policy instrument to the money market and retail rates, but a breakdown of the long-term relationships concerned mostly deposits of households, consumption and loans for housing and sole proprietors. Other retail rates exhibited more delayed adjustment. What is specific for emerging market economies, it is a significant role of the exchange rate in the transmission mechanism and the fact that the increased global uncertainty caused massive capital outflows. In the case of Poland we do not find evidence that it hampered output via credit channel. Though our setting does not allow us to draw hard conclusions on credit channel operation, we observe that after the crisis reactions of loans to small entities became deeper, what is consistent with credit channel and asymmetric information literature.

Our results based on the Polish data suggest a significant drop in the overall monetary policy effectiveness since the fourth quarter 2008 and a slight improvement at the end of 2009. The increased role of credit market imperfections and the weakening of the exchange rate channel can be viewed as typical phenomena in the current phase of the business cycle. There is some evidence that the latter tends to fall during recession and remains stable during expansion. All in all, it seems that disturbances in the monetary policy transmission rather reflect increased perception of risk and cyclical features of the transmission process activated by the financial crisis and to a much smaller extent structural changes in the economy. The

magnitude of the crisis and its duration, as well as the likely evolution of the regulatory framework and adjustments in macroeconomic policies can lead to changes in the behaviour of economic agents and result in the evolution of the monetary transmission mechanism. The learning process of economic agents – consumers, producers and the banking sector will exert a significant impact on the whole process.

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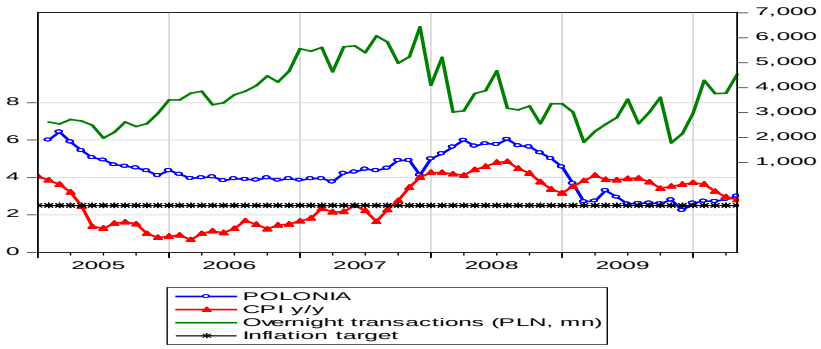
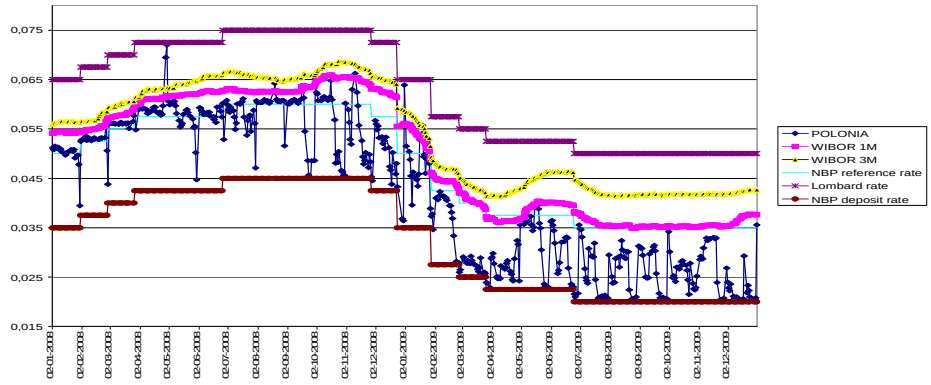
Appendix

Figure 1. Overnight transactions in the unsecured market, POLONIA, inflation CPI y/y and inflation target



