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THE MULTI-REGIME BANK LENDING CHANNEL AND THE EFFECTIVENESS OF THE POLISH MONETARY POLICY TRANSMISSION DURING TRANSITION

Rafał Kierzenkowski

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Rafał Kierzenkowski, Université de Paris IX Dauphine

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Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

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ABSTRACT

The Multi-Regime Bank Lending Channel and the Effectiveness of the Polish Monetary Policy Transmission During Transition*

This Paper examines the consequences of interactions between the bank lending channel and the traditional interest rate and exchange rate channels on the effectiveness of the monetary policy transmission in Poland since 1994. First, we develop a small open-economy credit-augmented model. Under two different exchange rate arrangements, namely a fixed rate system with sterilized intervention and a pure floating rate system, we establish that the bank lending channel can generate several regimes in the transmission of monetary policy shocks. In essence, it may not only amplify, as usually considered in the literature, but it may also attenuate the impact of monetary policy on output, prices and the real exchange rate as compared to the standard effects of both the interest rate and the exchange rate channels. The variations in the interest rate spread between the loan rate and the central bank's intervention rate are found to be a good indicator of amplification and attenuation regimes, provided that there is a positive relationship between both rates. Second, we find an attenuation bank lending channel regime from the beginning of 1996 to the end of 1998, and on average a neutral effect of the bank lending channel since then.

JEL Classification: E44, E51, E52, G21 and P00
Keywords: bank lending channel, credit channel, monetary policy, monetary transmission mechanism and transition economies

Rafał Kierzenkowski
CREFED-CERPEM
Université de Paris IX Dauphine
Place Maréchal de Lattre de Tassigny
F-75775 Paris Cedex 16
FRANCE
Tel: (33 1) 44 05 49 47
Fax: (33 1) 44 05 40 98
Email: rafal.kierzenkowski@dauphine.fr

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1 Introduction

It is widely accepted that monetary policy actions conveyed through various interrelated transmission channels have a significant impact on real economic activity (at least in the short-run) and inflation. There is also a broad consensus that more than a decade after the beginning of transition, the Polish capital markets are still fairly shallow as compared to international standards and the financial system is principally a bank-oriented one. These stylized facts motivate our study since we seek to explain the role played by the banking sector in the transmission of monetary policy in Poland from 1994 to mid-2001. More specifically, we investigate the consequences of interactions between the bank lending channel and the traditional interest rate (or money) and the exchange rate channels. The difficulties of the authorities' control over credit activity prove that the Polish banking sector is a key element in the understanding of the effectiveness of monetary policy actions during the 1990s (Polański, 1998, Brzoza-Brzezina, 2000).

Based on the Bernanke and Blinder's (1988a,b) seminal model of the bank lending channel, the main result presented in the literature states that this transmission channel generates an amplification of monetary policy actions when compared to the traditional interest rate channel (see, for instance, Kashyap, Stein and Wilcox (1993), Bernanke and Gertler (1995)). The existence of an imperfect substitutability between bonds and loans on the asset side of the banking sector and on the liability side of firms makes monetary policy more restrictive (expansionary) due to a reduction (increase) in the loan supply by the banking sector to "bank-dependent" borrowers. The variations in both the spread between loan and bond interest rates and the credit supply summarize the amplifying nature of the bank lending channel: the interest rate spread increases (decreases) and the supply of credit decreases (increases) in the event of a restrictive (expansionary) monetary policy (Bernanke, 1993).

Following Dale and Haldane (1993, 1998) and using the Bernanke and Blinder's (1988a,b) model, Kierzenkowski (2002) shows that the bank lending channel can generate several regimes in the transmission process. As a general rule, it may not only amplify, but also attenuate the effects of the traditional interest rate channel, since the systematic amplification result is in fact conditioned by several special assumptions (see Bernanke and Blinder (1988a) for their detailed exposition). The attenuation regime corresponds to a situation where the impact of monetary shocks on output is smaller than in the standard IS/LM model. This work also establishes that, as a general rule, after a monetary policy shock the direction of change in the spread between loan and bond interest rates is a good indicator of attenuation and amplification regimes. Following a monetary tightening (expansion) there is an increase (decrease) in the interest rate spread in the event of amplification effects and a decrease (increase) when monetary policy shocks are attenuated.

However, these testable implications cannot be used for empirical investigations in Poland since

Polish monetary authorities use an interest rate target monetary policy and not, as assumed in the Bernanke and Blinder's (1988a,b) model, a base money one. In this paper, we study the impact of an interest rate control within a Bernanke and Blinder's (1988a,b) framework that we extend in several ways. We consider a small open-economy credit-augmented model with flexible prices, an imperfect nominal wage indexation and capital mobility under two different exchange rate systems: a fixed one with sterilized intervention and a floating one. Within this framework, we derive the theoretical assumption that must be met in order to use the variations in the interest rate spread between the loan rate and the central bank's intervention rate as a valuable indicator of different bank lending channel regimes. Empirically, the question to be addressed is the impact of the bank lending channel on the potency of monetary policy transmission to the corporate sector in the Polish transition process, characterized by, among others, the gradual evolution from fixed to floating exchange rates.

The paper is organized as follows. The next section provides a bird's eye view of Polish monetary policy during the 1990s. Section 3 presents the theoretical credit-augmented model. Section 4 uses the testable implications of the model for investigating the potency of monetary policy transmission from February 1994 to June 2001. The final section concludes the paper.

2 An Overview of the Polish Monetary Policy in the 1990s

2.1 The Main Goals of Monetary Authorities

The monetary policy during the 1990s aimed to achieve several goals, but this task proved to be difficult because of constant changes in the national and international environments.

The primary goal was to carry out a lasting disinflation process in order to converge to an inflation level comparable to those prevailing in the European Union countries. This objective was fulfilled even though the disinflation path was rather slow. The main instrument of monetary policy used for this purpose was the interest rate policy.

