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MONETARY POLICY TRANSMISSION IN POLAND: A STUDY OF THE IMPORTANCE OF INTEREST RATE AND CREDIT CHANNELS

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Abstract

The importance of credit in the monetary transmission mechanism has recently attained a lot of attention due to a growing understanding that credit market imperfections can have an impact on the monetary policy effectiveness. In this study, using Vector Error Correction Models (VECMs) and Structural Vector Autoregressions (S-VARs), we go in-depth of the role of credit in the Polish monetary policy transmission.

Papers on the role of credit in the money transmission mechanism (MTM) in Poland show that the credit channel operates. It seems however, that factors through which it affects the aggregate demand might have changed over time. The most recent study on the bank-level data suggests that the degree of bank liquidity has an impact on its efficiency: the most liquid banks do not reduce their loan supply for firms after monetary policy tightening. Previous works suggested that bank size and capital as well as variables connected

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with risk taking might have played a role in the credit channel operation. The results presented in this study suggest that the monetary policy impact on loan supply is, if anything, weak. One of the reasons is that Polish banks hold large amounts of highly liquid assets in their portfolios. Banks are therefore able to implement buffer-stock behaviour: in response to a tighter monetary policy, they can reduce their stocks of most liquid assets and insulate loan portfolios.

To shed some light on the behaviour of the corporate sector we show how interest rate shocks affect the indebtedness of various types of firms (private, individual – i.e. small privately owned entities employing up to nine persons, state-owned). Since the balance sheet channel (one of the concepts within the broad credit channel theory) stresses the impact of monetary policy on the borrowers' balance sheets, we examine the relationship between loans and financial standing of firms. We find some support for the hypothesis that firms' balance sheets are an important factor in the loan supply function. We also analyse the reactions of various types of loans, i.e. investment, revolving and export credit, as well as real estate and securities loans to monetary policy shocks. Our results suggest that after a monetary tightening the response of investment loans differs from the response of other types of loans.

TABLE OF CONTENTS

1. Introduction

In the foreword to the seminal book on monetary transmission in the euro area (Angeloni, Kashyap, Mojon (2003)), Otmar Issing wrote that *monetary transmission is a difficult subject*. It seems it can be even more difficult for the transitional economies facing a problem of scarce data and rapid changes in the economic structure. In the case of Poland, changes in the economic structure and economic policy typical for any transitional economy, like privatisation or deregulation, are compound with those resulting from the EU membership – the elimination of trade barriers, an easier access to labour markets of the old-member states and an inflow of membership-related funds. All these factors affect the equilibrium interest and exchange rate as well as expectations' formation, continuously reshape the monetary transmission and therefore can have a negative impact on the robustness of empirical analysis. In the case of Poland, there is, however, also an important factor that acts in the opposite way – it is monetary policy. Since 1998 it has been conducted within the same framework which is of key importance in the assessment of the properties of the monetary transmission. Thus, a crucial point of any empirical study of the transmission mechanism of a transitional economy and the new member states of the EU is the robustness analysis. The aim of this study is to provide new evidence on monetary transmission in Poland that would include the period after EU accession[2] and would cover the period of the homogenous monetary policy. We focus on the role of bank loans in the monetary transmission.

Bank loans reflect the operation of the traditional interest rate channel as well as the credit channel and therefore they are a crucial element of the monetary transmission. Disentangling the response of loan supply and loan demand to the monetary policy actions is a difficult but necessary condition to identify the specific role of these two channels. Many papers bring conflicting results on the credit channel operation and therefore well illustrate the related problems (see Ehrmann et al. (2003) for the euro area and Hülsewig, Mayer and Wollmershäuser (2005) for Germany). The identification problem seemed to be more acute for the aggregate time series and induced many researchers to use the micro level data. However, several recent papers try to cope with the identification problem of applying Vector Error Correction Models (VECMs) to the aggregate data (Hülsewig, Winker and Worms (2001) and Hülsewig,

[2] Poland entered the EU in May 2004.

Mayer and Wollmershäuser (2005)). By distinguishing between factors that affect loan supply and loan demand they obtain long run loan supply and demand functions and in this way verify the existence of the credit channel.

This study depicts changes in the monetary transmission mechanism (MTM) since 2002. Most of the earlier studies of Polish transmission covered the period 1996–2002 (Łyziak (2002), Przystupa (2002), Wróbel and Pawłowska (2002)). The key result was that the monetary transmission in Poland tended to be broadly in line with the "stylized facts" i.e. monetary policy tightening resulted in a hump-shaped downward response of output and prices. However, the S-VAR models showed short-lived price and output puzzles. Comparing these results to the findings for mature market economies (Peersman and Smets (2003) and Mojon and Peersman (2003)) we have observed that the reaction of both output and prices in Poland was smaller and slower. On the other hand, in response to interest rate increase, the exchange rate appreciated as expected. Exchange rate shock (depreciation) resulted in an upward movement of output and prices. The estimated exchange rate pass-through effect for CPI was much bigger than in mature market economies, but tended to decrease (in 2002 it was approximately 0.2 after 8 quarters (Przystupa (2002, 2006))[3]. Empirical research on inflation expectations of consumers shows that Polish consumers' expectations deviate significantly from the values targeted by the NBP. Consumers inefficiently use available information while forming their expectations (see Łyziak (2005)). They are highly influenced by current inflation rate and past inflation deviations from the target.

Evidence on credit channel operations in Poland is mixed. Early studies on monetary transmission on the bank-level data (Wróbel and Pawłowska (2002)) confirm the existence of the credit channel and point at capitalisation and bank size as the characteristics that affect its operation. Later works also indicate variables connected with bank risk taking (Chmielewski (2005)). However, the most recent analysis (Grabek (2006))shows that the evidence for the existence of the credit channel in Poland is not robust and does not confirm either the size nor the capitalisation as the characteristics shaping its operation. Grabek (2006) shows that the degree of banks' liquidity affects loan supply to the enterprise sector, but cannot confirm this effect for the household sector.

The value added of this study is twofold. Firstly, it sheds some light on the monetary transmission in Poland over a period of a homogenous monetary

[3] According to the latest estimates, in 2005 it decreased by almost one half to 0.11.

policy (inflation targeting). In many ways this study continues and extends our previous research[4]. Applying S-VARs we obtain a sketchy picture of the monetary transmission. These results, however, do not preclude any of the possible channels from affecting the economy. The role of equities in the households' portfolios is growing, but bearing in mind that monetary policy affects their prices only temporarily and that consumption tends to respond to permanent changes in wealth rather than transitional ones, we can safely assume that the contribution of the wealth channel is modest and therefore ascribe the whole effect to the conventional interest rate channel and credit channel (we do not treat the exchange rate channel as independent from the interest rate). To assess the role of the credit channel we follow Hülsewig, Winker and Worms (2001). Then we use S-VARs to verify the existence of the buffer-stock behaviour of banks. We show that the credit channel apparently plays a minor role in the monetary transmission in Poland. Secondly, the study is the first in the Polish literature to examine the behaviour of various types of loans and economic agents (private and state owned firms as well as small private entities). To check the robustness and stability of results we compare them, whenever possible, with previous studies, and use various approaches and data frequencies. Sample shortness practically rules out the possibility of using rolling windows.

The remainder of the study is organised as follows: The next part presents the key characteristics of the monetary policy framework and financial market in Poland. Section 3 summarizes the results of our empirical examination of the credit channel operation. We start with a brief theoretical overview. Then we show how macroeconomic variables respond to the monetary policy shocks. We examine two S-VARs (a recursive and a non recursive identification scheme) to show how the interest rate and exchange rate affect output and prices. Next, we provide evidence on the credit channel operation: we start with the aggregate data and show the results of estimation of the long run supply and loan demand functions. Since the evidence for the credit channel existence is not robust, we devote the next subsection to the disaggregated analysis showing behaviour of various types of loans and firms. Finally, we discuss the buffer-stock behaviour of banks. Due to the surplus liquidity of the banking sector, banks in Poland have large portfolios of liquid assets (NBP-bills). Thus, facing monetary policy contraction, banks can potentially offset reserves' drainage and shield credits. This effect can make the credit channel less potent or even eliminate its operation. Owing to the fact that the banking sector in Poland is dominated by foreign ownership, banks have an

[4] See (Łyziak (2002), Przystupa (2002), Wróbel, Pawłowska (2002)).

easy access to foreign markets through their parent entities. We check whether they passed-by the credit channel and raised funds in the foreign markets after monetary tightening. Section 4 concludes.

2. Monetary policy and financial system in Poland

2.1. Monetary policy framework and inflation

Poland has been applying inflation targeting (IT) since 1998. The framework has evolved over time, but its core has remained the same. It started quite modestly, as an implicit system, to finally take a form of a fully-fledged IT framework, comprising of the publication of inflation forecasts on a regular basis. The evolution of the IT embraced mostly activities aimed at introducing more transparency into monetary policy.

The ground for the IT was set in 1997, when the National Bank of Poland (NBP), facing an increasing problem with base money control, implicitly replaced M0 with an interest rate as its primary target. 1998 marked a breakthrough for Polish monetary policy, not only because of the IT adoption, but also because the new Constitutional Law prohibited debt monetization. At that time, price dynamics had been continuously falling, but Poland was still experiencing a two-digit inflation rate. The Monetary Policy Council (MPC), a new decision-making body, committed itself to reducing inflation to a level of below 4% by the end of 2003. Every year the MPC fixed the inflation target for the next calendar year (sometimes as a point, sometimes as a range). Between 1998 and 2003, the MPC twice changed the target for the current year (for the details see Table1). Figure 1 shows actual inflation and inflation targets for the period 1998–2006. To make it more readable, we have chosen not to indicate target ranges, instead choosing to show the mid-points of respective ranges; the same being done for the years in which the target was defined as a point with a tolerance band. The targets used to be set in terms of the year-on-year inflation rate in December only, so to obtain monthly targets we have interpolated the respective values. Since 2004 a constant target of 2.5% ±1% has been in force.

When examining the role of the exchange rate in overcoming inflation, it is worth noting that before 1990 the exchange rate was an accounting phenomenon only, with almost no links to the monetary sphere and the real sector. To form such links and to anchor inflation expectations, the zloty was fixed to the dollar in January 1990 (see Figure 2 and Table A1 in the Appendix). The fixed exchange rate of the zloty curbed hyperinflation, but, on the other hand, it worsened competitiveness of Polish exports. As a compromise between disinflation and a decline in competitiveness, a regime of having a crawling peg to the currency basket was established in October 1991 with

the crawling rate gradually decreasing from 1.8% per month to 1.2% in February 1995. The crawling peg was combined with a narrow NBP margin (±0.5%). This resulted in low exchange rate volatility enhancing credibility of this nominal anchor for inflation expectations. The process of exchange rate liberalisation continued since the NBP faced increasing problems with sterilization of capital inflows, monetary control and inflation decelerating too slowly. Thus, to overcome these problems, a crawling band of ±7% was introduced in May 1995; it was gradually expanded to ±15% in March 1999. Over this period, the crawling rate was reduced from 1.2% per month to 0.3%. As a side effect, exchange rate volatility rose rapidly so the exchange rate lost its status as the nominal anchor for inflation expectations. The process of exchange rate liberalisation ended up with the official adoption of pure float in 2000, but in fact, the NBP decided to refrain from interventions much earlier (July 1998).

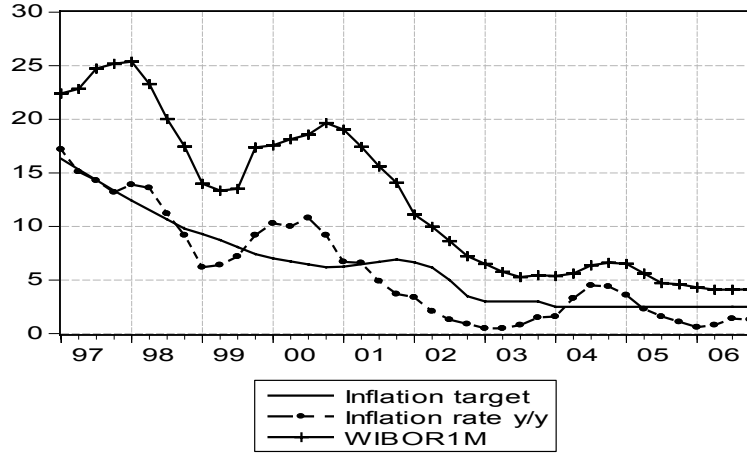
Over the period 1997 Q1–2006 Q2 inflation had a clear downward trend with two episodes of an upward movement (see Figure 1). The first one started in 1999 Q3 and subsisted until 2000 Q3. It resulted from a too-loose monetary policy in 1998 and a negative supply shock (increase in oil prices). The second one occurred in 2004 and was connected to EU accession. Elimination of trade barriers led to a considerable increase in foreign demand for domestic foodstuffs and a related price pressure. Moreover, a fear of future price increases (anticipated increases in VAT rates) induced an increase in consumer demand. The upsurge in inflation due to the EU entry was sharp but also short-lived – in the second half of the year inflation started to fall.

Table 1 Actual and targeted inflation rate 1998–2006

Year	Target	Actual
1998	9.5	8.6*
1999	8.0–8.5 (changed in March to 6.6–7.8)	9.8*
2000	5.4–6.8	8.5*
2001	6.0–8.0	3.6*
2002	5.0±1pp (changed in June to 3.0±1pp)	0.8*
2003	2–4	1.7*
2004	2.5±1pp	(4.4*); (3.5**)
2005	2.5±1pp	(0.7*); (2.1**)
2006	2.5±1pp	(1.4*); (1.0**)

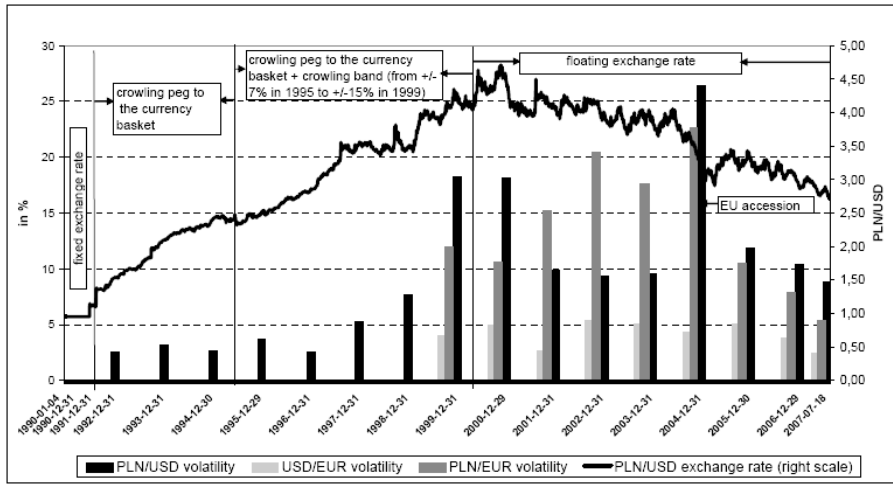
* at year end, **year average
Source: Central Statistical Office and own calculations of the authors.

Figure 1 Inflation rate (CPI, y/y), inflation target, and 1-month WIBOR rate (a proxy for the NBP intervention rate) 1997–2006, quarterly data



Source: Central Statistical Office and own calculations of the authors

Figure 2 History of the Polish zloty exchange rate



Source: National Bank of Poland and own calculations of the authors

The history of inflation targeting in Poland – starting from its adoption in 1998 – was characterized by persistent inflation deviations from the central bank inflation target. All short-term targets were missed – even those that were revised in the course of the year they had been set for. This was caused by supply shocks (food and oil prices), excessive restrictiveness or expansiveness of monetary policy as judged ex-post, imperfect knowledge

of the monetary transmission mechanism amplified by ongoing structural, institutional and behavioural changes in the economy. Target misses might have negatively affected the credibility of the NBP. To test the credibility of inflation targets, Mackiewicz, Łyziak and Stanisławska (2007) used direct measures of consumers' and commercial bank analysts' inflation expectations in line with the literature, suggesting that central bank credibility can be measured by a gap between policy targets or forecasts and the public's expectations or proxied by the weight λ attached to the inflation target in the formation of private sector's inflation expectations.