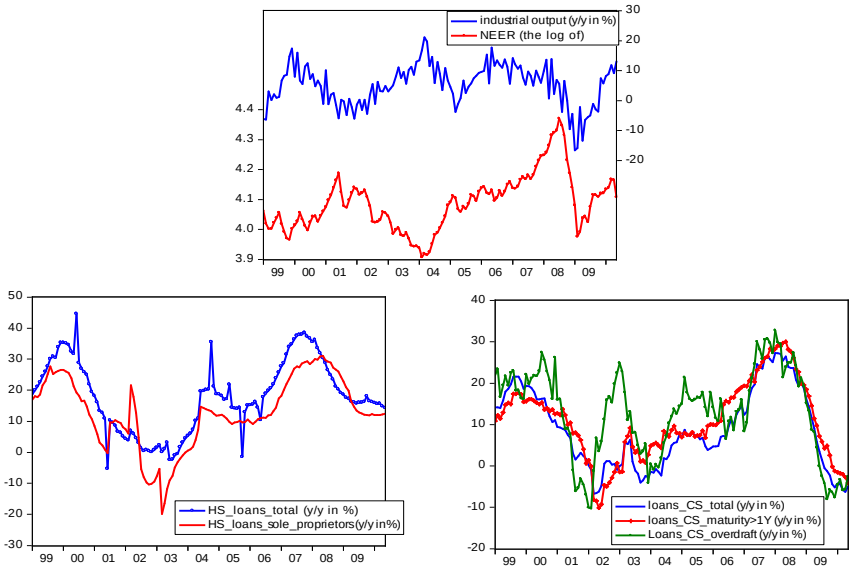
Source: NBP

Figure 2. NBP rates and unsecured market interest rates



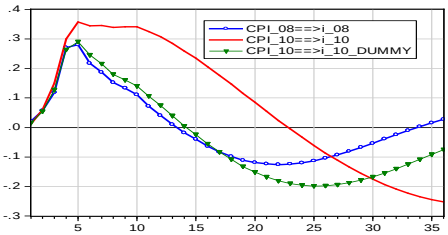
Source: NBP

Figure 3. Main variables used in the estimation: industrial output (y/y), NEER, loans in the domestic currency to households – total amount(y/y), to the sole proprietors (y/y), to the corporate sector – total amount (y/y), of maturity over 1Y (y/y) and overdraft (y/y)