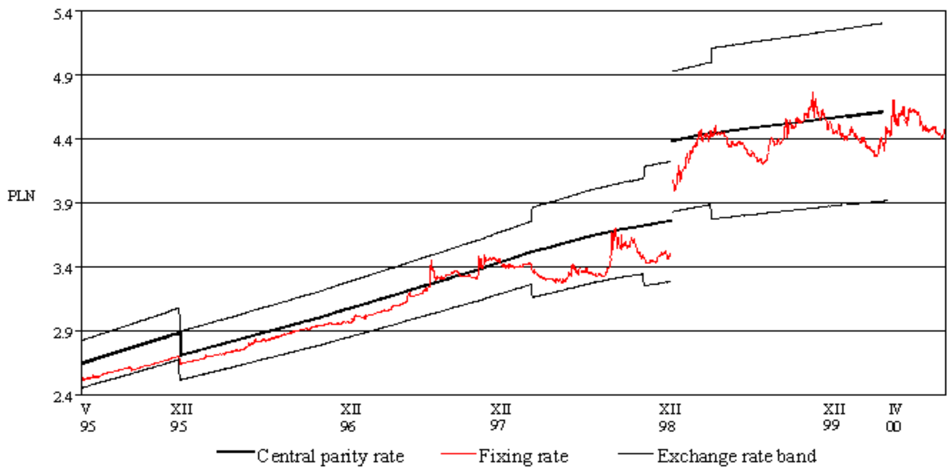
The weakness of Polish exporters' competitiveness was the second concern of the authorities. Thus, they acted in order to control the volatility of the nominal exchange rate and to curb the appreciation of the real exchange rate. Different types of fixed exchange rate policies implemented since 1990 played a major role in this respect. However, the growing commercial and financial integration of Poland considerably increased the cost of these policies, implying huge and costly sterilization operations, particularly since 1995.

Finally, in order to stimulate national currency savings, special attention was given to guarantee positive real interest rates in zloty denominated deposits.

2.2 The Monetary Policy Trade-offs

Until 1994, the disinflation and pro-exporter policies did not encounter major external constraints. Yet, the problem of their consistency emerged. A fixed exchange rate system against the US dollar was in force between January 1990 and May 1991. It acted as a nominal anchor for inflation while producing a strong real appreciation, which turned the trade surplus in 1990 into a deficit in 1991. After a 14.4 per cent devaluation of the zloty against the US dollar, and a brief period of fixed exchange rate against a currency basket, Poland adopted a pre-announced crawling-peg regime in October 1991. This mechanism was designed to offset the inflation differential between Poland and its main commercial partners. The zloty was devaluated on a daily basis against a basket of currencies with a publicly known monthly rate. The rate of crawl was reduced each time the registered inflation lowered. However, in order to limit the pro-inflationary characteristics of this mechanism, the initially fixed devaluation rate was lower than the inflation rate (Polański, 1999). This led to an appreciation of the real exchange rate, and consequently to a fall in exports, pushing the authorities to conduct two separate devaluations against the basket: 8 per cent in February 1992 and 12 per cent in July 1993.

Figure 1. Basket Exchange Rates, V/95 - VIII/00



Source: National Bank of Poland.

Notes: a) Composition of the basket prior to 1999: 45 per cent USD, 35 per cent DEM, 10 per cent GBP, 5 per cent FRF and 5 per cent CHF.

b) Since 01.01.1999: 55 per cent EUR , 45 per cent USD.

1994 was a transitory year, characterized both by capital inflows and a rise in the central bank's gross official reserves. There were several factors that announced their escalations (Polański, 1998). First, between 1991 and 1993, most long-term and some short-term (e.g. resulting from T-bill transactions) capital flows were liberalized. Second, privatization of firms occurred with an increased involvement of foreign investors. Third, the agreements signed for foreign debt rescheduling with

Paris and London Clubs (respectively in 1991 and 1994) and positive growth prospects led several rating agencies to give positive marks to Poland, enabling the country to return to international capital markets. More importantly, a pre-announced crawling-peg exchange rate system, and a policy of high interest rates (see Figure 2), both acted as magnets for short-term capital inflows in search of high return with relatively low risk, especially after the December 1994 Mexican financial crisis.

Table 1. Selected Balance of Payments Items and Economic Indicators, 1993-2001 (USD Billion)

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Current Account (C/A)	**-2.9**	**0.7**	**5.3**	**-1.4**	**-4.3**	**-6.8**	**-11.5**	**-9.9**	**-7.2**
Relative to GDP (per cent)	*-3.4*	*0.7*	*4.2*	*-1.0*	*-3.0*	*-4.3*	*-7.4*	*-6.2*	*-4.0*
Trade Balance	-2.5	-0.9	-1.9	-8.2	-11.3	-13.7	-14.4	-13.2	-11.7
Unclassified C/A Transactions	2.1	3.7	7.1	6.4	6.0	6.0	3.6	4.0	4.4
Capital and Financial Account	**1.7**	**-1.2**	**3.8**	**4.7**	**4.9**	**11.0**	**8.2**	**7.7**	**3.0**
Foreign Direct Investments	0.6	0.5	1.1	2.7	3.0	5.0	6.3	8.2	7.0
Portfolio Investments	0	-0.6	1.2	0.02	1.5	1.7	0.7	2.6	1.1
Gross Official Reserves (stock)	**4.3**	**6.0**	**15.0**	**18.0**	**20.7**	**28.3**	**27.3**	**27.5**	**26.6**
GDP (annual growth rate)	*3.8*	*5.2*	*7.0*	*6.0*	*6.8*	*4.8*	*4.1*	*4.0*	*1.0*
Inflation Rate (CPI based, yearly average)	*35.5*	*32.2*	*28.1*	*19.9*	*15.0*	*11.9*	*7.3*	*10.1*	*5.5*

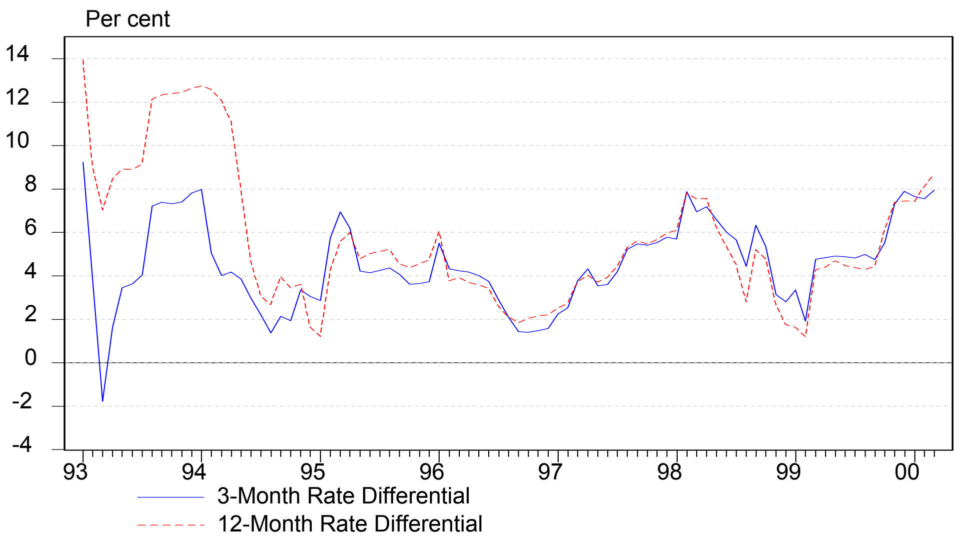
Sources: National Bank of Poland, Central Statistical Office (GUS), and own calculations.