Estimates of the credibility parameter λ in the way suggested by Bomfim and Rudebush (1997) show that in the case of consumers λ is significant, but negative, implying a lack of credibility. In contrast to consumers, commercial bank analysts follow the inflation target closely with a lower weight attached to current price changes (see Table 2). The results of our estimations seem to be robust with respect to the inflation target measure considered in the test equation.[5]

Table 2 Estimation of the credibility parameter λ

Measure of the NBP target	Consumers' inflation expectations (1)		Commercial bank analysts' inflation expectations (2)	
	λ (standard errors in parentheses)	R^2 and residuals' diagnostics	λ (standard errors in parentheses)	R^2 and residuals' diagnostics
Official target for a given year	-0.16 (0.05)	R^2 [adjusted R^2] – 0.98 [0.98] DW – 0.75 JB [probability] – 0.09 [0.96] ADF [probability] – -3.18 [0.03]	0.83 (0.04)	R^2 [adjusted R^2] – 0.91 [0.91] DW – 0.36 JB [probability] – 4.03 [0.13] ADF [probability] – -9.84 [0.00]
Linear interpolation	-0.16 (0.05)	R^2 [adjusted R^2] – 0.98 [0.98] DW – 0.69 JB [probability] – 0.48 [0.78] ADF [probability] – -3.06 [0.03]	0.90 (0.04)	R^2 [adjusted R^2] – 0.96 [0.96] DW – 0.23 JB [probability] – 2.35 [0.31] ADF [probability] – -7.84 [0.00]

(1) $T = t + 12$, sample period: 1998:10–2004:12, equations are estimated by OLS using the covariance matrix corrections suggested by Newey and West (1987).
(2) $T = t + 12$ until October 2000 and $T = t + 11$ since November 2000, sample period: 1998:10 to 2004:12, equations are estimated by OLS using the covariance matrix corrections suggested by Newey and West (1987).

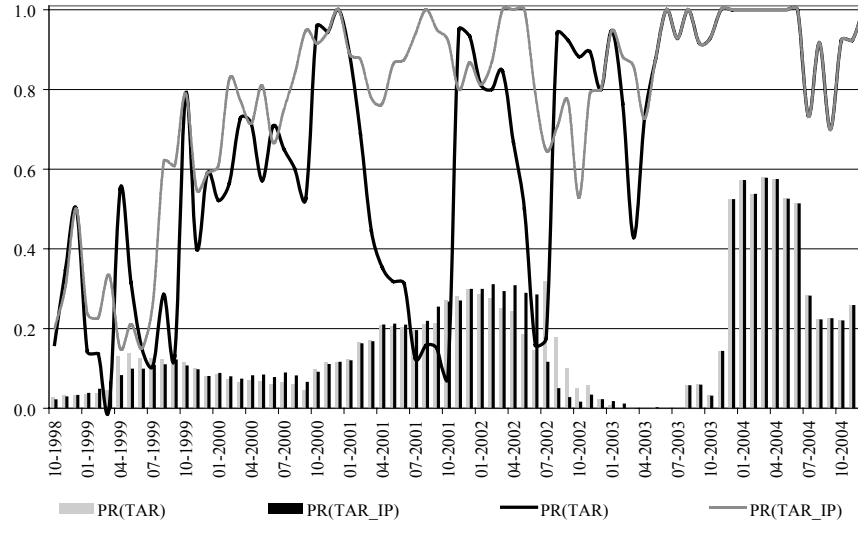
Source: Mackiewicz, Łyziak, Stanisławska (2007), p. 74.

However, as underlined by Mackiewicz, Łyziak and Stanisławska (2007), the probability of future inflation being within the NBP target range was characterized by a positive trend both in the case of commercial bank

[5] Two continuous inflation target measures were derived on the basis of point targets applied between 1998–2003, namely: the official target for a given year and the linearly interpolated target.

economists and consumers (Figure 3). There were two exceptions to this tendency: a rapid disinflation in 2002-2003 and the EU-accession shock in 2004. Excluding these episodes, we may say that there is a growing credibility, although in the case of consumers, there is still room for a significant improvement.

Figure 3 Probability of future inflation being within the NBP inflation target range – consumers (bars) and commercial bank analysts (lines)



TAR – official inflation target for a given year
TAR_IP – interpolated inflation target

Source: Mackiewicz, Łyziak and Stanisławska (2007), p. 75.

2.2. Financial system and banking sector: an overview

The structure of the financial sector is a key determinant of the monetary transmission mechanism and the credit channel in particular; therefore in this section we discuss the main characteristics of the financial sector in more detail. We show that although non-bank intermediaries have been developing rapidly since the mid-1990s, it is still dominated by banks. Thus, in the section that follows, we shall concentrate on the banking sector and discuss its basic characteristics: ownership structure, concentration level, term structure of assets and liabilities as well the breakdown of assets and liabilities by currency. For the analysis of the transmission mechanism – its strength and lags – it is important to stress that investment in Poland is predominantly financed from

investors' own resources – in 2004 economic entities (employing more than 49 persons) financed some 9% of investment outlays using domestic credits and another 3% using credit from foreign sources.

The level of financial intermediation in Poland is relatively low but is steadily increasing. This is well illustrated by the ratio of financial system assets to GDP – in 2005 this ratio was around 86%, whereas in the other new member states, like the Czech Republic or Hungary – it amounted to around 120%. Banks remain the main financial intermediary, currently holding some 70% of total assets, but their role is apparently decreasing (Table 3 and Table 4). Since 1997 open pension funds, investment funds and credit unions have developed most rapidly (Table 4). The development of non-banking institutions is reflected in the parallel advances of new financial services and instruments offered by these institutions, e.g. leasing or venture capital. In Poland leasing is mostly used by small and medium enterprises. In 2003 about 30% of enterprises reported the use of leasing, while 50% of firms used bank loans. The value of leased assets related to GDP is relatively low when compared with the European leaders – UK and Germany: in 2005 it amounted to 1.7%, but is comparable to the respective levels in Denmark or Norway. Private equity/venture capital – although growing – does not play a significant role as a source of financing in the enterprise sector. The value of PE/VE related to GDP is below 1%. Likewise, corporate bonds do not count much in firms financing – their value relative to GDP varies within a range of 1.3–2% and does not display any significant movement upwards. On the other hand, the stock exchange has recently become an important source of financing: its capitalisation relative to GDP increased from being as low as 13% in 1998 to 31.9% in 2005[6].

The level of intermediation in Poland and the distance of banking sector development between Poland and the other new member states, as well as the euro area are presented in Table 5.

[6] All figures concerning financial market come from: "Financial Market in Poland 1998–2001" and "Financial System Development in Poland (2004), (2005)".

Table 3 Assets of financial institutions in Poland (PLN bn)

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Commercial and cooperative banks	247.7	318.7	363.4	428.5	469.7	466.5	489.0	538.5	587.0
Credit unions	0.4	0.6	0.9	1.2	1.8	2.5	3.4	4.2	5.3
Insurance companies	13.2	20.7	28.9	37.9	48.0	57.5	65.7	77.9	89.6
Investment funds	1.9	1.8	3.1	9.5	12.1	22.8	33.2	37.5	61.3
Open pension funds	0.0	0.0	2.3	9.9	19.4	31.6	44.8	62.6	86.1
Brokerage firms	3.0	3.2	3.6	3.9	2.9	2.8	3.7	5.5	6.9
Total assets	266.2	345.0	402.2	490.9	553.9	583.7	639.8	726.2	836.2

Source: NBP

Table 4 Assets of financial institutions in Poland (as a share of total assets)

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Commercial and cooperative banks	93.05	92.38	90.35	87.29	84.80	79.92	76.43	74.15	70.20
Credit unions	0.15	0.17	0.22	0.24	0.32	0.43	0.53	0.58	0.63
Insurance companies	4.96	6.00	7.19	7.72	8.67	9.85	10.27	10.73	10.72
Investment funds	0.71	0.52	0.77	1.94	2.18	3.91	5.19	5.16	7.33
Open pension funds	0.00	0.00	0.57	2.02	3.50	5.41	7.00	8.62	10.30
Brokerage firms	1.13	0.93	0.90	0.79	0.52	0.48	0.58	0.76	0.83
Total assets	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: NBP

Table 5 Banking sector development: Poland, other new member states and the euro area, 2005

Country	Assets/GDP (in %)	Loans/GDP (in %)	Deposits/GDP (in %)
Poland	60.7	26.7	34.0
Czech Republic	100.8	32.1	58.0
Hungary	80.6	39.5	40.0
Euro area	283.3	116.0*	96.0*

* data for 2004

Source: NBP

Ownership structure of the banking sector

The banking sector in Poland is dominated by foreign banks: in 2005 the share of foreign banks' assets amounted to 70% of total assets. The role of foreign

banks increased sharply in 1999–2000 in the aftermath of Poland's decision to discontinue a privatisation strategy which assumed that the state would retain about 30% of the total shares issued, 30% of shares would be taken over by a foreign strategic investor and 30% of shares would be offered to individual investors as a public offering and to employees on privileged terms. Foreign investors confronted with the continued presence of a powerful state shareholder were not interested in buying shares in Polish banks. A change in the attitude towards foreign investors resulted in the privatisation of three big state-owned banks (Bank Przemysłowo-Handlowy, Polska Kasa Opieki S.A. and Bank Zachodni). Since then the ownership structures have only undergone minor changes (Table 6 shows the share held by foreign banks of total assets of the banking sector).

Table 6 Banking sector ownership structure, 1997–2005

Share of banking sector assets, in %									
	1997	1998	1999	2000	2001	2002	2003	2004	2005
Commercial banks	95.5	95.7	95.8	95.8	95.4	95.0	94.8	94.7	94.2
with majority public sector interest	49.3	45.9	23.9	22.9	23.5	25.1	24.4	20.5	20.3
with majority private sector interest	46.2	49.8	71.8	72.9	71.9	69.9	70.4	74.2	74.0
- Polish	30.9	32.2	24.6	3.4	3.2	2.5	2.6	6.6	4.0
- foreign	15.3	16.6	47.2	69.5	68.7	67.4	67.8	67.6	70.0
Cooperative banks	4.5	4.3	4.2	4.2	4.6	5.0	5.2	5.3	5.8

Source: NBP

Concentration level

The concentration level of the banking sector measured by the Herfindahl-Hirschman Index (HHI) for net assets, deposits and gross loans is low (if the HHI is below 0.1, the market is considered to be not concentrated). The index has been falling since 2001 due to the fact that small and medium-sized banks have been developing faster than the large ones. A previous rise in the level of concentration was due to bank mergers. A similar picture emerges from the analysis of other measures of concentration: indices CR_5, CR_{10}, CR_{15} (Figure A1 in the Appendix) representing the market share of the 5, 10, and 15 largest banks respectively, which exhibit the same pattern i.e. the expansion of smaller entities.

Table 7 Concentration of commercial banks: Herfindahl-Hirschman Index (HHI) , 1997–2005 (0=no concentration; 1=full concentration)

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Assets	0.0739	0.0675	0.0791	0.0761	0.0894	0.0877	0.0839	0.0773	0.0732
Deposits	0.0885	0.0777	0.0824	0.0798	0.0943	0.0932	0.0977	0.0888	0.0856
Gross loans	0.0505	0.0452	0.0606	0.0604	0.0762	0.0767	0.0709	0.0717	0.0724

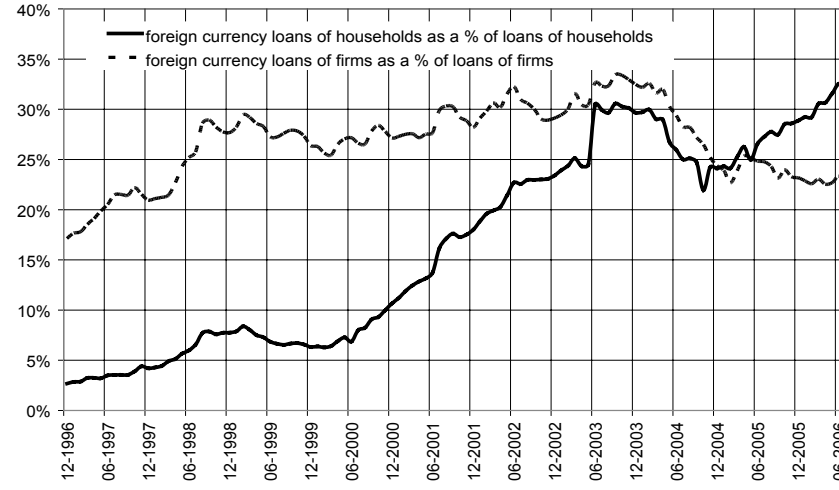
Source: NBP

Deposits and loans: term and currency structure

Non-financial sector deposits are mostly short-term: these of maturity up to one year (including current account deposits) amount to about 90% of total PLN deposits. Between 1997 and 2005 there was a clear-cut change in the term structure of deposits: the share of these with the shortest maturities was increasing at the expense of longer maturities. This phenomenon reflected the households' change in attitudes towards savings patterns: longer term savings were removed from banks and deposited with investment funds. Deposits in foreign currencies amount to about 15–17% of the total amount of deposits. The process of zloty appreciation (Figure 2) and the low inflation rate discourage households from deposits in foreign currencies. On the other hand, exporting firms may want to hold such deposits to lessen the negative influence of exchange rate appreciation.

Bank loans to households and firms are dominated by loans with the shortest maturity (in the current account and up to one year) and by loans of maturity exceeding 5 years. In contrast to deposits in foreign currencies, the role of loans denominated in foreign currencies has been growing (see Figure 4). The latter phenomenon is mostly due to households' preference for long-term loans denominated in foreign currencies and results from the interest rate disparity between the Polish zloty (PLN) and the European currencies (CHF, EUR) In 2006, the Committee for Banking Supervision, concerned about the rapid increase in demand for foreign currency loans and its possible negative consequences for the stability of the banking system, issued a regulation (known as "Recommendation S") which tightened households' eligibility conditions for foreign currency loans. A considerable role played by deposits and especially by the loans denominated in foreign currencies makes monetary transmission weaker, since domestic interest rates affect directly only a part of banks' assets and liabilities. In the following section, we shall consider the loans denominated in the domestic currency only. Foreign currency loans require separate analysis.

Figure 4 Loans denominated in foreign currencies (firms and households)



Source: NBP

Liquidity

The Polish banking sector has been exhibiting surplus liquidity[7] since the mid-1990s. It has aroused as a result of capital inflows which started when Poland restructured its foreign debt (see: Table A2 in the Appendix). Since then, the NBP has been conducting absorbing open market operations. After a temporary slowdown in the process of surplus liquidity build-up over 2001 Q3–2004.Q2, it re-started in the second half of 2004 due to an inflow of the EU membership-related funds. Funds which are to be used in the domestic currency are converted by the NBP creating additional liquidity. The scale of the surplus liquidity, approximated by the outstanding stock of NBP bills compared with loans to firms and households is shown in Figure A2 in the Appendix.

Surplus liquidity has the potential to affect the interest rate pass-through and therefore can weaken both the interest rate channel and credit channel operation. It is easier for banks having surplus liquidity to insulate loans from a monetary policy tightening by the central bank. But whether this potential materialises is an empirical question. Ganley (undated) reports no significant pass-through problems in a number of countries exhibiting surplus

[7] Surplus liquidity occurs where the banks' working balances on accounts at the central bank persistently exceed the required level of reserves. Transitional countries are among the most prone to liquidity surpluses, see: Ganley (undated).

liquidity – the Czech Republic, Finland, Hungary and South Africa. Previous estimates on the interest rate pass-through in Poland (Wróbel and Pawłowska (2002)) did not show signs of a disruptive influence of the surplus liquidity. Examining a sample of monthly data between 1995.01 and 2002.02 they concluded that the instantaneous adjustment of retail rates to money market rates was only partial, but in the longer-run most deposit rates and loan rates adjusted fully, with the consumer credit rate being the most striking exception. They ascribed such behaviour of the consumer credit rate to poorer collateral. In sum, the picture of the interest rate pass-through emerging from these estimates was akin to the one obtained for the euro area (De Bondt (2002)) The latest estimates of the interest rate pass-through for the period February 2002 to April 2006.[8] (Wróbel (2006)) shows that the deposit rates have adjusted less than in the past. The opposite seems, however, to be true for the loan rates for the corporate sector. The result is presumably period-specific and the shortness of the sample can be an important factor explaining this phenomenon. Over-reaction of loan rates was probably a by-product of fierce competition in the credit market on the eve of EU entry.

[8] Due to the changes in monetary statistics in February 2002, earlier data on the retail interest rates is not fully comparable, so we have used two subsamples.

3. Monetary transmission mechanism – theoretical remarks and the new empirical research

3.1. Theoretical remarks

In the traditional interest rate channel an increase in the short term central bank interest rate leads to an increase in longer rates – deposit and loan rates as well as yields on Treasury bills and bonds – and to a dip in equities and real estate prices. In the world of sticky prices an increase in nominal rates leads to an increase in real rates. An increase in investment cost depresses investment, while consumption falls due to both wealth effect and substitution effect. As a result, total output declines, bringing down the inflation rate. In short, for the interest rate channel to be operative the central bank must have a possibility to control the short-term interest rate, prices need to be sticky, and finally output should react to real rates.

According to the credit channel theory of monetary transmission, monetary policy has a direct effect on aggregate spending that does not operate through the traditional interest rate channel. The main assumption is that banks play a special role in the financial system, since they are especially well suited to deal with certain types of borrowers, in particular small enterprises and households whose access to the capital market is difficult. Monetary contraction drains reserves and – reducing banks' lending ability – has an impact on bank-dependent borrowers. As a result of the tightening of monetary policy, credit allocated to bank-dependent borrowers may fall, making these agents cut their spending (Hubbard (1994)).