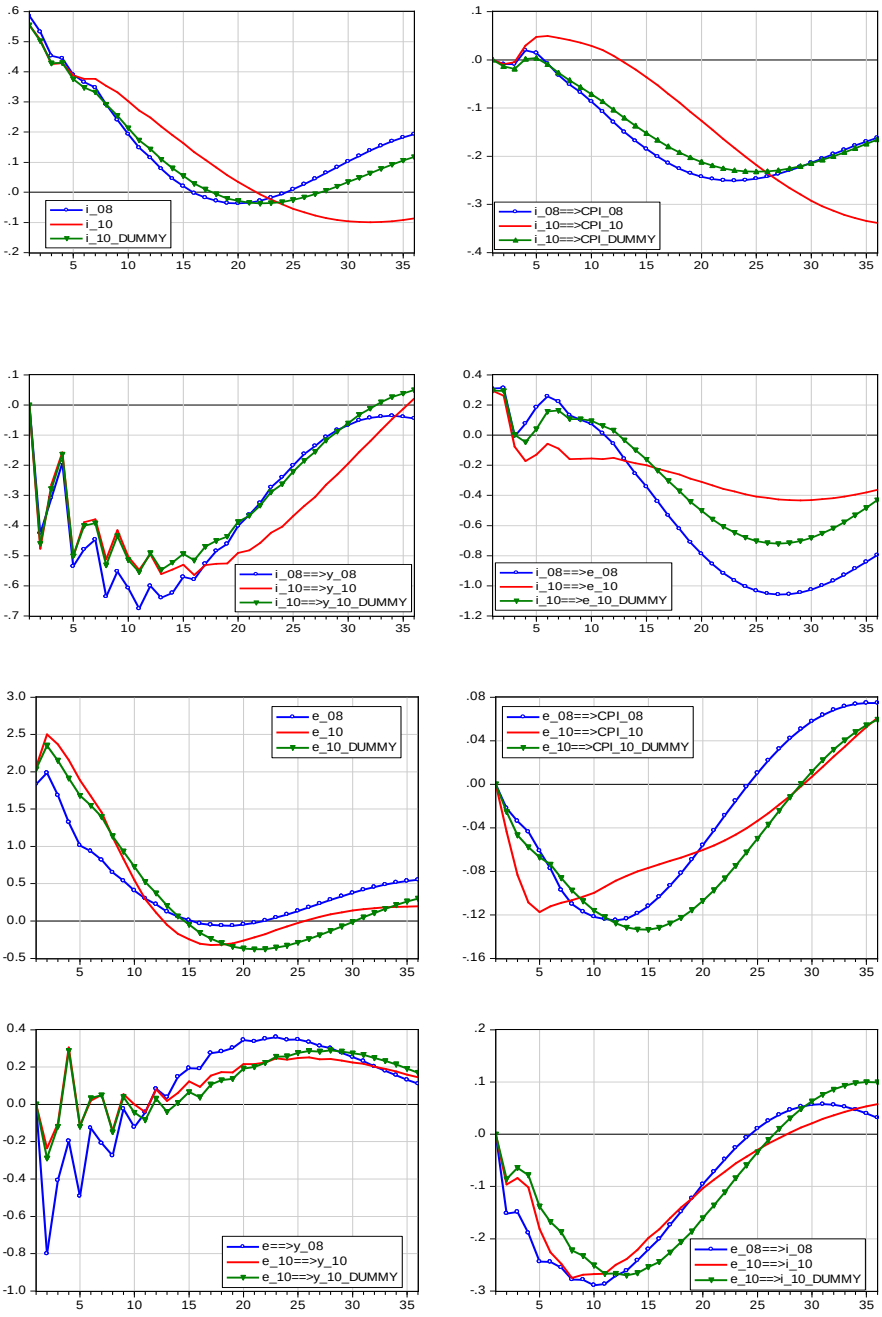
Source: Central Statistical Office and NBP