Note: The balance of payments items are based on bank processed payments.

In 1995, the stock of gross official reserves increased from 6 to 15 USD billion (see Table 1). Two factors were behind this huge foreign assets growth. First, although the official trade balance was in deficit, the existing price differential between Poland and its neighbours produced a strong increase in unregistered foreign trade which, included in the current account statistics, yielded a USD 5.3 billion surplus. Second, for the aforementioned reasons, there were long-term and short-term capital inflows. Throughout 1995, in order to counter appreciating pressures and defend the crawling-peg mechanism, the National Bank of Poland (hereafter NBP) carried out interventions on the foreign exchange market that it subsequently sterilized. In the perspective of future debt repayment, the increase in gross official reserves was initially welcomed by monetary authorities (Durjasz and Kokoszczyński, 1999). Nevertheless, in mid-May 1995 the central bank introduced a pre-announced crawling-band mechanism with a ± 7 per cent exchange rate band around the central parity rate. The essence of the crawling-peg mechanism was preserved but the introduction of the band aimed to increase the risk of foreign portfolio investments. Moreover, in order to break the appreciation anticipations, the authorities made a 6 per cent appreciation of the exchange rate (in December 1995) and reduced the rate of crawl to 1 per cent on a monthly basis (in January 1996).

In the 1996-1998 period, the gross official reserves accumulation and the appreciation pressures on the exchange rate continued as capital inflows overfinanced the increasing deficit of the current account. Short-term capital inflows were particularly huge in 1997 and 1998. This resulted from the interest rate differential between Polish and foreign interest rates (see Figure 2), but also from an

Figure 2. Differential Between Polish and Foreign Interest Rates, I/93 - III/00



Sources: National Bank of Poland, Datastream, and own calculations.

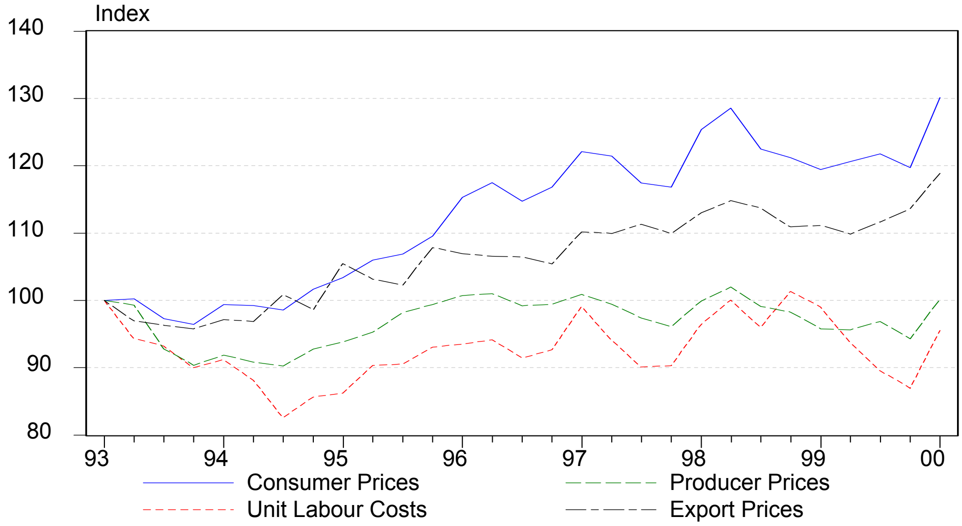
Notes: a) 3 (12)-Month Rate Differential = 3 (12)-Month Polish Treasury bill rate — 3 (12)-weighted average foreign rate — crawling peg devaluation.

b) weighted average foreign rate = weighted average of interbank interest rates of zloty basket currencies.

almost absent exchange rate risk that lasted until the end of 1997. As shown in Figure 1, the central bank continued its interventions on the foreign exchange market by closely controlling the nominal exchange rate in a much narrower corridor than the official band. In doing so, it was slowing down the appreciation of the real exchange rate (see Figure 3). However, the monetary authorities had to sterilize the impact of their interventions afterwards by using open-market operations. Were the opposite to occur, there was the potential risk that the increase in the base money would have subsequently led to a decrease in market interest rates. This would have included T-bills, lending and deposit rates and would have undermined the disinflation interest rate policy. Therefore, every rise in gross official reserves was followed by an increased scale of open-market operations for a given interest rate. The withdrawals of liquidity were conducted primarily with 1 to 14-day reverse repo operations, with the central bank's securities issued for different maturities in the 1994-1997 period, and with the 28-day NBP's securities since then. They created a situation of net indebtedness of the central bank towards commercial banks.

In December 1998, the scale of overliquidity of commercial banks absorbed in open-market operations and in mandatory reserves amounted to USD 13.6 billion, approximately 14.2 per cent of the total assets of the commercial banking sector (NBP, 1998). The cost of sterilization operations ranged between 1-1.5 per cent of GDP in 1995-1997 according to Nuti (2000) and were of the order of 0.7-0.8 per cent of GDP between 1997 and 1998 according to Rosati (1999). This led to an exhaustion of the NBP's profit (see Figure 4) and required a gradual evolution towards a flexible exchange rate system. Exchange rate bands were progressively widened to 10, 12.5, and finally 15 per cent. Above

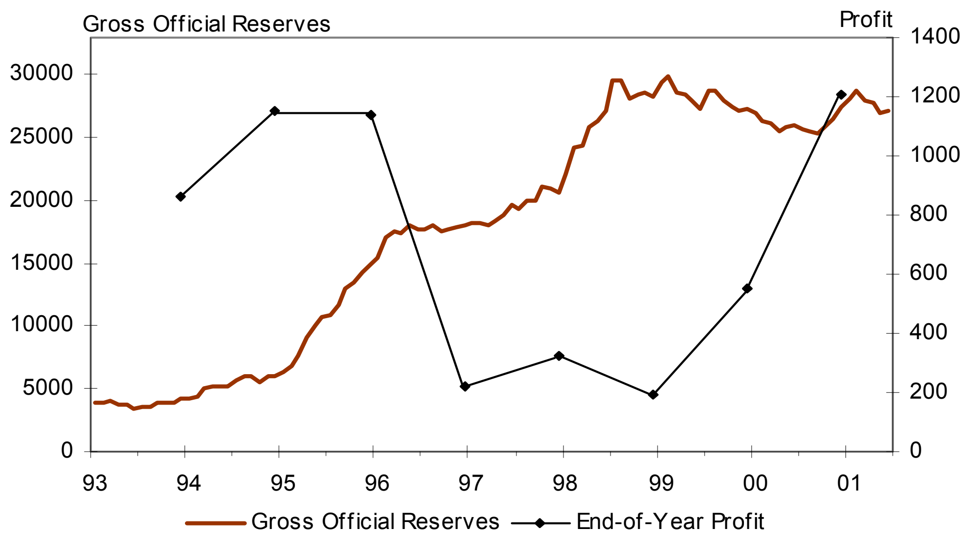
Figure 3. Real Effective Exchange Rates of the Zloty (December 1993=100), Q1/93 - Q1/00



Source: National Bank of Poland.

all, the NBP ceased its direct interventions on the foreign exchange market since the end of July 1998, and its indirect interventions by abolishing fixing transactions starting in June 1999 (Polański, 2000). This move eliminated the main source of overliquidity in the banking system. Finally, a floating exchange rate system has been adopted in April 2000.