The credit channel is not a separate, independent alternative to the traditional interest rate channel, but rather a set of supplementary factors that amplify and propagate it (Ramey (1993)). The direct effects of monetary policy on interest rates in the banking sector are amplified by endogenous changes in the external finance premium, which is a difference between the cost of funds raised externally (by issuing equity or debt instruments) and funds generated internally (by retaining earnings). The size of the external finance premium reflects imperfections in the credit markets that drive a wedge between the return expected by lenders and the cost faced by potential borrowers. In the 'credit view', a change in monetary policy that raises or lowers interest rates tends to change the external finance premium in the same direction. *"Because of this additional effect of policy on the external finance premium,*

the impact of monetary policy on the cost of borrowing broadly defined – and, consequently, on real spending and real activity – is magnified" (Bernanke and Gertler (1995)).

There are two basic explanations why actions taken by the central bank affect external finance premium in credit markets. The first one – the balance sheet channel – stresses the impact of monetary policy on borrowers' balance sheets and their wealth, which constraints their debt capacity[9]. The second – the bank lending channel – focuses on the possible effects of monetary policy actions on the loan supply.

In the bank lending view, banks play a critical role in the transmission of monetary policy actions to the real economy. Changes in monetary policy generate adjustments not only in interest rates, but also in the banking sector balance sheet. Walsh (2003) points out that *"the ultimate effects on bank deposits and the supply of money are reflected in adjustments to the liability side of the banking sector's balance sheet. The effects on banking-sector reserves and interest rates also influence the supply of bank credit, the asset side of the balance sheet. If banks cannot offset a decline in reserves by adjusting securities holdings or raising funds through issuing nonreservable liabilities (such as CDs in the United States), bank lending must contract. If bank lending is 'special' in the sense that bank borrowers do not have close substitutes for obtaining funds, variation in the availability of bank lending may have an independent impact on aggregate spending. Key then to the bank lending channel is the lack of close substitutes for deposit liabilities on the liability side of the banking sector balance sheet and the lack of close substitutes for bank credit on the part of borrowers. Imperfect information plays an important role in credit markets, and bank credit may be "special", that is, have no close substitutes, because of information advantages banks have in providing both transactions services and credit to business. Small firms in particular may have difficulty obtaining funding from nonbank sources, so a contraction in bank lending will force these firms to contract their activities"*. There are two necessary conditions that must be fulfilled for a bank lending channel to exist, (Ramey (1993)): firstly, banks should not be capable of shielding their loan portfolios from changes in monetary policy; in other words, monetary policy actions should influence banks' loan supply;

[9] According to the interest rate channel, banks – facing tightening in monetary policy – raise lending rates and thus affect demand for credit. Empirical evidence from the USA shows that banks first respond to changes in the cost and availability of loanable funds by changing non-price lending terms and conditions of lending, i.e. adjusting credit supply. Only then they change interest rates (Schreft and Owens (1991)).

and secondly, borrowers (at least a part of them) should not be able to fully insulate their spending from changes in the availability of bank credit.

The broad credit channel is not restricted to the bank lending channel. The balance sheet channel stresses the importance of costs associated with information asymmetries and the inability of lenders to monitor borrowers costlessly. As a result, cash flow and net worth become important factors affecting the cost and availability of finance and the level of investment spending. The main idea of the balance sheet channel is that the external finance premium depends inversely on a borrower's creditworthiness, which in turn depends on macroeconomic conditions and therefore on the monetary policy (de Bondt (1999)). In particular, contractionary monetary policy that produces an economic slow-down reduces firm cash flow and profits, and by weakening creditworthiness increases the external finance premium generating a so-called financial accelerator effect. "*Financial accelerator effects can arise from the adjustment of asset prices to contractionary monetary policy. Borrowers may be limited in the amount they can borrow by the value of their assets that can serve as collateral. A rise in interest rates that lowers asset prices reduces the market volume of borrowers' collateral. This reduction in value may then force some firms to reduce investment spending as their ability to borrow declines"* (Walsh (2003)).

3.2. Interest rate channel and bank lending channel effects

3.2.1. From a policy variable to output and prices

In this section we examine stylized facts of the monetary transmission. Using structural vector autoregression (S-VAR) models we determine the monetary policy shock and then discuss impulse responses of output and prices to both the interest rate shock and the exchange rate shock. Since the impulse responses can substantially differ in various identification schemes, we use two identification methods: Christiano, Eichenbaum and Evans (1994, 1998) – hereafter referred to as CEE, and Kim and Roubini (1995). This should provide arguments for the robustness of results. In the first method, monetary policy shock is identified through a standard Cholesky recursive decomposition, whereas in the second one – through a non-recursive decomposition.

To identify the monetary policy shock in line with CEE, one must make assumptions on variables the monetary authority considers when setting the level of the policy instrument, and the interaction between variables in

the information set and the monetary policy shock. Thus, we assume that a central bank observes developments in the world economy (prices and interest rates) as well as developments in domestic output and prices. Using this information, a central bank sets its short-term interest rate accordingly. Furthermore, we assume that variables included in the information set considered by the central bank react to the monetary policy impulses with a lag. The exchange rate is assumed to react contemporaneously to interest rate developments, but the interest rate does not respond contemporaneously to the exchange rate. Thus, the ordering of the variables is as in (2). This identification method has, however, two serious shortcomings: it is not only more suitable for a large closed economy, like the US, but it also relies on the assumption that the monetary authority reacts to the contemporaneous price and output developments though in practice, due to lags in the statistical data availability, it does not. In contrast to the CEE identification scheme, in the Kim-Roubini-type decomposition, monetary policy rule takes into account data which can currently be observed, namely – foreign interest rate and the monetary aggregate (one must, however, bear in mind that these variables are not of primary importance for the monetary authority within the inflation targeting framework). Moreover, in the Kim-Roubini identification scheme, the exchange rate is allowed to react simultaneously to the developments in the monetary policy instrument and the interest rate reacts contemporaneously to exchange rate fluctuations. The latter feature of the Kim-Roubini identification scheme makes it more suitable for the analysis of the monetary policy shocks in the open economies.

Our VAR includes 7 variables: world oil price (Brent in USD) – denoted as p^{oil}, introduced to estimate the effects of a supply shock and to avoid misspecification that usually leads to price puzzles; foreign interest rate – i^f (either 1-month LIBOR or 1-month EURIBOR), domestic output (proxied by industrial production) – y, consumer prices denoted as p, monetary aggregate M0 – m, 1-month interbank domestic interest rate which represents monetary policy instrument, i, and either the PLN/USD or PLN/EUR exchange rate, e. We analyse impulse responses to the bilateral exchange rate shocks instead of effective exchange rates shocks, since we believe that depreciation with respect to the US dollar and the euro should bring about various responses of output and prices reflecting the specific role of both currencies in the Polish foreign exchange market and in the economy as a whole. Up to 2003, the foreign exchange market was dominated by the US dollar, since then the dollar has been replaced by the euro. Over the whole period the euro seems to be more important for the real sector (due to the role of trade exchange between Polish and EU firms).

The estimates are based on monthly data, so we use industrial production instead of the GDP as a variable representing the real sector of the economy. The lag length of the VAR is determined by the information criteria, but we also consider autocorrelation of the error term. Data series have been seasonally adjusted with X-12. Centred seasonal dummies were introduced where necessary to eliminate the rests of seasonality and autocorrelation of the error term.

Thus, in the VAR format we have:

$$A_0 x_t = \sum_{i=1}^{k} A_i x_{t-i} + B v_t, \tag{1}$$

where:

$$x_t = (p^{oil}, i_t^f, y_t, p_t, m_t, i_t, e_t)'. \tag{2}$$

The CEE identification procedure uses Cholesky decomposition, i.e. A matrix is lower triangular, whereas in the case of Kim and Roubini (1977)-type decomposition, the matrix A_0 is following:

$$A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{31} & 0 & 1 & 0 & 0 & 0 & 0 \\ \alpha_{41} & 0 & \alpha_{43} & 1 & 0 & 0 & 0 \\ 0 & 0 & \alpha_{53} & \alpha_{54} & 1 & \alpha_{55} & 0 \\ \alpha_{61} & 0 & 0 & 0 & \alpha_{65} & 1 & \alpha_{67} \\ \alpha_{71} & \alpha_{72} & \alpha_{73} & \alpha_{74} & \alpha_{75} & \alpha_{76} & 1 \end{bmatrix}. \tag{3}$$

In this specification real activity is contemporaneously affected by oil prices; domestic prices – by oil prices as well, but also by the current output. Both react to the interest rate and exchange rate shocks with a delay. The fifth row of matrix A represents demand for money – it responds contemporaneously to the output, prices and the short-term interest rate. The interest rate is set taking into account contemporaneous developments in oil prices (supply shocks), monetary aggregate and the exchange rate. The last row reflects the assumption that the exchange rate reacts contemporaneously to all other variables. The S-VAR is over-identified, but the over-identifying restrictions cannot be rejected ($\chi^2(5) = 3.17$, prob.: 0.67 for the specification with PLN/EUR exchange rate and $\chi^2(5) = 2.99$, prob.: 0.70 for the specification with PLN/USD exchange rate).

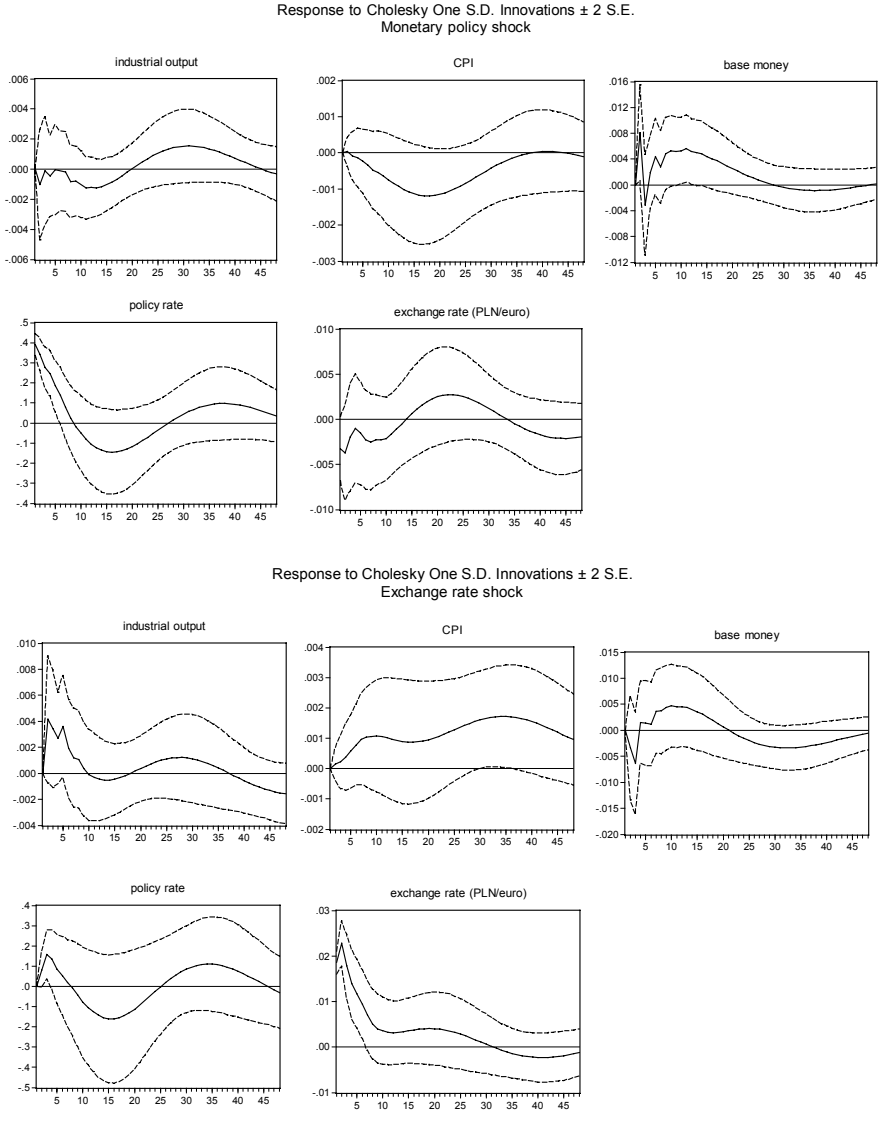
The results of the CEE identification scheme and Kim-Roubini-type are shown in Figure 5, Figure 6, Figure 7 and Figure 8.

The main conclusion that arises from Figure 5, Figure 6, Figure 7 and Figure 8 is that the two identifications bring about similar results as far as price and exchange rate responses to the monetary policy shocks are considered, but somewhat different in the case of output reaction. Specifically, the output reaction in the CEE identification is more hump-shaped than in the Kim and Roubini identification. In the former, the maximum reaction of output occurs about 12 months after the shock, in the latter it is as soon as 2 to 5 months. In any case, the output reaction seems to be faster than it was in our previous study (Wróbel and Pawłowska (2002)) and the difference is considerable, amounting to 6 months. Output reaction to the exchange rate shock is shorter than in our previous estimates and as expected, there is a clear-cut difference in the output reaction to PLN/EUR and PLN/USD shocks. In both identifications the cumulated output response to the former is bigger than to the latter, confirming the importance of trade exchange with the EU countries, and the euro area in particular. The reaction of the price level is bigger and occurs earlier than in the previous estimates. Now the maximum reaction occurs 16–20 months after the shock, while in Wróbel and Pawłowska (2002) it was 20–25 months. There are no major changes in the exchange rate reaction to the interest rate shock – monetary policy tightening leads to the appreciation, yet somewhat bigger than previously observed. A plausible interpretation of these results would point at advances in the monetary propagation – e.g. more flexibility of the real sector, and changes in the monetary policy. These two factors would explain a bigger reaction of prices and quicker response of the industrial output. This finding complies to some extent with the recent results for developed market economies (Kuttner and Mosser (2002)). They suggest that financial innovation, improved inventory management resulting from the progress in the information technology, as well as the conduct of monetary policy diminish the sensitivity of the real sector of the US economy to the federal funds rate. Without doubt, this list should be complemented with factors connected with globalisation. We cannot exclude however, that what we observe in Poland as increased responsiveness of inflation to the interest rate is at least in part also due to a better identification of the monetary policy shock resulting from the homogeneity of the monetary policy framework over the period covered by the estimates.

To sum up, our vector autoregressions bring responses which are consistent with the stylized facts for a small open economy with nominal and real rigidities. There is some evidence that monetary transmission has accelerated. However, the picture of the monetary transmission is somewhat blurred by the reaction of the monetary aggregate to the policy rate: there is no clear-cut drop in money demand in response to the monetary policy tightening but

this effect may to some extent result from changes in the ratio of required reserves[10].

Figure 5 Impulse response functions, CEE–type identification (responses to the monetary policy shock – upper panel, responses to the exchange rate shock – lower panel), PLN/EUR exchange rate



[10] A tentative introduction of the required reserves ratio as an exogenous variable resulted in serial correlation of the error term.