Figure 4. Response of WIBOR1M to a shock to the consumer price index



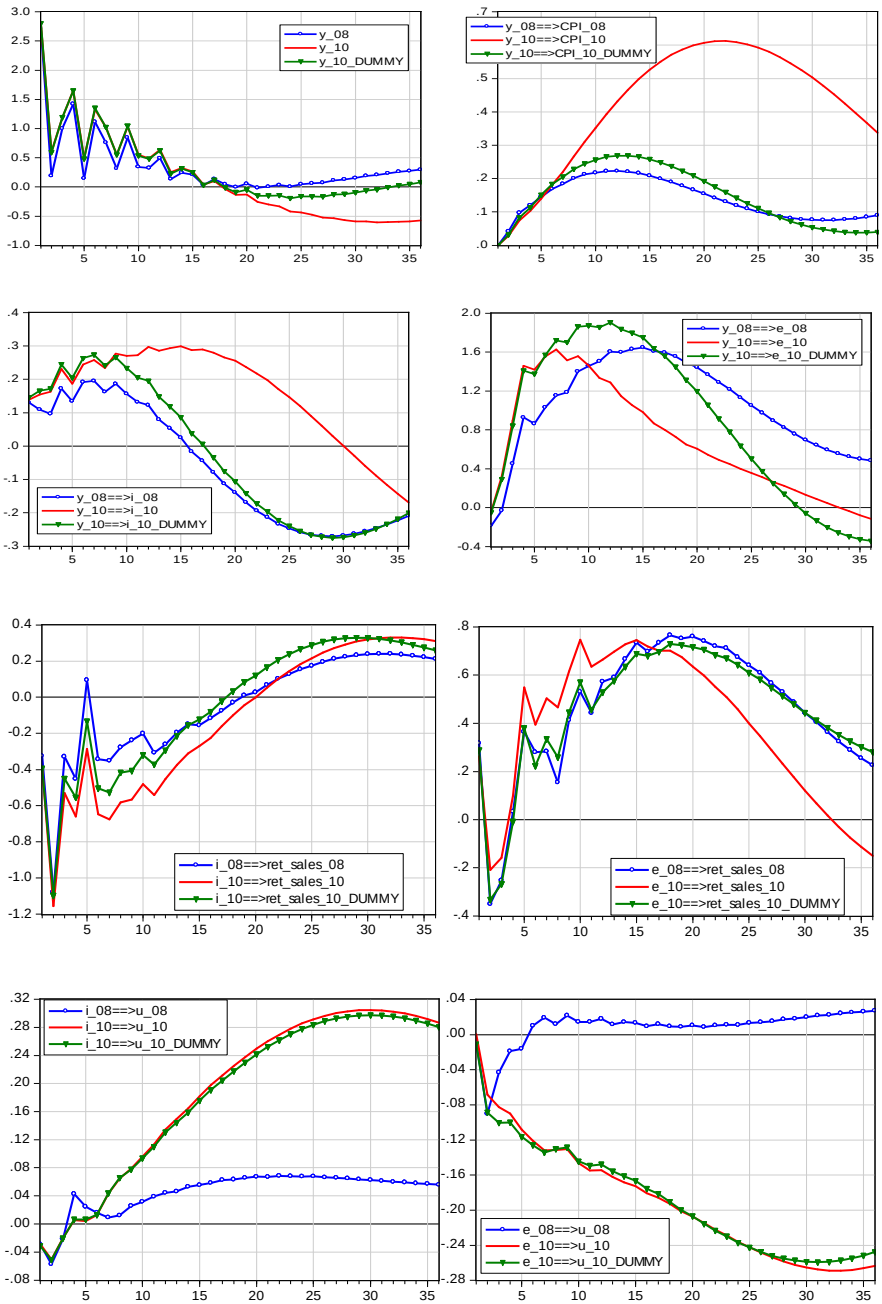
Source: Authors' calculations

Figure 5. Reaction functions of main economic categories before and during the financial crisis: interest rate shock (upper panel) and exchange rate shock (lower panel)



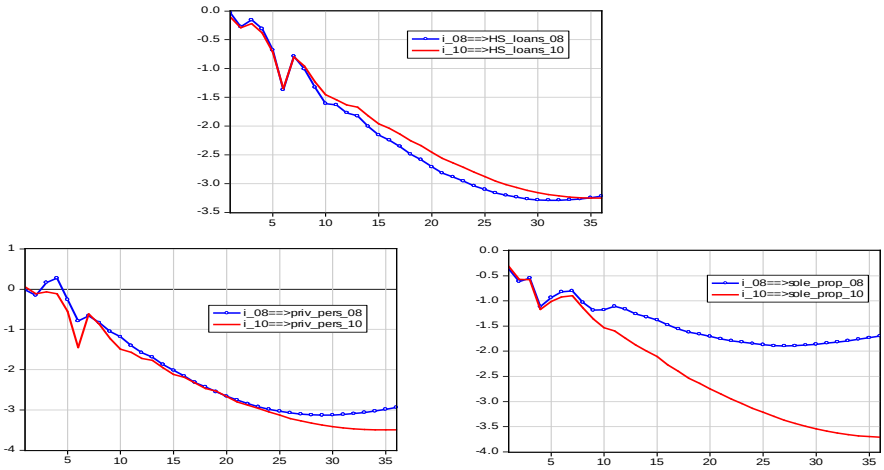
Source: Authors' calculations

Figure 6: Reaction functions of main economic categories before and during the financial crisis: domestic demand shock (upper panel), interest rate and exchange rate shocks on retail sales and unemployment rate (u) (lower panels)