Figure 4. Gross Official Reserves and End-of-Year Profit of the NBP, I/93 - VI/01 (USD Million)



Source: National Bank of Poland.

In the next section we make an attempt to highlight the role of the bank lending channel in order to explain several of these stylized facts. Using a simple open-economy framework, we show that this transmission channel can in fact amplify or attenuate the impact of monetary policy impulses on output, prices, the real exchange rate, and gross official reserves. In any case, bank lending should be considered an important component of the transmission of monetary policy to the corporate sector in Poland. Indeed, the ratios of short-term and total credit to the corporate sector to GDP were in 1992 and 1995 stronger than in several Western countries, as Table 2 attests.

Table 2. Bank Loans to Non-Financial Corporations (as a percentage of GDP)

	Short-Term		Total[d]	
	1992	1995[a]	1992	1995[b]
Poland	**8.7**	**6.8**	**20.6**	**16.4**
Netherlands	6.6	4.5	16.9	14.1
Italy	7.2	4.7	13.1	8.6
Spain	5.5	2.6	11.8	6.4
France	2.3	1.7	11.3	14.1
Norway	0.5	0.5	18.0	18.1
United States	8.6	8.4	21.2	20.2
Belgium	14.0	11.8	30.1	24.1
United Kingdom	29.9	21.7	-	-
Japan[c]	47.4	49.3	101.4	107.9

Sources: OECD (1996), National Bank of Poland, and own calculations.
Notes: a,b) France and United States: 1994. c) Loans from financial institutions.
d) Due to data unavailability, the ratios for France, United States, and Norway are overstated as they include total long-term borrowed funds rather than bank loans.

3 A Simple Small Open-Economy Model of the Bank Lending Channel

3.1 General Assumptions

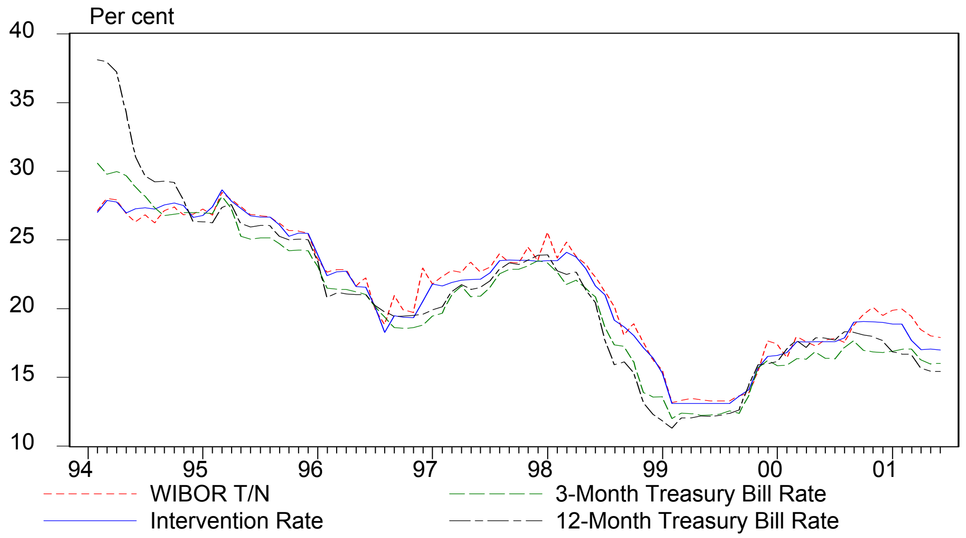
In the closed-economy model developed by Bernanke and Blinder (1988a,b) monetary policy is characterized in terms of the authorities' control over banking reserves, assuming fixed prices. We modify and extend this framework in several ways.

First, in a perfectly deterministic environment without any stochastic disturbances, we invert the policy rule, modelling the central bank as operating on interest rates rather than controlling the base money. The interest rate control assumption reflects the actual conduct of monetary policy in Poland since 1994. According to Osiński (1995, 1999) and Sławiński and Osiński (1997, 1998), the NBP was setting a 1-day reverse repo interest rate (and more generally was controlling the short-term WIBOR T/N interest rate[2]) in the 1994-1995 period, while during the 1996-1997 period the main interest rate instrument was a 14-day reverse repo rate. Since February 1998, the Monetary Policy Council sets the minimum yield on 28-day NBP's securities. For the period under study (February 1994 - June 2001), these interest rates were used in open-market operations in order to absorb the excess liquidity of the

[2] Tomorrow Next Warsaw Interbank Offer Rate.

banking system created by a combination of strong capital inflows and fixed exchange rate policies followed till late 1990s. We calculated a single intervention rate of the NBP as a weighted average of 1 to 14-day reverse repo operation rates and that of the central bank securities issued for different maturities between February 1994 and January 1998 and, since then equal to the actual rate on 28-day NBP bills[3]. As it appears in Figure 5, our indicator of monetary policy stance is almost equal to WIBOR T/N and, since August 1994, is very close to the yield of 3-month and 1-year Treasury bills on the primary market.

Figure 5. Intervention, WIBOR T/N, and Treasury Bill Interest Rates, II/94 - VI/01



Sources: National Bank of Poland and own calculations.

An indicator of monetary policy stance comparable to ours is used by Kokoszczyński (1999). Moreover, similarly to Kokoszczyński (1999), we find a significant impact of our indicator on Treasury bill interest rates. More precisely, as shown in Table 3, the intervention rate (IC) Granger caused the 3-month Treasury bill interest rate (IB3M) for the entire period under consideration, the 6-month interest rate (IB6M) in the February 1994 - August 1998 period[4] but failed to affect the 12-month rate (IB12M)[5,6]. Nevertheless, in the latter case, the expected relationship still occurred even if only for a shorter period of time. On the whole, by controlling its intervention rate, the central bank exerts an important influence on the market interest rates. Given these different observations, we assume, for

[3] The indicator also includes the average rate of outright operations, which were systematically used since September 2000 and seldom before that date.
[4] Due to breaks in data since August 1998, the test could not be made for the entire period.
[5] As in Kokoszczyński (1999), the number of lags is set to one, all variables are in nominal terms and expressed in first difference (therefore, they are stationary - cf. Appendix A).
[6] In the case where there are cointegration relationships between the variables, the estimates for series in first difference might make the Treasury bill interest rates appear less significant than they really are.

the sake of simplicity, that the bond interest rate of the model[7] is equal to the yield of NBP's securities, i.e. to the intervention rate. Presenting the model, we use both terms interchangeably.