Figure 6 Impulse response functions, CEE–type identification (responses to the monetary policy shock – upper panel, responses to the exchange rate shock – lower panel), PLN/USD exchange rate

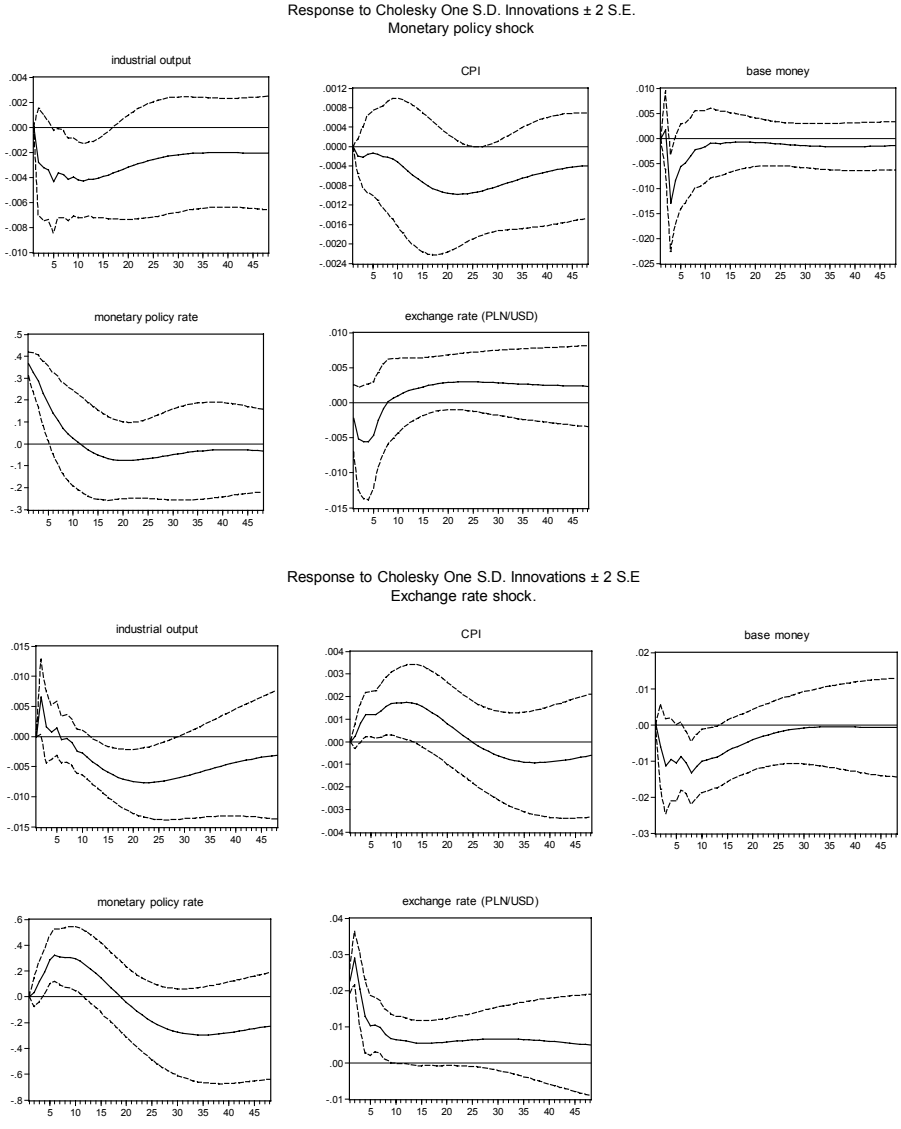


Figure 7 Impulse response functions, Kim and Roubini-type identification (exchange rate PLN/EUR)

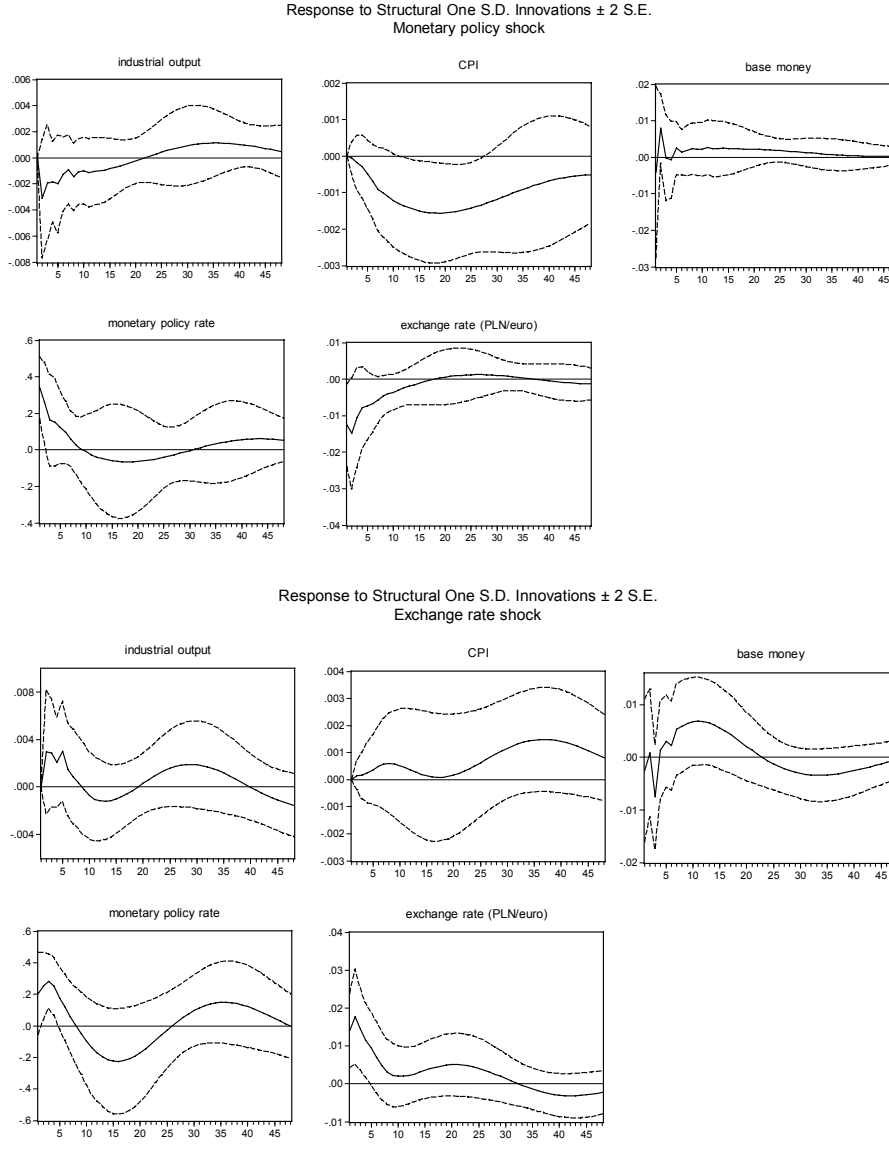
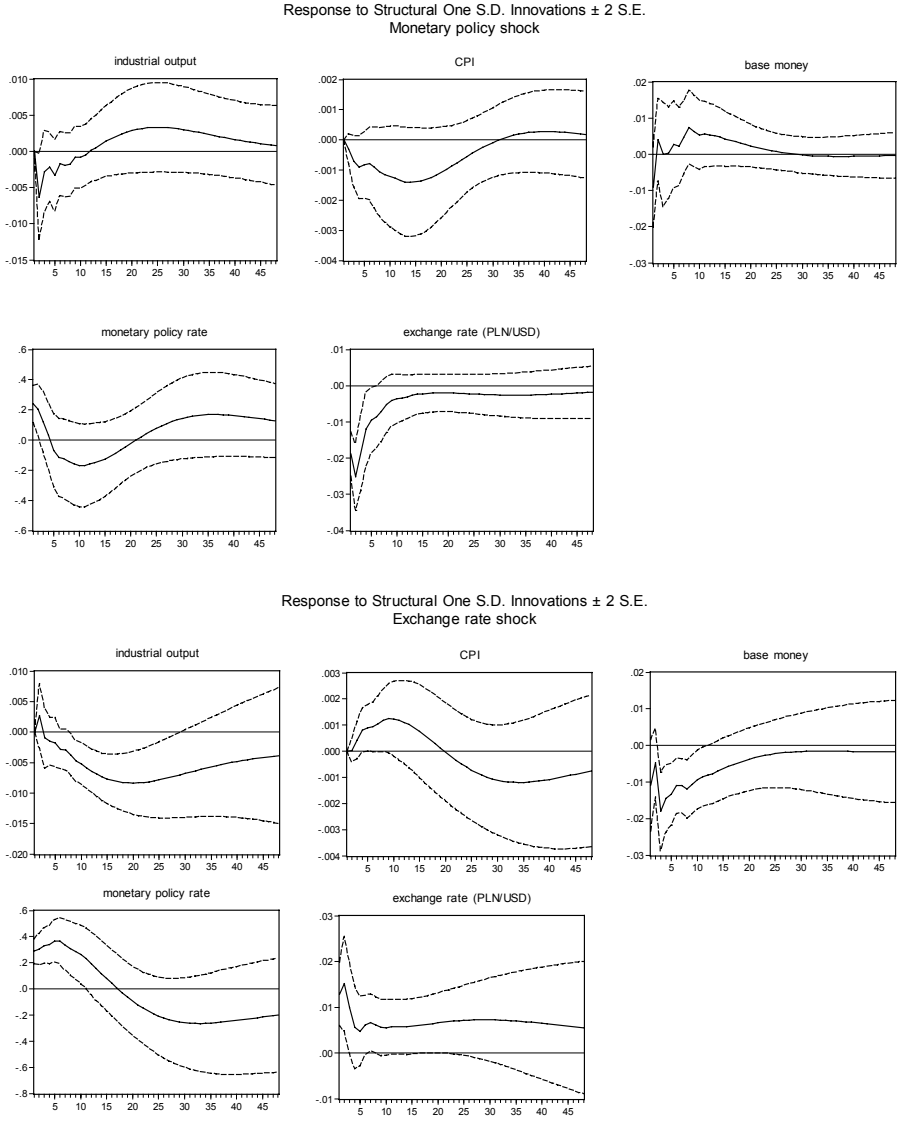


Figure 8 Impulse response functions, Kim and Roubini-type identification (exchange rate PLN/USD)



3.2.2. Credit channel – aggregated data

This part of the study is aimed at showing the role the credit channel plays in the monetary transmission in Poland. For the bank lending channel to be operative a central bank must be able to affect the loan supply. If banks are able to offset a decrease in deposits resulting from a central bank's purchase of T-bills via open market operations, then the lending channel will not affect the real sector. In other words, if banks are able to raise funds from other sources – issue CDs, liquidate treasuries or resort to foreign markets, they can insulate against the decrease in demand deposits. In the case of Poland two of these are particularly important: due to the surplus liquidity banks have big portfolios of liquid papers, i.e. NBP-bills and as a result of the ownership structure, they can easily get funds from their parent entities. Funds obtained from the parent entity, either in the form of debt or equities, are relatively cheap, since subsidiaries do not face information asymmetries. There is some empirical evidence demonstrating that in Germany banks raise funds in foreign markets after monetary policy tightening Ehrmann and Worms (2001). In what follows we check whether banks in Poland used both possibilities of passing-by the lending channel, however taking into account that surplus liquidity means that banks hold a bigger than desired portfolio of liquid assets, and that liquidating them is – if anything – simple and fast way of raising funds, and basing on our previous research on the buffer stock behaviour of banks (Łyziak (2000)), we can suspect that in Poland banks relied more on their portfolio of liquid securities than on funds raised through the parent entities in the foreign markets.

To check the existence of credit channel we follow Hülsewig, Winker and Worms (2001) and Hülsewig, Mayer and Wollmershäuser (2005) who build a vector error correction model and then estimate the restricted co-integrating vectors which represent the long-run loan supply and demand functions. Supply of loans depends on the credit margin, i.e. the spread between loan rate and the policy rate, and on banks' capital, while the loan demand depends on the GDP and the policy rate.

We build our estimates on the following assumptions: a bank increases its loan supply with an increase in the loan rate and reduces it with the policy rate increases. Bernanke and Blinder (1988) suggest that the demand for credit increases with output (scale variable). We accept this view for the long-run estimates. In the short run however, we allow for a fall in the loan demand with output increases, since a better financial standing of firms enables them to finance their investment expenditures from retained earnings. Thus, in the

short run the response of loans to an output shock may be either positive, or negative. Further, we assume that the loan supply and demand react to the interest rate shocks with a delay. This is due to the cost of portfolio adjustment and some inertia in the investment process. In line with the credit channel or the bank lending concepts, we assume that the monetary policy tightening affects negatively net worth of firms and limits the possibility of financing investment expenditures from their own sources. Thus, a firm that is planning to invest has to resort to the external financing and its balance sheet can affect a bank's willingness to extend a loan. On the other hand, due to the reserves drainage, banks are more reluctant to expand loans. The same effect may result from an adverse shock to banks' capital.

To sum up, we use a model of loan supply and loan demand according to the following formula:

$$l^s = f(i_t^p, i_t^{loan}, capital_t) \tag{4a}$$

or alternatively:

$$l^s = f(i_t^p, i_t^{loan}, loss_t) \tag{4b}$$

and

$$l^d = f(y_t, i_t^{loan}). \tag{5}$$

We specify loan supply and loan demand functions using a VECM according to the following formula:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{k=1}^{n-1} \Gamma_k \Delta Z_{t-k} + \Phi D_t + \varepsilon_t, \tag{6}$$

where Z_t is a vector of endogenous variables integrated of order one, D_t is a vector of constant terms (seasonal dummies), and

$$Z_t = (y_t, l_t, i^p, i^{loan}, capital_t)' \tag{7a}$$

or:

$$Z_t = (y_t, l_t, i^p, i^{loan}, loss_t)'. \tag{7b}$$

In the above specification, y is GDP, l stands for loans to firms and households in real terms, i^p is the short-term money market interest rate that proxies the policy rate (WIBOR 1M), i^{loan} represents the loan rate (3-year loans to firms), and *loss* stands for the net loss of the corporate sector in real terms – a proxy for the financial standing of firms. Alternatively we have *capital* – a variable representing banks' balance sheets, a sum of capital and reserves in real terms. Loans are a sum of banks' lending to the corporate sector and households (in

the domestic currency only). They are deflated by a weighted average of the CPI and PPI, with weights corresponding to the share of respective loans in the total amount of loans. Capital and reserves are deflated in the same way, while the net loss of the corporate sector is deflated with the PPI. Data are quarterly statistics and all besides the interest rates are in logs. The sample covers the period 1997 Q1–2006 Q1 (effective sample: 1997 Q4–2006 Q1). In cases when we could not eliminate serial correlation from the residuals in any other way, the sample was shortened to 1998 Q1–2006 Q1.

Trace statistic indicates that for y_t, l_t, i_t^p, i_t^{loan}, $capital_t$ there are 3 cointegrating vectors (Table A3 in the Appendix). The LM test does not show signs of autocorrelation (Table A5 in the Appendix). For y_t, l_t, i_t^p, i_t^{loan}, $loss_t$, the trace statistic indicates 2 cointegrating vectors (Table A4 in the Appendix), and, as before, the LM test does not show signs of autocorrelation (Table A6 in the Appendix).

For y_t, l_t, i_t^p, i_l^{loan}, $capital_t$ we estimate the VECM applying a set of restrictions to obtain: (i) a loan supply equation, (ii) a loan demand equation, and (iii) an equation for the capital and reserves. In the loan supply equation we restrict coefficient standing at the GDP to zero and the coefficient standing at the policy rate to be equal to the coefficient standing at loan rate but with the opposite sign; for the loan demand coefficients at i_t^p and $capital_t$ are restricted to zero; for capital and reserves equation we restrict coefficients at l_t, i_t^p, and i_t^{loan} to zero. The first two equations are normalized with respect to l_t, while the third one to $capital_t$. The VECM is over-identified, and the LR test shows that the over-identifying restrictions could be rejected. Namely, in this specification, capital and reserves seem to depend on the interest rate. This fact can be attributed to a plausible relationship between the interest rate and reserves – a high interest rate increases the opportunity cost but at the same time it results costly to have too small reserves and have to borrow them in the market. Reserves account for about 40% of the sum of the aggregate "capital and reserves" but the obtained high value of the respective semi-elasticity makes us suspicious about the results. All obtained parameters have the expected sign and are statistically significant. The estimated income elasticity of loan demand seems to be too low at first sight, but since the data cover a relatively short period, and what most important, the period of a slow increase in loans to the non financial sector, the elasticity of 0.60 can be accepted[11] (the elasticities are shown in Table A7 of the Appendix). Impulse

[11] It should also be emphasised that we cover only loans in the domestic currency, whereas credits granted by domestic banks in foreign currencies have a considerable share in the amount of total credits. In addition, firms seek credits from foreign sources (see: Table A2).

response functions are obtained from the Cholesky decomposition. The ordering is as follows: y_t, l_t, i_t^p, i_l^{loan}, $capital_t$ which means that we assume that the GDP and loans react to the monetary policy shocks with a delay, while the loan rate and capital adjust within the same quarter. Impulse responses look rather reasonably (see Figure 9)[12]. GDP falls after the monetary policy shock and the maximum reaction takes place in the eighth quarter after the shock. The demand for loans also falls, but its maximum reaction comes later – in the fourteenth to sixteenth quarter. Shocks to the monetary policy rate induce, as expected, an increase in the loan rate. The upward movement of loans after the loan rate shock is, however, relatively small and temporary – it disappears after seven quarters and then a much greater downward shift can be observed. This last observation raises even more doubts with respect to this specification.

Now we shall estimate the VECM for the second specification that uses $loss_t$ instead of $capital_t$. This time there are only two cointegrating equations. Once again, in the loan supply equation we restrict coefficient at GDP to zero and the coefficient standing at policy rate to be equal to the coefficient standing at loan rate but with the opposite sign, whereas for the loan demand coefficients at i_t^{loan} and $loss_t$ are restricted to zero. We test whether banks consider firms' balance sheets when they make credit decisions. As in the previous case, the VECM is over-identified but now LR test does not show that the over-identifying restrictions can be rejected ($\chi^2(2) = 2.12$, prob.: 0.35). Once again, all obtained parameters have the expected sign and are statistically significant. There is, however, a problem with the magnitude of the elasticities (Table 7). The income elasticity of loan demand is too low (0.12). On the other hand, the interest rate semi-elasticities of the loan supply seem far too big. The impulse responses (Cholesky decomposition with the ordering analogous to the previous case) of the GDP and loans to the policy rate shock display initial puzzles but afterwards both GDP and loans fall as expected. The credit puzzle seems to last too long which induced us to verify the assumption on the loans' stickiness reflected in the place they occupy in the Cholesky ordering. Putting it after the monetary policy rate and thus assuming that it adjusts within a quarter of the policy rate shock[13] brought about much more sensible impulse response (presented on the right hand side of the lowest row of Figure 10). The loss of firms moves upward after the

[12] To be able to interpret the obtained interest rate shocks as monetary policy shocks, we should have specified the VECM using also inflation. We do not introduce inflation because we were concerned about the shortness of sample and wanted to save the degrees of freedom. Thus, interpreting the obtained interest rate shock as monetary policy shock is somewhat overstated.