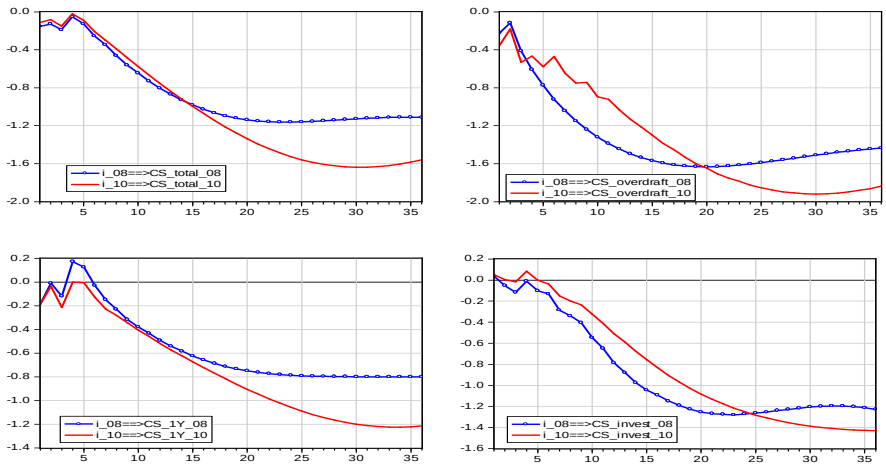
Source: Authors' calculations

Figure 7. Response functions of loans in the domestic currency to households (interest rate shock)



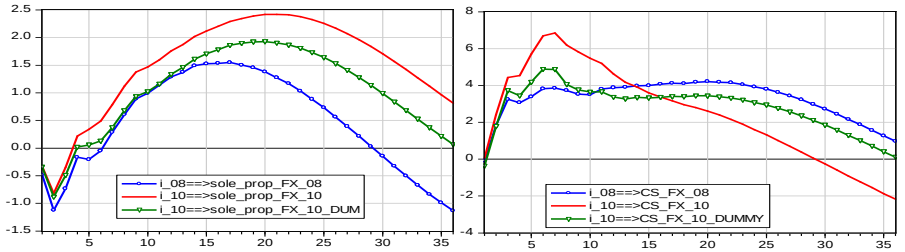
Source: Authors' calculations

Figure 8. Response functions of loans in the domestic currency to the corporate sector (interest rate shock): total domestic currency loans, overdraft, loans of maturity up to 1 year and exceeding one year ("investment")