Table 3. Granger Causality Tests Between Intervention and Treasury Bill Interest Rates

Null Hypothesis	F-Statistic	Probability	Period
ΔIB3M does not Granger Cause ΔIC	2.478	0.119	III/1994 - VI/2001
ΔIC does not Granger Cause ΔIB3M	4.345	**0.040**	
ΔIB6M does not Granger Cause ΔIC	0.887	0.350	III/1994 - VIII/1998
ΔIC does not Granger Cause ΔIB6M	5.035	**0.029**	
ΔIB12M does not Granger Cause ΔIC	3.554	0.062	III/1994 - VI/2001
ΔIC does not Granger Cause ΔIB12M	0.392	0.532	
ΔIB12M does not Granger Cause ΔIC	1.501	0.226	I/1995 - XII/1998
ΔIC does not Granger Cause ΔIB12M	3.860	**0.055**	

Source: Own calculations.

Second, we model two exchange rate systems in order to take into account the heterogeneity of the period under study. The fixed rate system with sterilized intervention aims to reflect, at least partially, the period ranging from 1994 to June 1999 which is characterized by capital inflows and sterilization operations under the crawling-peg and, since May 1995, the crawling-band exchange rate arrangements. The second system under study is a pure float that Poland has officially adopted since April 2000. However, it has been put into practice since June 1999, when the central bank stopped its indirect interventions on the foreign exchange market.

Third, we consider the prices of goods to be perfectly flexible. However, since we intend to analyse the medium-run impact of monetary policy, we assume an imperfect indexation of nominal wages to the price level. When the nominal interest rate is the monetary instrument as in our case, the latter assumption avoids additionally any indeterminacy problems in modeling the flexible exchange rate system.

Fourth, as is standard in the literature, we introduce in the aggregate-demand-and-supply framework (hereafter AD/AS) a bank lending channel working over and above the interest rate and the exchange rate channels by assuming that bonds and loans are imperfect substitutes. Therefore, there is a clear distinction between both assets. Hence, following a monetary tightening, banks cannot offset a decline in deposits by simply adjusting their bond holdings and keeping their loan supply unaffected. Similarly, firms cannot offset a decrease in loan supply by simply increasing their bond issue without incurring higher costs.

Finally, as the methodology employed in the model is comparative statics, the expected exchange rate and the expected inflation rate are assumed to be fixed and omitted. Foreign country variables are marked with an asterisk.

[7] Empirically, Bernanke and Blinder (1988a,b) use the 3-month Treasury bill interest rate as a proxy for the bond interest rate.

The characteristics of different markets are as follows.

The loan supply is deduced from the following simplified banks' balance sheet (which ignores net worth):

$$R^b + B^b + L^s = D^s, \tag{1}$$

with assets: nominal reserves, R^b; nominal bonds, B^b; nominal loans, L^s; and liabilities: nominal deposits, D^s. Since reserves consist only of required reserves, i.e. $R^b = \tau D^s$, where τ denotes the reserve requirement coefficient, the banks' adding-up constraint is:

$$B^b + L^s = (1-\tau)D^s. \tag{2}$$

Assuming that the desired structure of banks' portfolio is a function of rates of return on loans and bonds, the loan supply is:

$$L^s = \Gamma(I_l, I_b)D^s(1-\tau) \qquad \text{with } \Gamma_{I_l} > 0, \Gamma_{I_b} < 0, \tag{3}$$

where Γ is the proportion of deposits out of required reserves that banks wish to hold under credit form. The loan supply is an increasing function of the loan interest rate. This means that the price of loans is perfectly flexible and clears the loan market. Due to the substitution effect, it is a decreasing function of the bond interest rate. In order to simplify our expressions we write hereafter each variable as a deviation around the steady state: we write, for instance for an X variable, x as a deviation in percentage (or in logarithm): $x = \log \frac{X}{X_0} \simeq \frac{X - X_0}{X_0}$. Therefore, for a given reserve requirement coefficient, the linear form of the loan supply function (3) is:

$$l^s = \gamma_l i_l - \gamma_b i_b + d^s, \tag{4}$$

with γ_l and γ_b standing for the loan interest rate and the bond interest rate elasticities of loan supply respectively. In the credit market, borrowers choose between loans and bonds according to the interest rates on the two instruments. The nominal loan demand is:

$$l^d = p - \lambda_l i_l + \lambda_b i_b + \lambda_y y, \tag{5}$$

with λ_l, λ_b, and λ_y denoting the loan interest rate, the bond interest rate and the income elasticities of loan demand respectively, y the real output, and p the price of output. The positive dependence on income captures the transactions demand for credit which might arise from working capital or liquidity considerations.

We ignore cash and we do not model the deposit supply while assuming that it is determined by shocks to deposit demand. Hence, the nominal supply of deposits is equal, for a given reserve requirement ratio, to bank reserves r_b:

$$d^s = r_b. \tag{6}$$

The nominal demand for deposits d^d depends positively on the real income and negatively on the bond interest rate:

$$d^d = p + \beta_y y - \beta_b i_b, \tag{7}$$

where β_b and β_y are the bond interest rate and the income elasticities of deposit demand respectively.

As in Dibooglu and Kutan (2001) we assume an imperfect capital mobility, thus the equation of the overall balance of payments is written as:

$$b \equiv -zy + \rho(e + p^* - p) + k(i_c - i_c^*), \tag{8}$$

with e the nominal exchange rate expressed as the domestic currency price per unit of foreign currency, z the imports elasticity of output demand, p^* the price of foreign output, and i_c^* the foreign interest rate. The current account is determined by the level of output at home in relation to output abroad (assumed fixed and hence omitted) and the real exchange rate. The positive coefficient on the real exchange rate, ρ, assumes that the Marshall-Lerner condition holds. The capital account is determined by the home interest rate in relation to the interest rate abroad. The parameter k represents the degree of capital mobility and large values of k indicate higher levels of capital mobility. In case of a purely flexible exchange rate system the balance of payments converges towards zero in equilibrium ($b = 0$) because by definition there is no foreign exchange intervention. However, in a fixed exchange rate system with sterilized intervention, $b = r_c$ where r_c is the amount of international reserves needed to clear the foreign exchange market. To illustrate what is meant by sterilization policy, consider the following simplified balance sheet of the central bank:

$$r_c + b_g = r_b + b_c, \tag{9}$$

with b_g government bonds and b_c central bank securities, meaning that there is net indebtedness of the central bank towards commercial banks. As will be shown below, a monetary tightening leads to an increase in international reserves and to a decrease in output, in prices and hence, given (6) and (7), to an endogenous decrease in banking reserves. We consider that the central bank completely neutralizes the effects that its intervention in the foreign exchange market has on the monetary base. Therefore, sterilization operations imply an increase in b_c such that $db_c = dr_c - dr_b$ or, alternatively, monetary authorities can proceed to an outright sale of government bonds (i.e. to a decrease in b_g such that $db_g = dr_b - dr_c$). In practice, the second possibility was seldom used by Polish monetary authorities.