[13] Such ordering is also used in Hülsewig, Winker, Worms (2001).

adverse shock to monetary policy. A shock to the loan rate induces an upward and relatively long-lasting movement of loans.

These results are ambiguous: on the one hand, some elasticities and semi-elasticities do not look reasonably, on the other – impulse response functions are mostly plausible and both the elasticities and semi-elasticities can be somewhat distorted by the fact that we use only a part of the total amount of loans and the sample is short. The results seem to support only weakly the operation of the credit channel in Poland or to be more specific – the lending channel. This conclusion led us to examine more disaggregated data and verify the buffer stock behaviour of banks.

Figure 9 Impulse responses to the monetary policy rate shock, specification: *y*, *l*, i^p, i^{loan}, *capital*

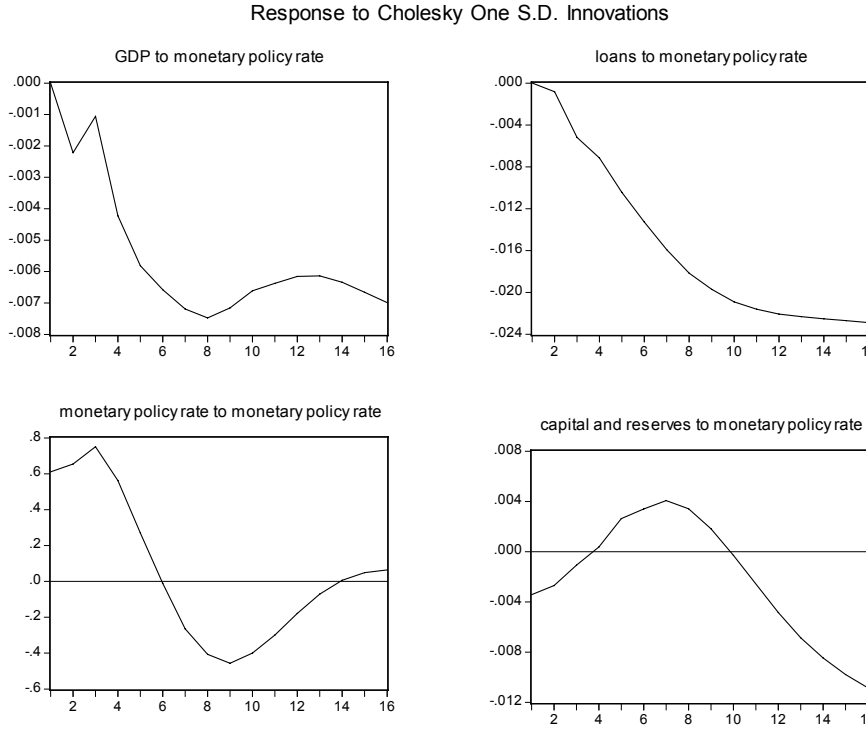
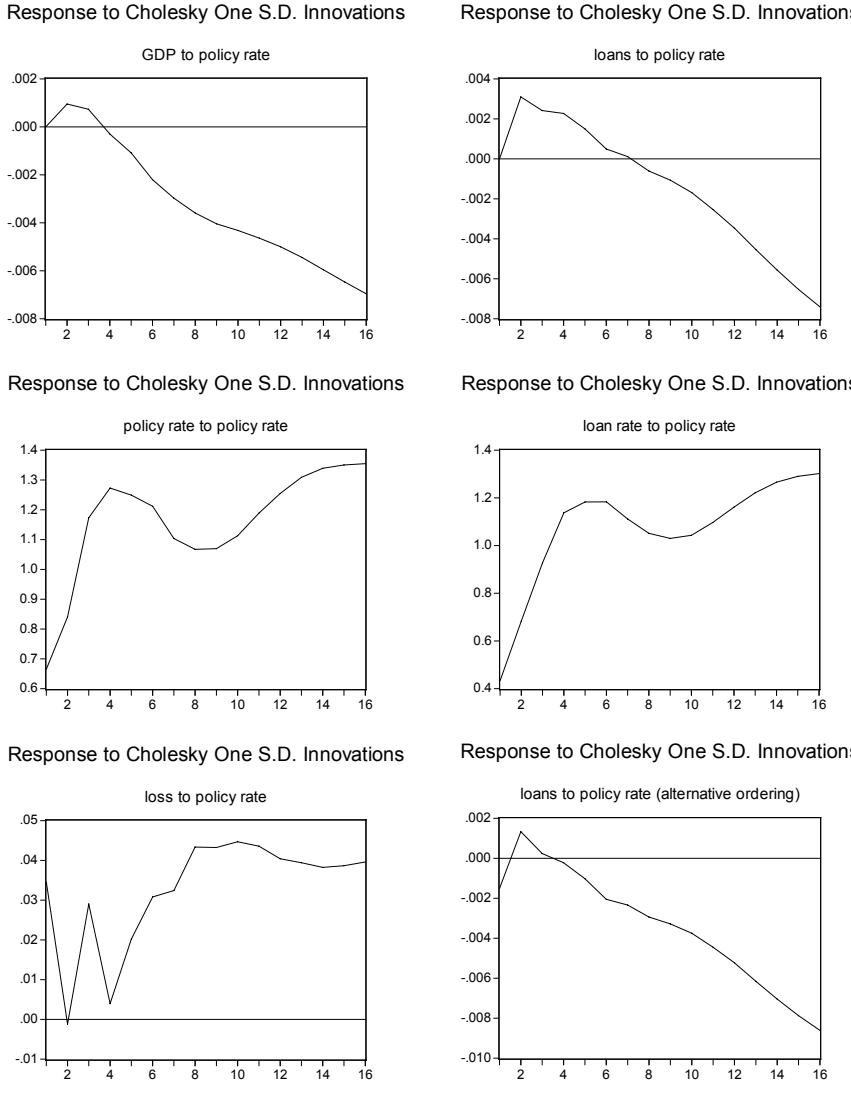


Figure 10 Impulse responses to the monetary policy rate shock, specification: *y*, *l*, i^p, i^{loan}, *loss*



3.2.3. Credit channel – disaggregated data

The exercise shown in section 3.2.2 was reproduced for disaggregated monthly data covering the period 1998:01–2006:05 in respect of the total amount of loans for individual, private and state-owned enterprises and credit

in the current account. Owing to the data constraint we analyse the behaviour of investment, revolving and export loans for the respective firms over a shorter period, namely 2002:02–2006:05.

The model of loan supply and loan demand differs from that from section 3.2.2 mainly in the specification of the loan supply – instead of capital in the equation (4a), we use lost loans (i.e. *loss claims*):

$$l^s = f(i_t^p, i_t^{loan}, lost\_loans_t). \tag{4'a}$$

We expect that a tightening of the monetary policy shall, with a few-month delay, result in an increase of the amount of lost loans and in reduced bank's propensity to extend new loans. The alternative equation, where the net real loss of firms is included, remains unchanged:

$$l^s = f(i_t^p, i_t^{loan}, loss_t). \tag{4'b}$$

Finally, y in the equation (5') does not stand for the GDP, but instead – for the real income of the respective firms:

$$l^d = f(y_t, i_t^{loan}). \tag{5'}$$

Before focusing on the operation of the credit channel among various types of enterprises, we present some stylized facts related to the structure of output and the amount and structure of loans extended to firms.

Income of private enterprises, i.e. private firms employing more than 9 persons, has been booming since the mid-1990s mainly due to the privatisation process and, to a lesser extent, the greenfield investment of foreign capital as well as the newly-born domestic capital. Over the last ten years private firms increased their share in the total income by about 40 percentage points (to almost 75% in mid 2006); however, state-owned firms lost even more. Income of individual enterprises (micro-firms employing up to 9 persons), having at their disposal a small amount of capital, has been growing at a moderate rate and at present it approaches a 10% share in the total income (see Figure 11). State-owned enterprises employ about 55% of the total labour force, i.e. almost twice as much as private companies. Individual firms employ nearly 15% of the total labour force.

Figure 11 Structure of income by the type of the ownership

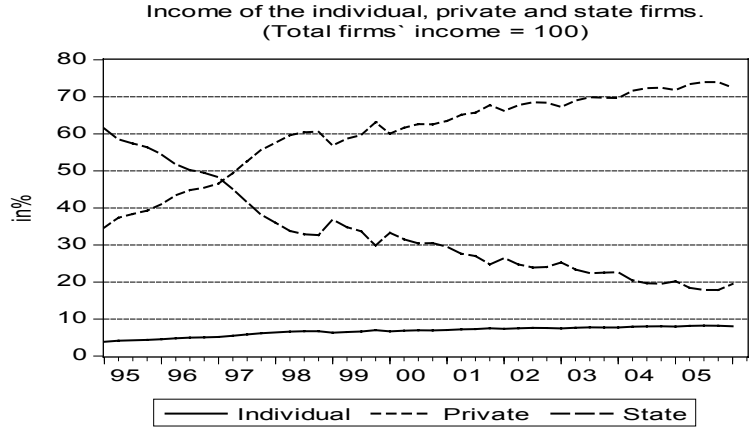
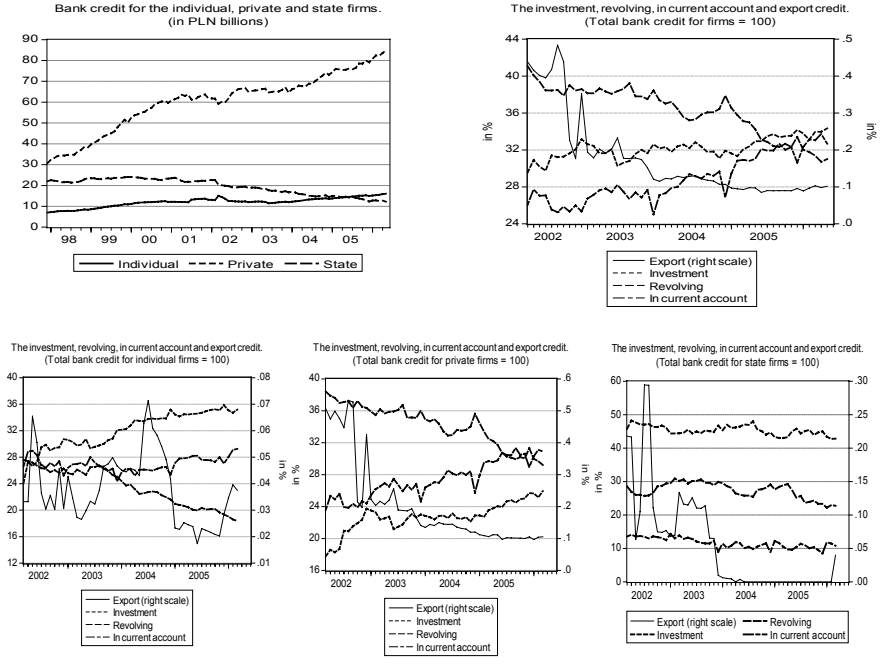


Figure 12 Structure of bank loans by the type of loans and the kind of enterprises



Bank loans reflect the ownership structure of enterprises (see Figure 12) – almost 80% of the total amount of loans has been extended to private firms. Of the total amount of loans 26% are investment loans, which have grown by 47% since Poland's accession to the EU. In the same period, the revolving credit and the credit in the current account increased at a twice lower rate.

The former rose at 8.5% rate and the latter, a solution that is more convenient for firms – at 38% rate. Both the revolving credit and the credit in the current account finance the working capital of enterprises and the cost of inventories maintenance. Their share in the total amount of loans has remained unchanged over the analysed period (62%). The value of export credit decreased from PLN 300 million in 2002 to about PLN 90 million following accession to the EU. It was mostly due to the growing number of export-oriented foreign direct investment by multinational companies and the free access to the EU market.

Micro firms (here called 'individual'), due to their small size and the lack of a long-lasting history of bank account, seem to be more dependent on the domestic banks' loans and vulnerable to banks' loan supply policy. The ratio of loans to the net income of these firms reaches 70%, compared to 41% for the private firms. Investment loans account for 36% of the total amount of loans, while short term loans, i.e. the revolving credit and the credit in current account – for 48%. The remaining 16% of loans are connected with real estate and house purchases. The credit in the current account has been growing the most rapidly. Since Poland's accession to the EU, it has increased by 46%, while investment loans rose by 31%.

The amount of loans granted to state-owned companies has dropped by 20% since mid 2004 and the decline was almost equally distributed among all types of loans. At the same time, the net income of these enterprises grew by 1.3%. Hence, the ratio of loans to the net income has fallen to 24%, the lowest level among the analysed groups of enterprises.

Taking into consideration the disaggregated picture of the Polish credit market and presumed stylized facts concerning the credit channel operation, we expect the following behaviour of firms and banks:

- Firstly, there shall be a difference in the behaviour between large and small firms and between private and state-owned companies. **On the demand side**, the large firms, having a relatively easy access to the commercial paper market and/or being a daughter-company of a multinational corporation, shall be less dependent on the domestic bank financing including both investment expenditures and working capital. It may result in a low interest rate semi-elasticity of the loan demand. On the other hand, the demand for loans shall be correlated with the real economic activity of firms (equation 5') but the direction of the reaction shall depend on firms' assessment of future economic conditions. If the expected future returns are

positive, the demand for loans may increase. The level of income elasticity of loan demand can be perceived as a measure of uncertainty attributed to the economic conditions by firms. A positive and low (much below 1.00) elasticity can indicate that a moderate rate of future returns combined with a high uncertainty is expected. However, large firms or multinationals are less vulnerable to the current economic conditions and therefore this elasticity can be somewhat higher than for other groups of enterprises. **On the supply side**, if banks perceive large (denoted as 'private' in our exercise) firms as less risky and easier to monitor, comparing with other groups of companies, both loan rate and short-term rate semi-elasticity of loan supply shall be relatively low. We assume that banks tend to decrease intermediation margins for their big clients provided that they have no losses and/or lost credits.

- Secondly, **on the demand side**, smaller enterprises will postpone investment rather than increase their demand for investment loans following the tightening of monetary policy. However, small ('individual') firms may rely heavily on short-term loans to finance working capital and inventories. Therefore, the interest rate semi-elasticity of the investment loan demand shall be relatively low and the respective elasticity of the revolving credits and credits in the current account shall be higher. Individual firms, relying more on external sources of financing, are presumably less risk averse than private companies. It may be supposed that particularly the demand for short-term loans financing current activity of individual firms is positively correlated with their real income, if the uncertainty is assessed as reasonable. It can result in a relatively high income elasticity of the loan demand, particularly for short-term credits. **On the supply side**, banks will not respond to such demand positively, adjusting loan supply rather moderately.

- Thirdly, the state-owned sector is characterized by a high risk aversion on the one hand, and a huge lack of funds for investment and current activity on the other. Therefore, the demand for loans is a game between risk aversion and the lack of funds. It is also tailored by the financial standing of the state-owned enterprises – they display net real loss. Thus, it is expected that both the **loan supply and loan demand** elasticities are relatively low.

Estimations were done for all disaggregated data mentioned above and the results are presented in Table 8 and Figure A4 in the Appendix. Owing to a large number of equations (and parameters), the respective elasticities

(parameters of equations) are shown in the table without their standard errors and t-statistics. We considered the respective elasticities as properly evaluated, if Johansen cointegration test indicated two cointegrating equations at the 0.05 level, the equation parameters were significant at the 0.05 level and the parameters had a correct sign.

The estimation is complex, since it takes into account both types of bank products and various groups of enterprises. To make it easier to follow the detailed results let us briefly summarize the main findings:

- It has been confirmed that there is a difference in the loan demand reaction between 'private' and 'individual' firms. The reaction of private companies to the monetary policy tightening is small and similar for all types of loans. Individual firms tend to resign from investing after an interest rate shock. Demand for investment loans is inelastic in state-owned enterprises.

- We cannot confirm that the size of enterprises labelled here as 'individual' and 'private' is a characteristic that discriminates banks' behaviour after the monetary tightening. Instead, we observe that banks' reactions differ with respect to various products.