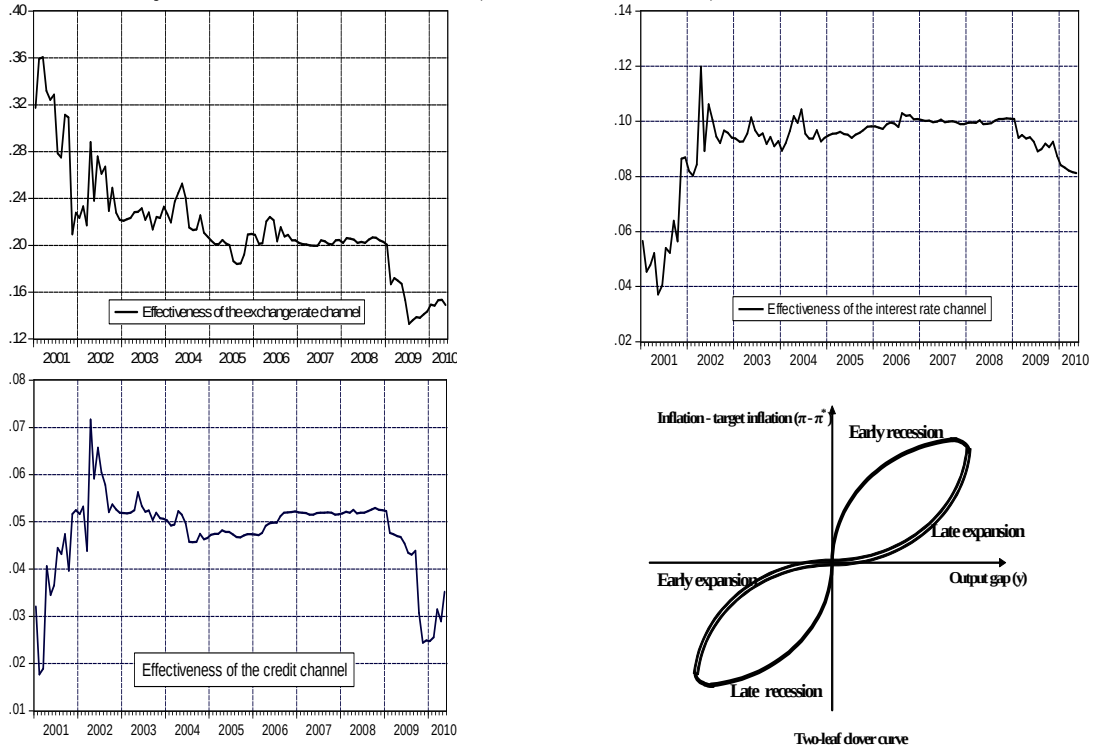
Source: Authors' calculations

Figure 9. Loans in foreign currencies to the sole proprietors and corporate sector (interest rate shock)



Source: Authors' calculations

Figure 10. Monetary transmission effectiveness (transmission to CPI)



Source: Authors' calculations

Figure 11. Direct impact of the output gap on inflation – nonlinear (NL) and linear (L) model

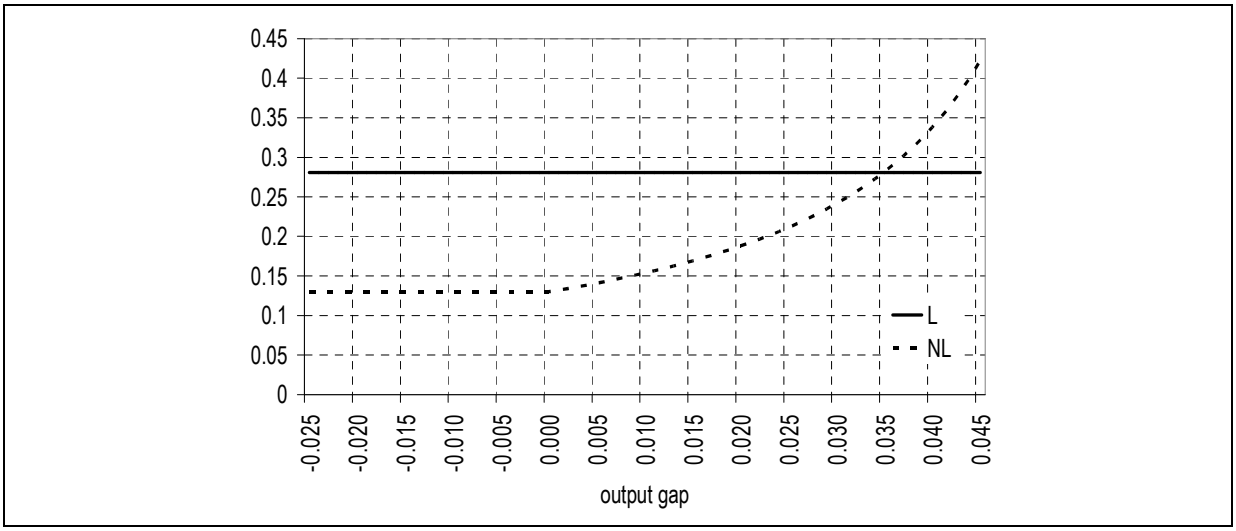
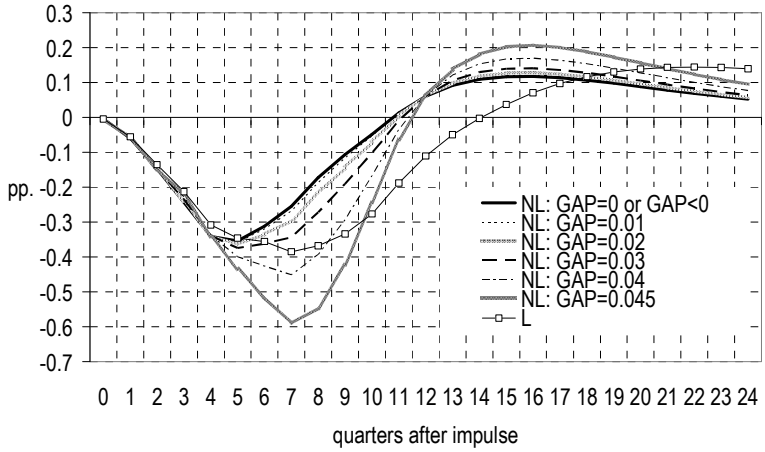