With foreign income and consumption being exogenous, the real net demand for domestic goods is given by:

$$y = -\theta_l i_l - \theta_b i_b - zy + \rho(e + p^* - p), \tag{10}$$

with θ_l, θ_b, and z the loan interest rate, the bond interest rate, and the imports elasticities of output demand respectively.

In accordance with Walras's law, we do not need to consider the bond market.

The aggregate supply function is derived from the following four equations:

$$
\begin{aligned}
y &= a + \alpha n \qquad \text{with } \alpha \in]0;1[, && (11)\\
p &= w - a + (1-\alpha)n, && (12)\\
w &= \sigma p_c \qquad \text{with } \sigma \in [0;1[, && (13)\\
p_c &= \chi p + (1-\chi)(e + p^*), && (14)
\end{aligned}
$$

with n labor, w wages, a total labor productivity, p_c the consumer price index, and σ measuring the degree of nominal rigidities in the labor market. Equation (11) is a production function, (12) is a price setting equation issued from the profit maximization condition in a perfect competition framework, (13) is a wage setting equation, and (14) defines the consumer price index as a weighted average of the price of home goods and the price of imported goods. We assume an influence of price variations on real wages due to an imperfect adjustment of nominal wages: $\sigma < 1$. The bigger the nominal rigidities are, the smaller σ is. Using (11), (12), (13), and (14) the aggregate supply curve can be written as:

$$y = \kappa_0 + \kappa_1 p - \kappa_2 e, \tag{15}$$

with $\kappa_0 = \frac{a - \alpha\sigma p^*(1-\chi)}{1-\alpha}$, $\kappa_1 = \frac{\alpha(1-\sigma\chi)}{1-\alpha}$, $\kappa_2 = \frac{\alpha\sigma(1-\chi)}{1-\alpha}$.

Finally, given our supposition that the bond interest rate is equal to the intervention rate, i.e. $i_b = i_c$, the general equilibrium of the model is solved for (y, p, i_l, r_b) and e (under a flexible rate system) or r_c (under a fixed rate system with sterilized intervention), using the following system of five equations:

$$
\begin{cases}
\text{(IS)} \quad y = -\theta_l i_l - \theta_b i_c - zy + \rho(e + p^* - p),\\
\text{(LM)} \quad p + \beta_y y - \beta_b i_c = r_b,\\
\text{(BP)} \quad b \equiv -zy + \rho(e + p^* - p) + k(i_c - i_c^*),\\
\text{(CR)} \quad p - \lambda_l i_l + \lambda_b i_c + \lambda_y y = \gamma_l i_l - \gamma_b i_c + r_b,\\
\text{(AS)} \quad y = \kappa_0 + \kappa_1 p - \kappa_2 e.
\end{cases} \tag{16}
$$

3.2 Comparative Statics of an Interest Rate Monetary Shock in the Two Exchange Rate Systems

As shown below, all different multipliers in both exchange rate systems can be expressed as a function of the variations in the interest rate spread between intervention and loan rates.

Let us first consider the fixed exchange rate system with sterilized intervention. Using (16) with $b = r_c$, the comparative statics of a monetary policy shock assimilated to a change in the intervention rate can be shown to take the following form:

$$\left(\frac{di_l}{di_c}\right)_{sa} = \frac{\kappa_1\theta_b(\beta_y - \lambda_y) + (\lambda_b + \gamma_b + \beta_b)\left[\rho + \kappa_1(1+z)\right]}{\kappa_1\theta_l(\lambda_y - \beta_y) + (\lambda_l + \gamma_l)\left[\rho + \kappa_1(1+z)\right]}, \tag{17}$$

$$\left(\frac{dy}{di_c}\right)_{sa} = -\frac{\kappa_1\left[\theta_l\left(\frac{di_l}{di_c}\right)_{sa} + \theta_b\right]}{\rho + \kappa_1(1+z)}, \tag{18}$$

$$\left(\frac{dp}{di_c}\right)_{sa} = -\frac{\theta_l\left(\frac{di_l}{di_c}\right)_{sa} + \theta_b}{\rho + \kappa_1(1+z)}, \tag{19}$$

$$\left(\frac{dr_c}{di_c}\right)_{sa} = \frac{(\rho + z\kappa_1)\left[\theta_l\left(\frac{di_l}{di_c}\right)_{sa} + \theta_b\right]}{\rho + \kappa_1(1+z)} + k, \tag{20}$$

$$\left(\frac{dr_b}{di_c}\right)_{sa} = \left(\frac{dp}{di_c}\right)_{sa} + \beta_y\left(\frac{dy}{di_c}\right)_{sa} - \beta_b. \tag{21}$$

Let us now consider a pure floating exchange rate system. Using (16) with $b = 0$, the comparative statics results of a monetary shock can be written as:

$$\left(\frac{di_l}{di_c}\right)_{fa} = \frac{(\theta_b + k)(\beta_y - \lambda_y) + \lambda_b + \gamma_b + \beta_b}{\theta_l(\lambda_y - \beta_y) + \lambda_l + \gamma_l}, \tag{22}$$

$$\left(\frac{dy}{di_c}\right)_{fa} = -\left[\theta_l\left(\frac{di_l}{di_c}\right)_{fa} + \theta_b + k\right], \tag{23}$$

$$\left(\frac{dp}{di_c}\right)_{fa} = -\frac{(\rho + z\kappa_2)\left[\theta_l\left(\frac{di_l}{di_c}\right)_{fa} + \theta_b + k\right] + k\kappa_2}{\rho(\kappa_1 - \kappa_2)}, \tag{24}$$

$$\left(\frac{de}{di_c}\right)_{fa} = -\frac{(\rho + z\kappa_1)\left[\theta_l\left(\frac{di_l}{di_c}\right)_{fa} + \theta_b + k\right] + k\kappa_1}{\rho(\kappa_1 - \kappa_2)}, \tag{25}$$

$$\left(\frac{dr_b}{di_c}\right)_{fa} = \left(\frac{dp}{di_c}\right)_{fa} + \beta_y\left(\frac{dy}{di_c}\right)_{fa} - \beta_b. \tag{26}$$

There is one theoretical ambiguity concerning these results. If the income elasticity of deposit demand, β_y, is different from the income elasticity of loan demand, λ_y, then the sign of the interest rate multipliers (17) and (22) is indeterminate and, as a result, it is also the case of the signs of all other multipliers in both regimes. Theoretically, we can solve these ambiguities directly by assuming that (17) and (22) are positive:

$$\left(\frac{di_l}{di_c}\right)_{sa} > 0 \text{ and } \left(\frac{di_l}{di_c}\right)_{fa} > 0. \tag{H1}$$

In this case, a rise in the intervention rate will lead to a decrease in output, in prices and in banking reserves in both systems but also to an increase in international reserves in the fixed rate system and to an appreciation of the nominal exchange rate in the floating rate system.