A detailed inspection of the results presented in Table 8 seems to confirm most of our hypotheses. We have found that there is a difference in behaviour of loan demand between large ('private') companies and micro ('individual') firms. The reaction of the former to the monetary tightening is relatively low and similar for all types of credits. The interest rate semi-elasticities of investment and export loans as well as credits in the current account vary from –0.001 for export to –0.043 for investment loans. These levels are comparable with findings of Hülsewig, Winker and Worms (2001) for Germany. The income elasticity of loan demand is also similar for all types of loans (it varies from 0.5 for investment loans to 0.6 for export credits), but it is twice as low as in the euro area. The relatively low elasticity can reflect enterprises' uncertainty about economic conditions resulting in an aversion to finance their activities from external sources. From the banks' perspective, the supply of loans depends on the type of credit. The interest semi-elasticity of investment loan supply amounts to 0.037 (similar to the loan supply in Germany) and for the revolving credits and credits in the current account the elasticity is more than ten times higher. It may indicate that the reaction of banks to the monetary tightening is higher with respect to the supply of the short-term credits (financing the working capital) than with respect to the long-term (investment) loans.

The reaction of loan demand of individual firms is a little different. After monetary policy tightening these enterprises tend to resign from investment and curb their activity rather than be financed by loans. The interest-rate semi-elasticity of investment loan demand equals –0.17 (4 times as high as the case of private companies) and for the revolving credit: –0.53 (twice as much). Only the demand for credit in the current account seems to be almost unaffected by the monetary policy measures. Banks' credit policy towards micro firms clearly depends on the history of the firms' account – a growing bulk of lost credits leads to a proportional fall in the supply of loans. On the other hand, the estimated spread semi-elasticity of investment loan supply which equals 0.76 is unexpectedly high (20 times higher than for private firms). This can be due to the relatively low amount of investment loans granted to micro firms and a great dispersion of credits.

Surprisingly, the elasticities of both loan supply and loan demand of state-owned companies look like the inversed elasticities of individual firms: demand for investment loans is inelastic with respect to both the loan rate and income. This phenomenon can result from a permanent lack of funds in these firms. The inelastic demand coexists with the inelastic supply of investment loans. To some extent, the inelastic supply of loans for the state-owned sector can be explained by its importance (too large and too "strategic" to fail). On the other hand, the total elasticity of loan demand of loans financing the working capital (the revolving and in the current account credits) is close to that of individual firms, but in state-owned companies the demand and supply of credits in the current account is more sensitive to the interest rate and income changes than it is the case for the revolving credit.

The demand for export loans seems to be insensitive to interest rate changes but is relatively sensitive to income changes, particularly those in state-owned companies. The supply of export credits is very low and depends heavily on changes in the loan rate.

Table 8 Elasticities and semi-elasticities of loan supply and loan demand

All enterprises	Income of individual, private, state enterprises	Monetary policy rate	Loan rate	Loss of respectively: individual, private, state enterprises	Lost credits of respectively: individual, private, state enterprises	Trend
Supply of						
investment loan for enterprises:						
- individual		-0.757	0.757	-	-1.051	-
- private		-0.037	0.037	0.213	-	0.011
- state		-0.001	0.001	0.005	-	-0.014
Revolving credit for enterprises:						
- individual		-0.140	0.140	-	-0.989	-
- private		-0.464	0.464	-	-1.027	-
- state		-0.020	0.020	0.812	-	-
credit in the current account for enterprises:						
- individual		-0.116	0.116	-	-0.946	-
- private		-0.502	0.502	0.795	-	-
- state		-0.102	0.102	0.483	-	-
Export credit for enterprises:						
- individual		-0.173	0.173	-	0.151	-
- private		-0.339	0.339	-	-5.539	-0.090
- state		-0.187	0.187	-	-0.841	-0.013
Demand for						
investment loan of enterprises:						
- individual	0.449		-0.170			-
- private	0.505		-0.043			0.004
- state	0.018		-0.001			-0.014
Revolving credit of enterprises:						
- individual	2.297		-0.527			-
- private	0.583		-0.221			-
- state	0.200		-0.116			-
credit in current account of enterprises:						
- individual	0.381		-0.013			-
- private	0.512		-0.034			-
- state	0.493		-0.405			-
Export credit of enterprises:						
- individual	0.410		-0.005			-
- private	0.607		-0.001			-0.003
- state	1.693		-0.003			-0.003

To conclude this section we would like to stress two findings:

- *Firstly*, the operation of the credit channel at disaggregated level is better documented than at the macro level. In most cases the elasticities and impulse reaction functions are similar.

- *Secondly*, with some exceptions (the investment loans of the private firms) the level of elasticities estimated for Poland differs significantly form these obtained for the Euro area but the reaction functions are similar.

3.3. Buffer-stock behaviour

A crucial assumption in the bank lending channel theory is that monetary contraction drains banks' reserves, which forces banks that are unable to offset a decline in reserves[14] to adjust their assets, including loans. However, as empirical studies suggest, credit contraction can be significantly weakened by changes in the portfolios of the most liquid assets such as Treasury securities. Contrary to loans, Treasury securities can be liquidated easily and can, therefore, serve as a buffer-stock. Special features of the relationship between banks and borrowers result in the fact that, independently of the monetary policy measures, banks may be reluctant to reduce loan supply at least for certain borrowers. Credit lines are an example of such relationships. In this case an immediate reduction of financing could make borrowers unable to meet their previous liabilities. Another factor is a privileged position of "big" customers (such as large firms), having a long-time relationship with a bank. Evidence from the United States and the U.K. suggests that a tightening of monetary policy initially leads high-quality borrowers to demand more loans at prevailing interest rates, while other borrowers, for whom bank credit is critical as the only possible source of financing, are faced with a decline in loan supply. The net results of these opposite responses may be that the total bank credit is not immediately affected by the interest rate rise (Gerretsen and Swank (1998)).

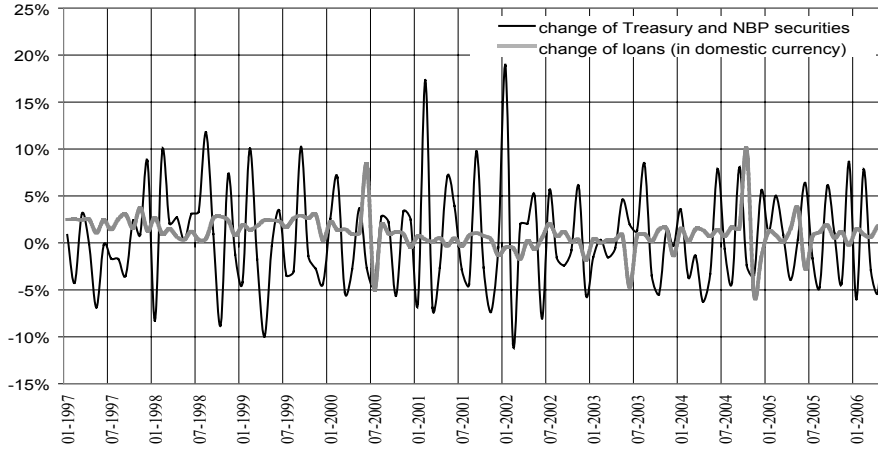
The buffer-stock behaviour may have consequences both for the interest rate channel and the credit channel, as documented in a number of empirical studies. As far as the interest rate channel is concerned, Altimari et al. (1997) show that the portfolio of Treasury bonds held by Italian banks played the role of a "secondary liquidity" that enabled them to offset potential results of

[14] For instance, by raising funds through issuing non-reservable liabilities such as CDs in the United States.

the monetary contraction and lower the sensitivity of interest rates on loans to changes in the monetary policy. As for the credit channel, the buffer-stock behaviour tends to diminish the importance of bank credit as a transmission channel of the monetary policy and reduce the information content of credit about future changeover in the real economy. Garretsen and Swank (1998) check the relationship between German money market interest rates and bond holdings and loans of Dutch banks.[15] The main finding is that bond holdings are adjusted almost immediately in response to the interest rate shock, which combined with the sluggish reaction of the intermediated loans suggests that banks display buffer-stock behaviour. Similar evidence of buffer-stock behaviour in the Netherlands is provided by Kakes (1998), who concludes that it leads to a limited importance of the bank lending channel of the monetary policy. The role of liquid assets in weakening bank loans' reaction to the monetary policy measures is also confirmed in Germany – Kakes, Sturm and Maier (1999) show that German banks respond to a monetary contraction by adjusting their securities holdings, rather than by reducing their loans portfolio.

It seems that Polish banks follow a similar behaviour. The volatility of the most liquid assets, namely Treasury securities and central bank bills, is higher than the volatility of loans (Figure 13).

Figure 13 Percentage monthly changes of selected commercial banks' assets

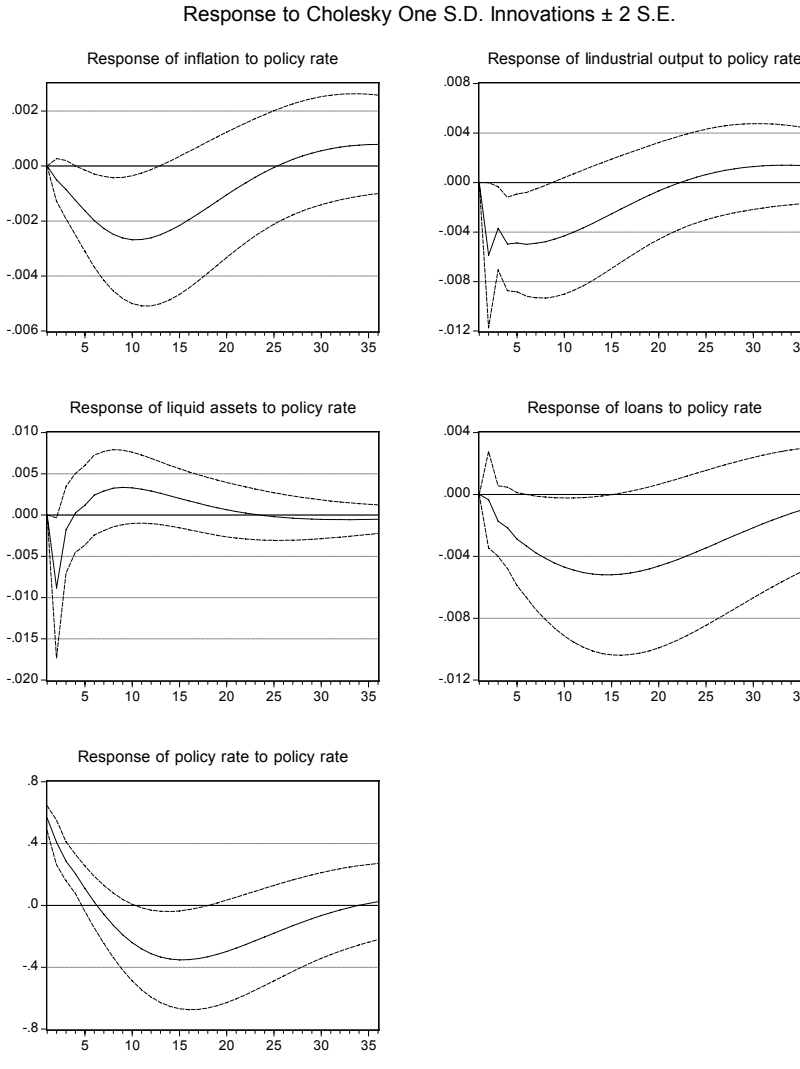


[15] In the period considered in the study, the Dutch guilder was tied to the Deutsche mark; therefore, Gerretsen and Swank (1998) use the German short-term interest rate as a policy variable.

The figure suggests that loans and highly liquid securities are not perfect substitutes in terms of commercial banks' asset management policy. To assess differences in their responsiveness to the monetary policy measures we estimate a vector autoregression (VAR) model. This type of model gives a possibility to measure the dynamic impact of different types of random disturbances on systems of variables. A list of series used in the model consists of five variables covering the period 1997.01–2006.05: interbank interest rate WIBOR 1M playing the role of the policy variable, Treasury and central bank securities in commercial banks' portfolios, domestic currency loans, industrial output and the consumer price index. All variables except the policy interest rate are in logs. Both types of banks' assets and industrial output are in real terms. The ordering of variables reflects the assumption that the policy rate affects first the banking variables (liquid assets, loans) and then the real sector (GDP) and inflation[16]. The procedure, which orders the policy variable in the last instance, corresponds to the assumption that innovations to the interest rate affect other variables with a lag. This assumption seems plausible taking into account that we use monthly data and the transmission of interest rate impulse to the real sector via bank balance sheets is – by nature – a relatively slow process. After the VAR had been estimated we generated the impulse response functions to one standard deviation shock to the interest rate (Figure 14). For each variable the horizontal axis shows the number of months that have passed after the shock, while the vertical axis measures – the response of the relevant variable. A value of 0.1 corresponds to 10 basis points in the case of the interest rate and inflation and 10% of the baseline value in the case of other variables.

[16] This way of ordering variables is consistent with the methodology adopted by Gerretsen and Swank (1998) in their Dutch VAR model and other studies, such as Gertler and Gilchrist (1993).

Figure 14 Buffer-stock behaviour, VAR model



According to the money view, a tightening of monetary policy should result in a similar fall in loans and securities held by banks, which are considered perfect substitutes. This is clearly contradicted by the Polish results. The reaction of bank loans is lagged, whereas the reaction of bond holdings is immediate and stronger than that of bank loans. These results indicate that securities holdings of banks and loans are not perfectly substitutable[17] and the

[17] Different degrees of liquidity, profitability and risk of the various kinds of bank assets may be perceived as the main causes of their imperfect substitutability (Hernando (1998)).

buffer-stock behaviour occurs. Given the observation that the most important reaction of banks after the interest rate impulse is the adjustment of their most liquid assets, the lagged response of bank loans is likely to be related to a fall in loan demand (the interest rate channel). Real activity and inflation show a negative reaction after the interest rate innovation – in the case of inflation the maximum reaction occurs approximately a year after the monetary policy shock.

Although the reaction of individual variables may not be stable across different VAR's specifications, the result concerning the existence of the buffer-stock behaviour seems to remain robust[18].

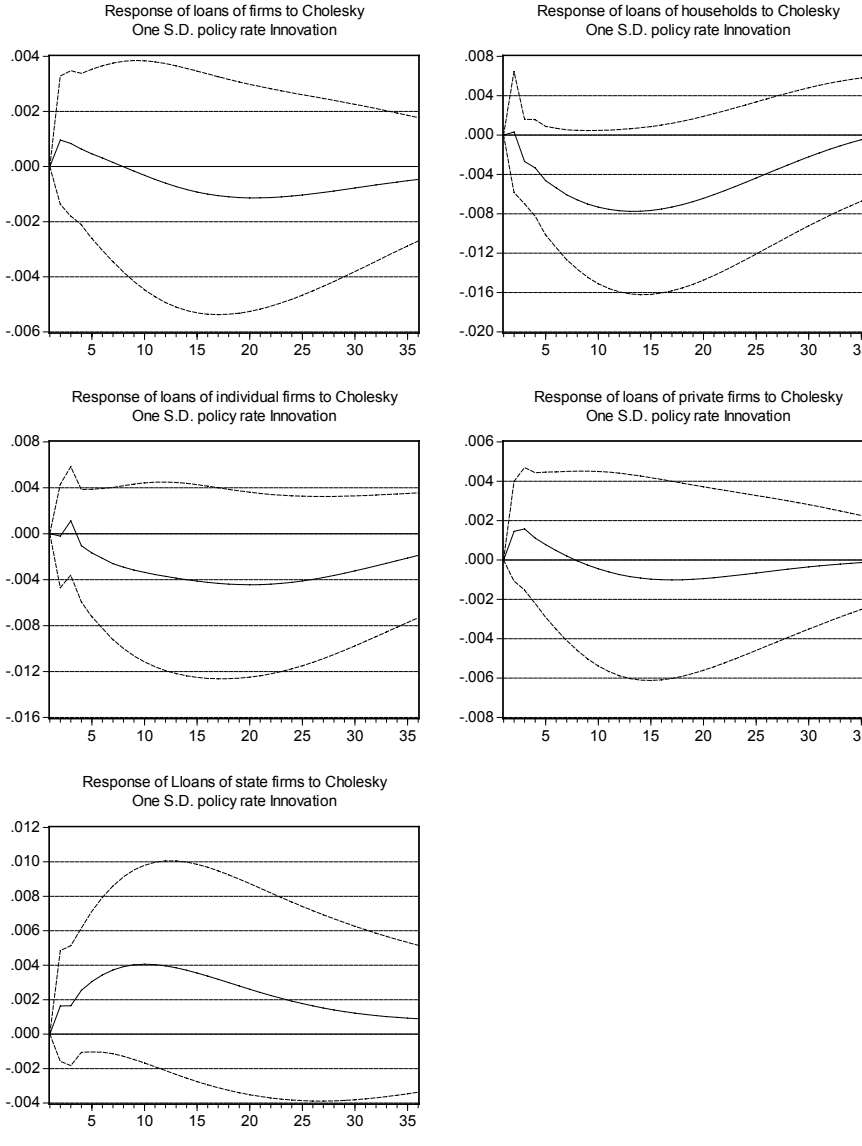
Similar VARs were built to analyse the supply of bank loans for different types of borrowers, i.e. individual, private and state-owned enterprises and households. Although the short-time response of loans defined in this disaggregated manner remains statistically insignificant, the responses give some intuitions concerning the different pattern of responses of banks with respect to different groups of borrowers (Figure 15). The loans of households seem to be reduced shortly after the interest rate shock, while the loans of the corporate sector are reduced with a delay, even after their initial increase. This increase may be attributed mainly to the response of loans of the state-owned enterprises and differs substantially from reactions of the remaining types of loans.