Figure 12. Inflation response to a positive interest rate impulse for different initial values of the output gap, nonlinear (NL) and linear (L) model



Source: Authors' calculations

Figure 13: Inflation response to a negative interest rate impulse for different initial values of the output gap, nonlinear (NL) and linear (L) model

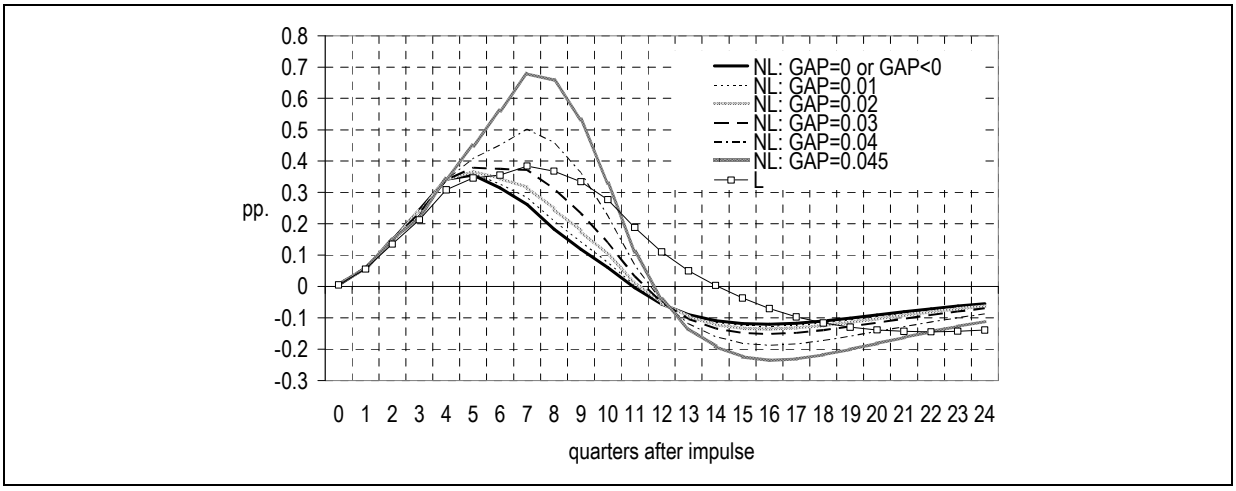


Table 1. Parameters of long-run relationship between WIBOR 3M and retail rates on deposits of households - stocks (s) and flows (f), 2005.01-2008.09 and 2005.01-2010.05

Maturity	α_1		β_1		β_2		time of adjustment (in months)	
	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.08	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05
$s \leq 2Y$	0.19	0.16*	0.32	0.03*	0.74	na	2.53	na
$f \leq 1m$	0.37	0.40	0.51	0.29	0.82	0.96	1.24	2.1
$1m \prec f \leq 3m$ **	0.89	0.69	0.43	0.03*	0.86	na	0.35	na
$3m \prec f \leq 6m$	0.83	0.75	0.48	0.02*	1.01	na	0.35	na
$6m \prec f \leq 1Y$	0.75	0.49	0.96	0.21	0.68	0.92	0.26	2.43
f average	0.57	0.54	0.37	0.09	0.91	1.46	1.16	5.11

Source: own calculations.
*Notes: * Statistically insignificant; if α_1 is insignificant, we show the adjustment time within a range of $(1-\alpha_1)/\beta_1$ and $1/\beta_1$.*
*** Stable relationship up to July 2008 only.*

Table 2. Parameters of long-run relationship between WIBOR 3M and retail rates on deposits of firms - stocks (s) and flows (f), monthly data 2005.01-2008.09 and 2005.01-2010.05