Empirically, provided that the model and the corresponding exchange rate systems are a good description of the economy, all these ambiguities will not occur if a positive correlation is found between the intervention rate and the loan rate. In the next section, we present the empirical results indicating that the loan rate was an increasing function of the intervention rate in the period under consideration.

3.3 The Variations in the Interest Rate Spread as an Indicator of Amplification and Attenuation Regimes

In order to distinguish between different bank lending channel regimes we need to define a standard AD/AS model as a benchmark model. This is readily done by assuming perfect substitution between bank credit and bonds. The above augmented model (16) then collapses to a model of the form:

$$\begin{cases} \text{(IS)} \quad y = -(\theta_l + \theta_b)i_c - zy + \rho(e + p^* - p), \\ \text{(LM)} \; p + \beta_y y - \beta_b i_c = r_b, \\ \text{(BP)} \; b \equiv -zy + \rho(e + p^* - p) + k(i_c - i_c^*), \\ \text{(AS)} \quad y = \kappa_0 + \kappa_1 p - \kappa_2 e. \end{cases} \tag{27}$$

For the fixed exchange rate system, the multipliers corresponding to the above model (27) (with $b = r_c$) are:

$$\left(\frac{dy}{di_c}\right)_{sm} = -\frac{\kappa_1(\theta_l + \theta_b)}{\rho + \kappa_1(1+z)} < 0, \tag{28}$$

$$\left(\frac{dp}{di_c}\right)_{sm} = -\frac{\theta_l + \theta_b}{\rho + \kappa_1(1+z)} < 0, \tag{29}$$

$$\left(\frac{dr_c}{di_c}\right)_{sm} = \frac{(\rho + z\kappa_1)(\theta_l + \theta_b)}{\rho + \kappa_1(1+z)} + k > 0, \tag{30}$$

$$\left(\frac{dr_b}{di_c}\right)_{sm} = \left(\frac{dp}{di_c}\right)_{sm} + \beta_y \left(\frac{dy}{di_c}\right)_{sm} - \beta_b < 0. \tag{31}$$

While under a pure float the comparative statics results of a monetary shock issued from (27) (with $b = 0$) can be written as:

$$\left(\frac{dy}{di_c}\right)_{fm} = -(\theta_l + \theta_b + k) < 0, \tag{32}$$

$$\left(\frac{dp}{di_c}\right)_{fm} = -\frac{(\rho + z\kappa_2)(\theta_l + \theta_b + k) + k\kappa_2}{\rho(\kappa_1 - \kappa_2)} < 0, \tag{33}$$

$$\left(\frac{de}{di_c}\right)_{fm} = -\frac{(\rho + z\kappa_1)(\theta_l + \theta_b + k) + k\kappa_1}{\rho(\kappa_1 - \kappa_2)} < 0, \tag{34}$$

$$\left(\frac{dr_b}{di_c}\right)_{fm} = \left(\frac{dp}{di_c}\right)_{fm} + \beta_y \left(\frac{dy}{di_c}\right)_{fm} - \beta_b < 0. \tag{35}$$

We now derive the conditions under which the bank lending channel amplifies or attenuates the impact of monetary policy shocks:

1) on output, prices and international reserves in the fixed rate system with sterilized intervention, using the expressions (18), (28), (19), (29), (20), and (30);

2) on output, prices and the nominal exchange rate in the floating rate system, using the expressions (23), (32), (24), (33), (25), and (34).

In the amplification regime, the impact of monetary policy on the aforementioned variables in both systems is higher in the augmented model than in the standard AD/AS model. Having solved these inequalities[8], we deduct (see Table 4) that this situation corresponds to an increase (decrease) in the interest rate spread between the bank lending rate and the intervention rate in the case of a restrictive (expansionary) monetary policy.

Table 4. Characteristics of an Amplification Regime

Fixed Rate System with Sterilized Intervention	Flexible Rate System
$\begin{cases} \left(\frac{dy}{di_c}\right)_{sa} - \left(\frac{dy}{di_c}\right)_{sm} < 0 \\ \left(\frac{dp}{di_c}\right)_{sa} - \left(\frac{dp}{di_c}\right)_{sm} < 0 \\ \left(\frac{dr_c}{di_c}\right)_{sa} - \left(\frac{dr_c}{di_c}\right)_{sm} > 0 \end{cases} \Rightarrow \left(\frac{di_l}{di_c}\right)_{sa} > 1$	$\begin{cases} \left(\frac{dy}{di_c}\right)_{fa} - \left(\frac{dy}{di_c}\right)_{fm} < 0 \\ \left(\frac{dp}{di_c}\right)_{fa} - \left(\frac{dp}{di_c}\right)_{fm} < 0 \\ \left(\frac{de}{di_c}\right)_{fa} - \left(\frac{de}{di_c}\right)_{fm} < 0 \end{cases} \Rightarrow \left(\frac{di_l}{di_c}\right)_{fa} > 1$

In the attenuation regime, the impact of monetary policy on the aforementioned variables is smaller in the augmented model than in the standard AD/AS model. Solving these inequalities indicates that this situation corresponds to a decrease (increase) in the interest rate spread between the bank lending rate and the intervention rate in the case of a restrictive (expansionary) monetary policy (see Table 5).

Table 5. Characteristics of an Attenuation Regime

Fixed Rate System with Sterilized Intervention	Flexible Rate System
$\begin{cases} \left(\frac{dy}{di_c}\right)_{sa} - \left(\frac{dy}{di_c}\right)_{sm} > 0 \\ \left(\frac{dp}{di_c}\right)_{sa} - \left(\frac{dp}{di_c}\right)_{sm} > 0 \\ \left(\frac{dr_c}{di_c}\right)_{sa} - \left(\frac{dr_c}{di_c}\right)_{sm} < 0 \end{cases} \Rightarrow \left(\frac{di_l}{di_c}\right)_{sa} < 1$	$\begin{cases} \left(\frac{dy}{di_c}\right)_{fa} - \left(\frac{dy}{di_c}\right)_{fm} > 0 \\ \left(\frac{dp}{di_c}\right)_{fa} - \left(\frac{dp}{di_c}\right)_{fm} > 0 \\ \left(\frac{de}{di_c}\right)_{fa} - \left(\frac{de}{di_c}\right)_{fm} > 0 \end{cases} \Rightarrow \left(\frac{di_l}{di_c}\right)_{fa} < 1$

Finally, if the variations in different variables are exactly the same in both frameworks, then after a monetary shock we should observe an unchanged interest rate spread (see Table 6).