To check whether the credit channel is further weakened by a possibility of resorting to the foreign parent entities of Polish banks we have constructed two VAR models containing various kinds of foreign capital which could be considered as a substitute for internally raised funds: inter-company loans and debt securities. Our VAR models consisted of four variables: GDP level, CPI, inter-bank short-term interest rate, approximating the NBP policy rate and either loans from direct investors, i.e. inter-company loans or debt securities. We used a simple Cholesky decomposition method with the ordering as above. Using a sample of quarterly data from 1999 to 2006, we found that after the monetary policy shock there was no increase in debt securities (in fact there was even a drop). On the other hand, inter-company loans slightly increased

[18] We experimented with different VAR's specifications: reducing the number of variables (excluding industrial output or prices) or replacing them with alternative ones (inflation with the price level, loans denominated in domestic currency with the sum of loans in domestic and foreign currency etc.), changing the lag structure, excluding time trend from exogenous variables etc. The conclusions on the immediate reaction of highly liquid assets to interest rate innovations and the postponed as well as relatively weak (in some cases even statistically insignificant) reaction of bank loans are similar across these specifications. Thus the existence of buffer-stock behaviour in Poland seems to be robustly confirmed.

just after the shock but the result is statistically insignificant (the respective impulse response functions are presented in the Appendix, Figure A3). In sum, these results suggest that although potentially capital inflows from the foreign direct investors can harm the operation of the credit channel, we have not found empirical evidence that they really did over the period 1999–2006.

Figure 15 The response of loans of different borrowers to monetary policy shock, VAR model



4. Summary and conclusions

This study offers a new picture of the operation of two important channels of the monetary transmission mechanism in Poland – the credit channel and the interest rate channel. Contrary to previous studies, the period under consideration in the present study, i.e. 1997.Q1–2006.Q1, is characterised by a homogenous monetary policy regime, i.e. inflation targeting. It makes the specification of VAR models we use more accurate.

In comparison with the results of the previous VAR studies on the monetary transmission mechanism in Poland its delays seem to have become shorter. In particular, the maximum reaction of the price level to the interest rate shock occurs 16–20 months after the innovation, while in Wróbel and Pawłowska (2002) it was 20–25 months. It may be caused to some extent by a more adequate specification of the VARs on a longer and more homogenous sample period taken into consideration. But on the other hand, it can also result from the development of the financial system in Poland, making economic agents more exposed to the interest rate innovations, a fast increase of the weight of private firms in the economy (as measured by the growth of income generated by this sector) as well as the Poland's accession to the European Union.

Evidence on the credit channel in Poland is mixed. Analyses on the aggregated data seem to confirm, albeit only weakly, that firms' balance sheets do matter in the loan supply decisions of banks. The obtained elasticities and semi-elasticities in the loan supply function can be regarded as dubious, but impulse response functions display a reasonable shape. Analyses performed on the disaggregated data confirm that the credit channel does operate – after the monetary policy tightening banks seem to reduce short-term loans (i.e. credit in current account), while the longer term loans for investment display lower semi-elasticities with respect to the interest rate and therefore seem to be more protected. It means that various types of loans are not considered by banks as close substitutes. The fact that banks protect investment loans more than the credit in the current account can be interpreted as a flight to quality.

In our estimates we could not confirm the hypothesis that banks' decisions on the loan supply depend on the size of firms, i.e. the hypothesis that after a negative monetary policy shock loans for smaller firms seem to be reduced more eagerly. This result, however, can be due to the fact, that the aggregate labelled here as 'individual firms' includes entities employing more than

9 persons, i.e. both very large entities as well as rather small ones. Data constraints make it impossible to make a different grouping of enterprises. In sum, the obtained results lead us to the conclusion that the role of the credit channel in the Polish monetary transmission is relatively weak. This is consistent with the results of previous studies on the credit channel in Poland. One of the explanations explicitly addressed in the study is that due to the fact that banks hold large portfolios of highly liquid assets, such as Treasury and central bank securities, they are able to insulate their loan portfolios after monetary tightening. An immediate reaction of liquid assets to the interest rate innovations and a delayed and relatively weak reaction of bank loans seem to be robustly confirmed by the various specifications of VAR models. Bearing in mind the present scale of the surplus liquidity and the expected inflow of the EU membership related funds, it may be expected that the buffer-stock behaviour of banks also in the medium term will affect the credit channel operation. A fact that we did not find the empirical evidence that banks in Poland tended to by-pass the credit channel resorting to the foreign markets does not mean that they will not act this way in the future. Development of new financial instruments and growing weight of the stock exchange as a source of capital will additionally depress the strength of the lending channel. All in all, we think that the lending channel will not grow in importance.

Appendix

Figure A1 Concentration level of the Polish banking sector: indices CR_5, CR_{10}, CR_{15}

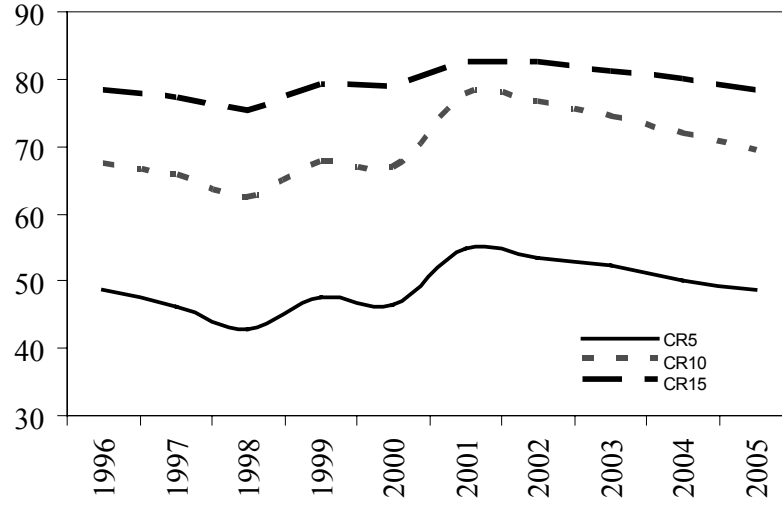


Figure A2 Surplus liquidity of the Polish banking sector

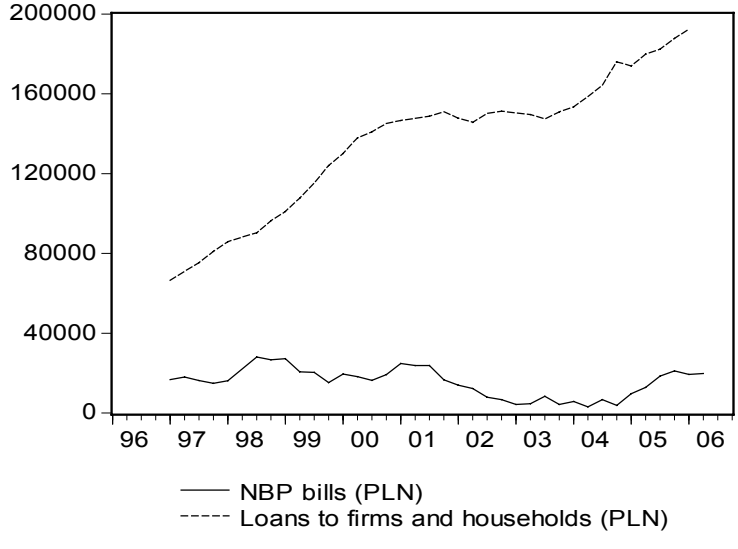


Figure A3 Foreign capital inflow to the Polish banking sector: inter-company loans and debt securities impulse response, response to Cholesky one S.D. innovations ±2 S.E.

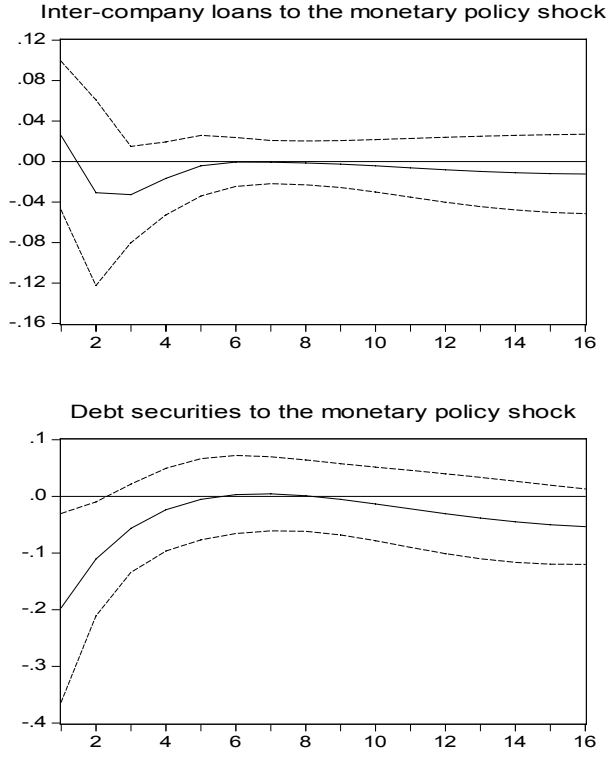


Table A1 Changes of the zloty exchange regime since 1990

Date	Change
1 January 1990	Exchange rate **fixed to the dollar**, 1USD=0.95PLN
16 May 1991	Exchange rate **fixed to a currency basket** (45% USD, 35%DEM, 10% GBP, 5% FFR, 5% CHF), devaluation to 1USD=1.11 PLN
14 October 1991	**Crawling peg to the currency basket**; crawling rate 1.8% monthly, NBP margin ±0.5%
26 February 1992	Devaluation to the basket by 12%
27 August 1993	Crawling rate 1.6, devaluation by 8%
13 September 1994	Crawling rate 1.5%
30 November 1994	Crawling rate 1.4%
16 February 1995	Crawling rate 1.2%
6 March 1995	NBP margin ±2%
16 May 1995	Introduction of **crawling band** ±7%, crawling rate 1.2% , interbank rates subject to free market forces and NBP intervention
22 December 1995	Revaluation by 6%
8 January 1996	Crawling rate 1.0%
26 February 1998	Crawling rate 0.8%, band ±10%
17 July 1998	Crawling rate 0.65%
31 July 1998	The last NBP foreign exchange intervention
10 September 1998	Crawling rate 0.5%
28 October 1998	Band ±12.5%
1 January 1999	Change of the currency basket; euro 55%, dollar 45%
25 March 1999	Crawling rate 0.3%, band ±15%
7 June 1999	NBP is not obliged to perform transactions with commercial banks during fixing
12 April 2000	Floating exchange rate

Source: National Bank of Poland and own calculations of the authors

Table A2 Financial account (1997–2006, EUR million)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Financial Account	6 561	11 845	9 819	11 191	3 495	7 646	7 707	6 869	11 557	9 980
Direct investment abroad	-40	-282	-29	-18	97	-228	-269	-636	-2 493	-3 300
Direct investment in Poland	4 343	5 676	6 824	10 334	6 372	4 371	4 067	10 292	7 703	11 568
Portfolio investment assets	722	-116	-514	-96	42	-1 208	-1 137	-1 055	-1 986	-3 590
Equity securities	50	1	-161	-25	-76	-283	168	-43	-474	-2 287
Debt securities	672	-117	-353	-71	118	-925	-1 305	-1 012	-1 512	-1 303
Portfolio investment liabilities	1 146	1 629	648	3 531	1 098	3 367	3 369	8 519	11 836	1 530
Equity securities	530	1 546	13	470	-339	-588	-717	1 295	1 027	-1 490
Debt securities	616	83	635	3 061	1 437	3 955	4 086	7 224	10 809	3 020
Other investment assets	-667	1 879	-3 135	-4 314	-4 495	1 878	-412	-9 452	-2 242	-2 466
Monetary authorities	0	1	1	3	3	0	0	-24	-103	9
Central and local government	36	47	-6	-56	-40	-39	-39	-30	-132	22
MFI (excl Central Bank)	-952	1 968	-2 529	-3 384	-3 766	3 210	384	-8 259	-627	-1 209
Other sectors	249	-137	-601	-877	-692	-1 293	-757	-1 139	-1 380	-1 288
Other investment liabilities	1 068	3 059	5 491	1 441	745	489	2 847	-953	-1 447	6 906
Monetary authorities	-496	177	357	-1 419	133	-511	8	-35	1 519	-625
Central and local government	-43	-328	-210	-299	-3 402	-540	-1 156	-1 833	-4 990	-978
MFI (excl Central Bank)	636	1 322	1 889	-518	327	-516	1 767	881	535	3 976
Other sectors	971	1 888	3 455	3 677	3 687	2 056	2 228	34	1 489	4 533
Financial derivatives	-11	0	534	313	-364	-1 023	-758	154	186	-668

Source: National Bank of Poland

Table A3 Cointegration test – y, l, i^p, i^{loan}, capital (sample: 1998–2006)

Rank	Trace statistic	Critical Values* 95% level
0	105.39	60.06
≤ 1	61.05	40.17
≤ 2	29.50	24.28
≤ 3	10.78	12.32
≤ 4	3.38	4.13

* MacKinnon, Haug, Michelis (1999)

Table A4 Cointegration test – *y*, *l*, i^p, i^{loan}, *loss* (sample: 1997–2006)

Rank	Trace statistic	Critical Values* 95% level
0	104.50	60.06
≤ 1	45.26	40.17
≤ 2	22.45	24.28
≤ 3	5.92	12.32

* MacKinnon, Haug and Michelis (1999)

Table A5 LM test – VECM – *y*, *cr*, i^p, i^{cr}, *capital* (sample: 1998–2006)

Lags	LM-Stat	Prob
1	29.97175	0.2253
2	34.03628	0.1071
3	30.49870	0.2062
4	33.90643	0.1099

Probs from chi-square with 25 df.

Table A6 LM test – VECM – *y*, *cr*, i^p, i^{cr}, *loss* (sample: 1997–2006)

Lags	LM-Stat	Prob
1	29.90605	0.2278
2	33.70690	0.1143
3	27.02248	0.3548
4	25.54558	0.4322

Probs from chi-square with 25 df.