Maturity	α_1		β_1**		β_2		adjustment time	
	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05
$s \leq 2Y$	0.08*	0.22	0.67	0.36	0.77	0.84	1.37-1.5	2.17
$f \leq 1m$	0.33	0.69	0.79	0.18	0.86	1.00.	0.85	1.72
$1m \prec f \leq 3m$	0.66	0.68	0.94	0.18	0.91	1.09	0.36	1.78
$3m \prec f \leq 6m$	0.92	0.80	0.49	0.08*	0.93	na	0.16	na
$6m \prec f \leq 1Y$	0.74	0.64	0.76	0.11	0.68	1.07	0.34	3.27
f average	0.37	0.68	0.78	0.25	0.87	0.99	0.81	1.28

Source: Authors' calculations.
*Notes: * Statistically insignificant; if α_1 is insignificant, we show the adjustment time within a range of $(1-\alpha_1)/\beta_1$ and $1/\beta_1$.*
*** Up to February 2009 r. parameter β_1 statistically significant*

Table 3. Parameters of long-run relationship between WIBOR 3M and retail rates on loans to households - stocks (s) and flows (f), 2005.01-2008.09 and 2005.01-2010.05

	α_1		β_1		β_2		adjustment time	
	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05
Total overdraft excluded, *s.*	0.37	0.18*	0.34	0.21	0.68	0.78	1.85	3.9-4.8.
f. for consumption, the annual percentage rate of change	0.05	-0.10*	0.22	0.15	1.13	0.75*	4.32	na
f. for house purchases	0.59	0.74	0.65	0.05*	1.09	na	0.63	na
f. for sole proprietors	0.24*	0.68	0.44	0.06*	1.59	na	1.7-2.3	na
f. total	0.05*	0.27*	0.70	0.44	1.28	0.97	1.3-1.4	0.8-2.3

Source: Authors' calculations.
*Notes: * Statistically insignificant; if α_1 is insignificant, we show the adjustment time within a range of $(1-\alpha_1)/\beta_1$ and $1/\beta_1$.*

Table 4. Parameters of long-run relationship between WIBOR 3M and retail rates on loans to firms - stocks (s) and flows (f), 2005.01-2008.09 and 2005.01-2010.05

	α_1		β_1		β_2		adjustment time	
	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05	up to 2008.09	up to 2010.05
Bank overdraft, *s.*	0.35	0.59	0.28	0.13	0.85	0.85	2.32	3.15
$1Y \prec s \leq 5Y$	0.15*	0.50	0.43	0.19	0.86	0.87	2-2.3	2.63
Total, excluding overdfraft, *s.*	0.29	0.37	0.24	0.26	0.82	0.79	2.96	2.4
Up to 3 months, variable and fixed rate up to 4 mln PLN, *f.*	0.54	0.65	0.33	0.26	1.0	0.94	1.39	1.35
Fixed rate, $1Y \prec f \leq 5Y$	-0.15*	0.54*	0.81	0.75	0.56	0.42	1.2-1.42	0.61-1.33
Total f.	0.76	0.72	0.74	0.16	0.96	0.94	0.32	1.75

Source: Authors' calculations.
*Notes: *Statistically insignificant; if α_1 is insignificant, we show the adjustment time within a range of $(1-\alpha_1)/\beta_1$ and $1/\beta_1$.*

Table 5. Maximum inflation response [delay (in quarters)] after the interest rate impulse for different initial values of the output gap, non-linear (NL) and linear (L) model

	NL: GAP=0 or GAP<0	NL: GAP=0.01	NL: GAP=0.02	NL: GAP=0.03	NL: GAP=0.04	NL: GAP=0.045	L
Interest rate increase	-0.35 5	-0.36 5	-0.36 5	-0.37 5	-0.45 7	-0.59 7	-0.38 7
Interest rate decrease	0.36 5	0.36 5	0.37 5	0.38 5	0.50 7	0.68 7	0.38 7

Source: Authors' calculations.