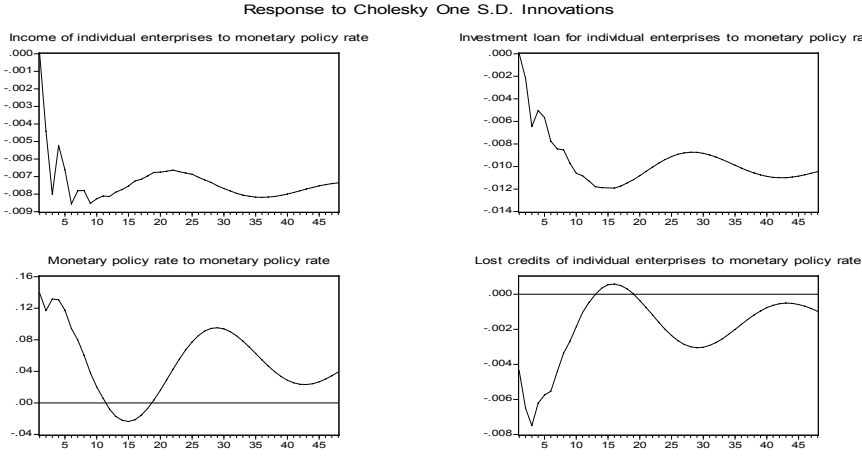
Table A7 Loan to firms and households supply and demand functions: estimation results (standard errors in ( ); t-statistics in [ ])

"credit channel specification"				*"bank lending specification"*		
Cointegrating Eq:	CointEq1	CointEq2	CointEq3	Cointegrating Eq:	CointEq1	CointEq2
y	0.000000	-0.602287 (0.00688) [-87.5208]	-0.549899 (0.00474) [-115.967]	y	0.000000	-0.122766 (0.00591) [-20.7797]
l	1.000000	1.000000	0.000000	l	1.000000	1.000000
i^{p}	0.006525 (0.01220) [0.53486]	0.000000	0.051159 (0.00362) [14.1458]	i^{p}	0.376350 (0.04560) [8.25413]	0.000000
i^{loan}	-0.006525 (0.01220) [-0.53486]	0.042453 (0.00303) [14.0309]	0.000000	i^{loan}	-0.376350 (0.04560) [-8.25413]	0.013811 (0.00130) [10.6606]
capital	-1.081806 (0.00934)	0.000000 [-115.791]	1.000000	loss	0.304926 (0.07951)	0.000000

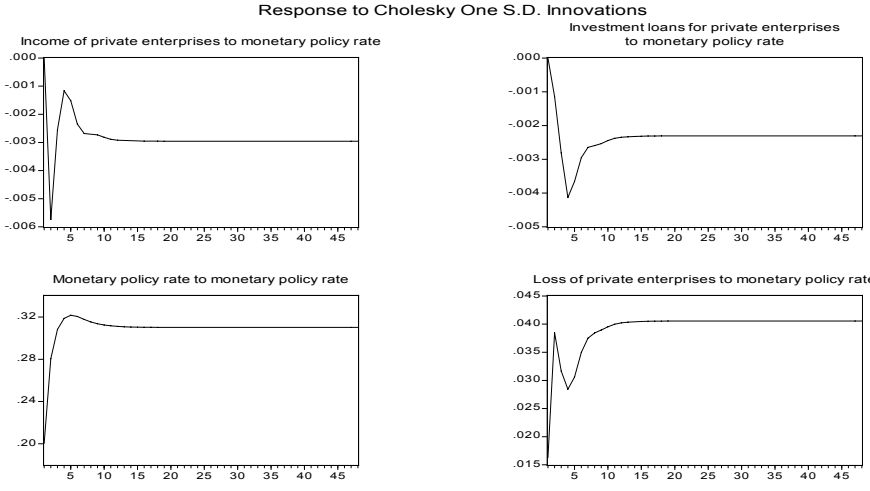
Figure A4 Impulse responses to the monetary policy interest rate shock

A: Investment loans

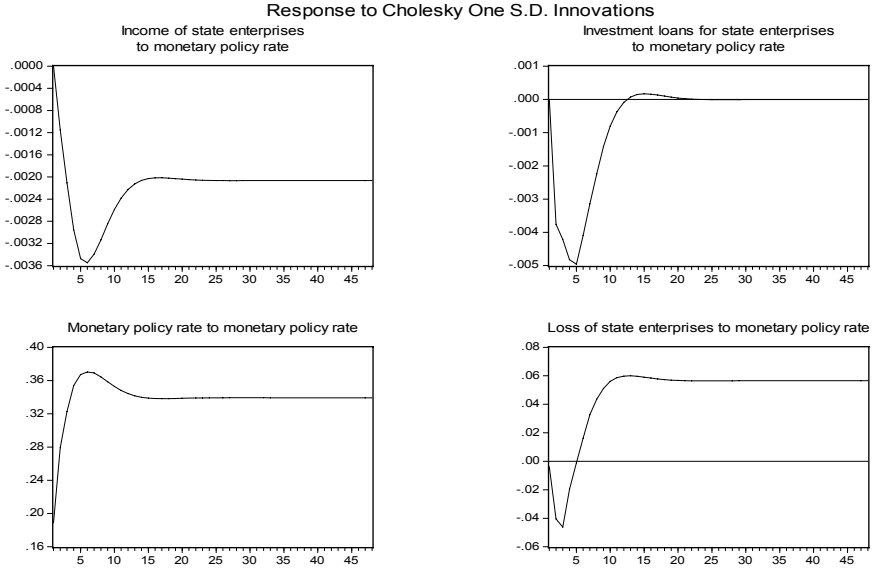
A1: Individual enterprises



A2: Private enterprises

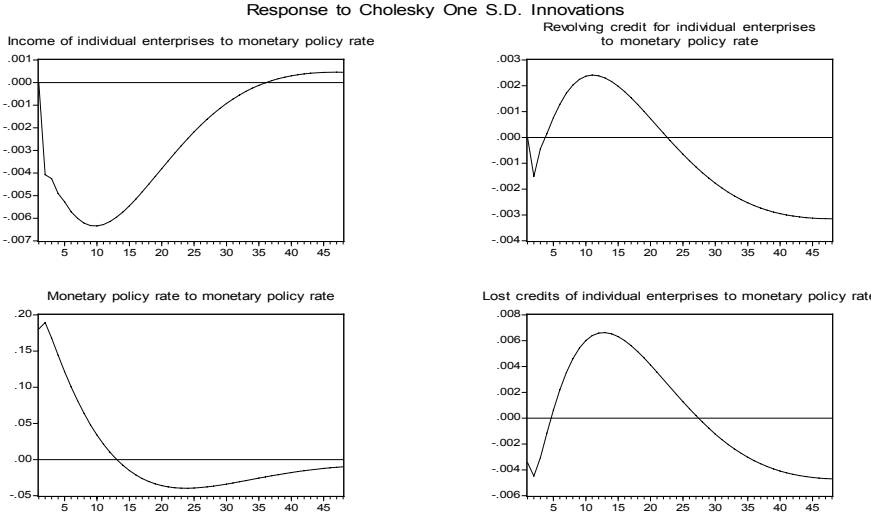


A3: State-owned enterprises

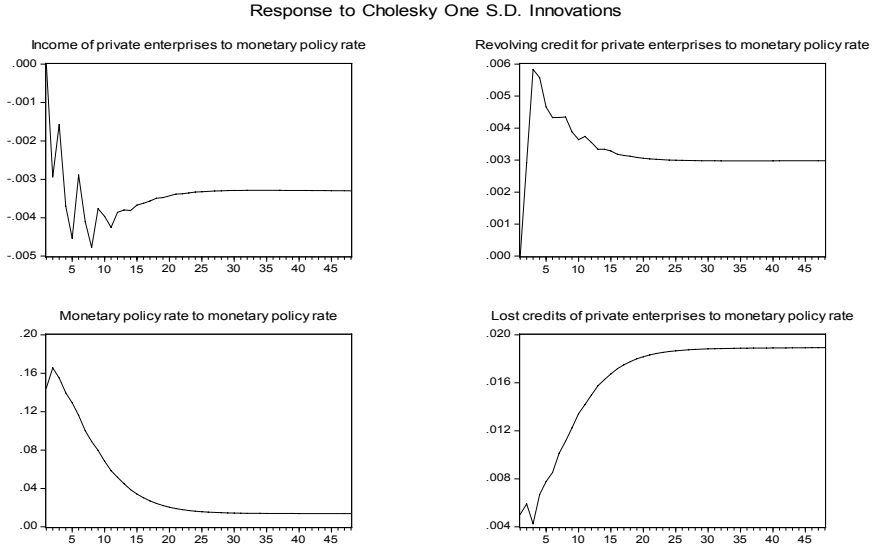


B: Revolving credit

B1: Individual enterprises



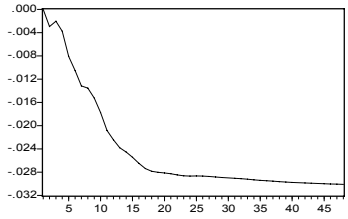
B2: Private enterprises



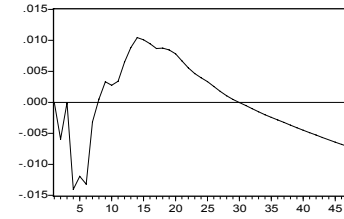
B3: State-owned enterprises

Response to Cholesky One S.D. Innovations

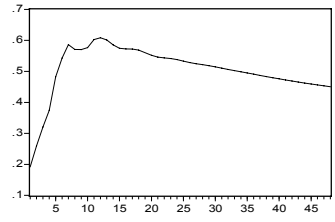
Income of state enterprises to monetary policy rate



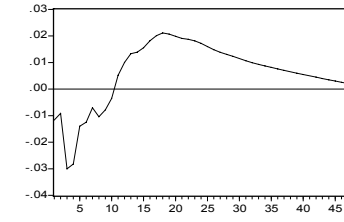
Revolving credit for state enterprises to monetary policy rate



Monetary policy rate to monetary policy rate



Lost credits of state enterprises to monetary policy rate

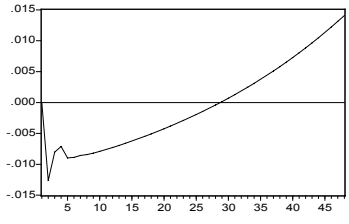


C: Credit in the current account

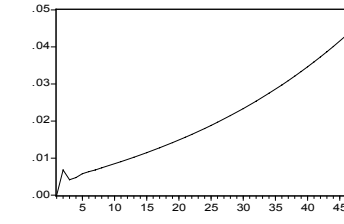
C1: Individual enterprises

Response to Cholesky One S.D. Innovations

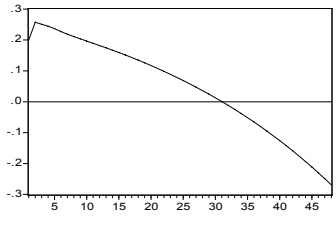
Income of individual enterprises to monetary policy rate



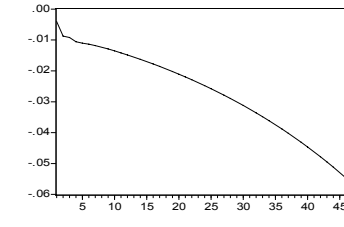
Credit in current account for individual enterprises to monetary policy rate



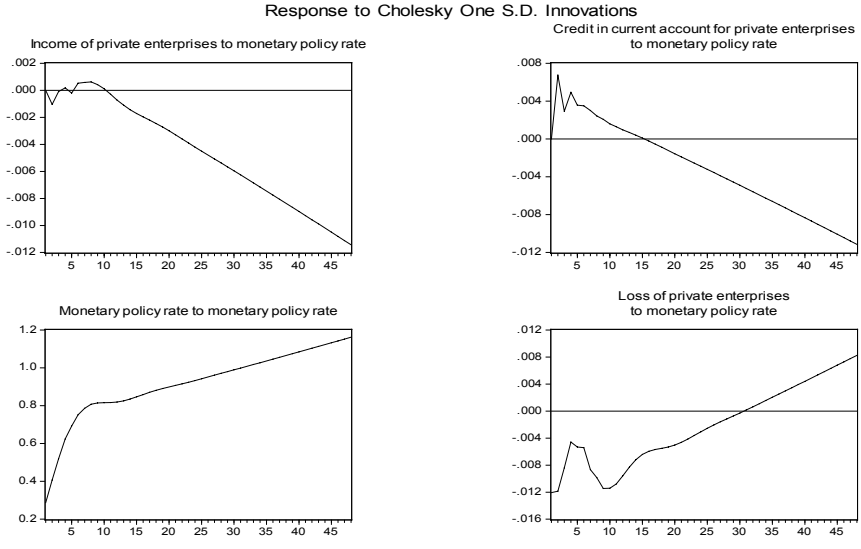
Monetary policy rate to monetary policy rate



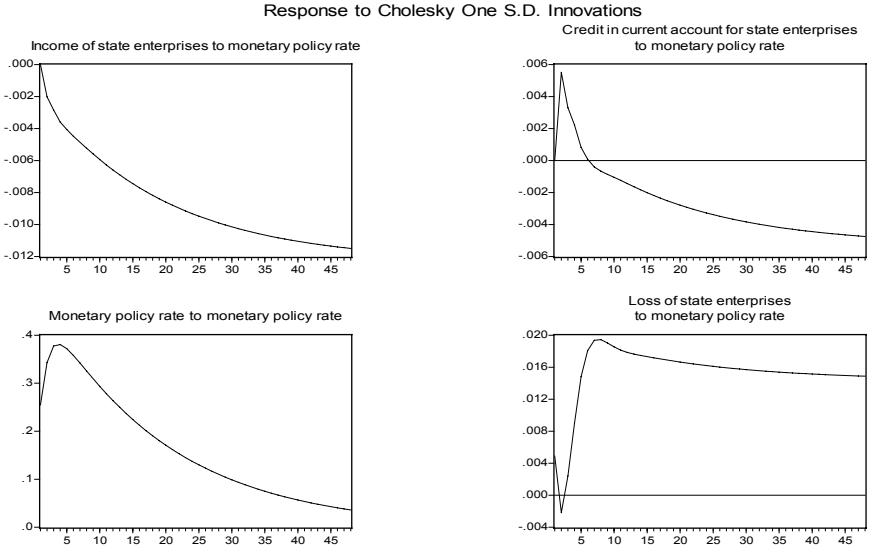
Lost credits of individual enterprises to monetary policy rate



C2: Private enterprises

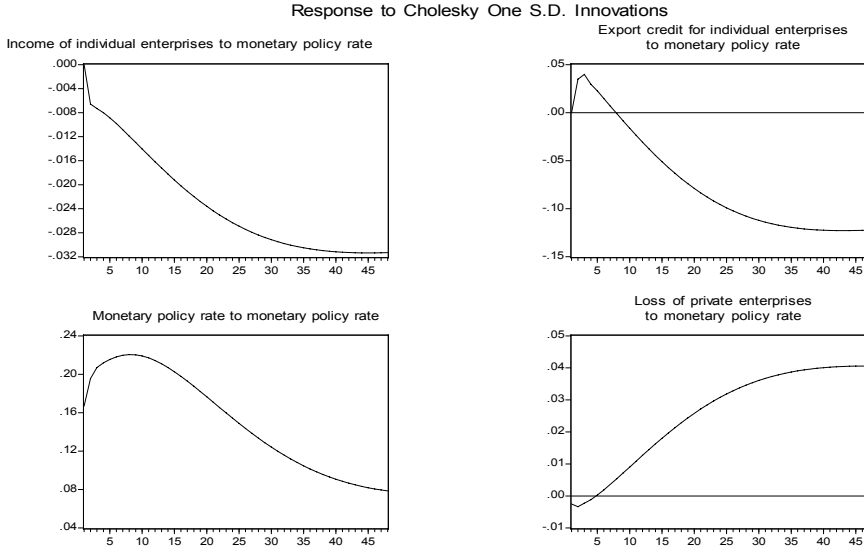


C3: State-owned enterprises

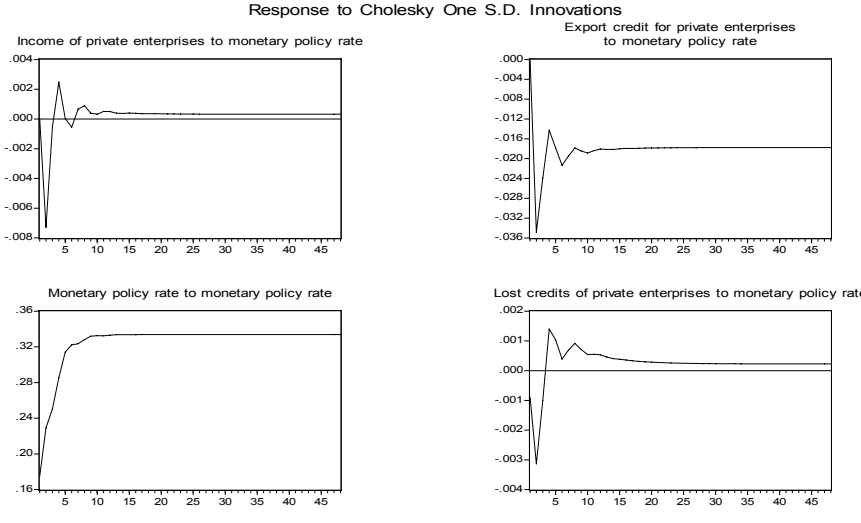


D: Export credit

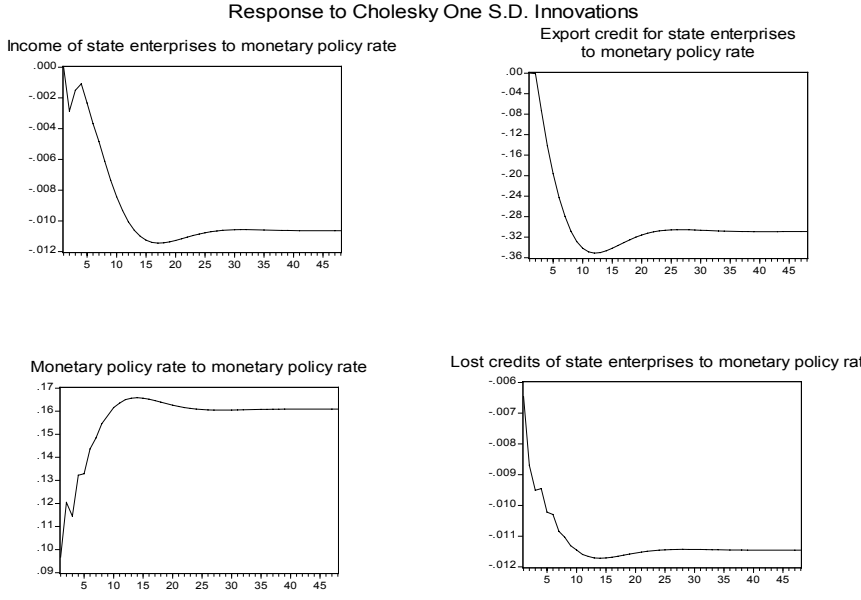
D1: Individual enterprises



D2: Private enterprises



D3: State enterprises



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