Table 6. Characteristics of a Neutrality Regime

Fixed Rate System with Sterilized Intervention	Flexible Rate System
$\begin{cases} \left(\frac{dy}{di_c}\right)_{sa} - \left(\frac{dy}{di_c}\right)_{sm} = 0 \\ \left(\frac{dp}{di_c}\right)_{sa} - \left(\frac{dp}{di_c}\right)_{sm} = 0 \\ \left(\frac{dr_c}{di_c}\right)_{sa} - \left(\frac{dr_c}{di_c}\right)_{sm} = 0 \end{cases} \Rightarrow \left(\frac{di_l}{di_c}\right)_{sa} = 1$	$\begin{cases} \left(\frac{dy}{di_c}\right)_{fa} - \left(\frac{dy}{di_c}\right)_{fm} = 0 \\ \left(\frac{dp}{di_c}\right)_{fa} - \left(\frac{dp}{di_c}\right)_{fm} = 0 \\ \left(\frac{de}{di_c}\right)_{fa} - \left(\frac{de}{di_c}\right)_{fm} = 0 \end{cases} \Rightarrow \left(\frac{di_l}{di_c}\right)_{fa} = 1$

Several additional comments can be made.

First, considering these results and given the expressions (21), (31), (26), and (35) it follows that the variations in the interest rate spread also enable us to distinguish between amplification and attenuation effects of the bank lending channel on banking reserves.

[8] The mathematics are straightforward when the multipliers of the credit-augmented models are written as a function of (di_l/di_c).

Second, the variations in the interest rate spread are also a good indicator of the effects of the bank lending channel on the real exchange rate in both systems. For the floating rate arrangement, the explanation originates from the fact that the real exchange rate is a decreasing function of the intervention rate: since $\kappa_1 > \kappa_2$, the impact of a monetary shock on the nominal exchange rate is higher than that on prices in the augmented model (compare (25) with (24)) as well as in the AD/AS model (compare (34) with (33)).

Third, in the fixed exchange rate system an amplified restrictive monetary policy shock leads to a stronger increase in international reserves and decrease in banking reserves and therefore to a higher volume of sterilization operations.

Fourth, a closer examination of (17) and (22) indicates that both interest rate multipliers are an increasing function of γ_b and λ_b, and a decreasing function of λ_l and γ_l. Therefore, if ceteris paribus $\gamma_l > \gamma_b$, i.e. if banks are more reactive in their credit decisions to loan interest rates as compared to monetary policy-led bond interest rates, then the response of loan rates to a change in the intervention rate will be smaller and the probability of attenuation effects will increase. The same outcome will arise if ceteris paribus $\lambda_l > \lambda_b$, i.e. if firms are "bank-dependent" borrowers having more difficult access to the bond market as compared to the loan market.

One should note that if the two main assumptions detailed in Bernanke and Blinder (1988a) apply, there will be a systematic amplification of monetary policy shocks in both exchange rate systems.

$$\text{If } \lambda_y = \beta_y \text{ and if } \left\{ \begin{array}{l} \gamma_l = \gamma_b \\ \lambda_l = \lambda_b \end{array} \right. \text{ then } \left(\frac{di_l}{di_c}\right)_{sa} = \left(\frac{di_l}{di_c}\right)_{fa} > 1. \quad (36)$$

Fifth, Poland's capital markets are fairly shallow: in March 2000, commercial bonds represented only 1.2 per cent and commercial papers only 5.8 per cent of total bank credit to enterprises (Łyziak, 2001). Hence, banks are almost the unique source of borrowed funds for the corporate sector. Moreover, according to the National Bank of Poland's monthly surveys of companies, the share of firms using bank credit grew from approximately 80 per cent in 1995 to more than 85 per cent in 1999 (Łyziak, 2001). These stylized facts make attenuation effects more likely since they suggest that the value of λ_l should be strong while that of λ_b close to zero.

4 An Empirical Assessment of the Bank Lending Channel Regimes

4.1 Data Description and Pre-testing

We analyze monthly data of a sample that runs from February 1994 to June 2001 inclusive. We use 3-month, 6-month, and 1-year minimum loan rates granted to Polish firms. The loan rates are weighted averages of interest rates applied by major banks, depending on the period (having decreased from 20 banks in February 1994 to 12 in June 2001, the difference due to the consolidation process) and representing, on average for the period under consideration, 75.2 per cent of the banking system in terms of total credit extended to firms and 84.7 per cent in terms of total deposits. Recall that the intervention rate of the central bank is defined as a weighted average of 1 to 14-day reverse repo operation rates and that of the central bank securities issued for different maturities between February 1994 and January 1998, and is equal since then to the actual rate on 28-day NBP bills (also taking into account the average rate of outright operations). These data are used to construct three different interest rate spreads defined as a difference between 3-month, 6-month, and 1-year loan rates and the intervention rate of the central bank.

Before having a closer look at the operation of the bank lending channel in Poland, we seek to verify two elements. First, we need to find out whether the loan rates and the intervention rate move in the same direction. This is the (H1) theoretical assumption of the model that must hold in order to ensure that the change in the spreads makes it possible to distinguish between attenuation and amplification regimes. Second, it is necessary to check the transmission lag from the policy rate to the loan interest rates. To this end, we use advanced and lagged correlations of monthly changes in the intervention rate with monthly changes in the loan rates. In Table 7 are shown the correlation coefficients between the variations in the intervention rate in the current month and the variations in the loan interest rates in the previous ($k < 0$), current ($k = 0$), and future ($k > 0$) month.

Table 7. Advanced and Lagged Correlations of Changes in Loan Rates with Changes in the Intervention Rate, III/94 - II/01

k	-4	-3	-2	-1	0	1	2	3	4
Δ3-Month Loan Rate/ΔIntervention Rate	0.210	0.259	0.197	0.322	**0.614**	0.422	0.229	0.178	0.193
Δ6-Month Loan Rate/ΔIntervention Rate	0.189	0.244	0.187	0.318	**0.614**	0.420	0.234	0.162	0.178
Δ12-Month Loan Rate/ΔIntervention Rate	0.207	0.216	0.152	0.292	**0.598**	0.361	0.203	0.138	0.156

Source: Own calculations.

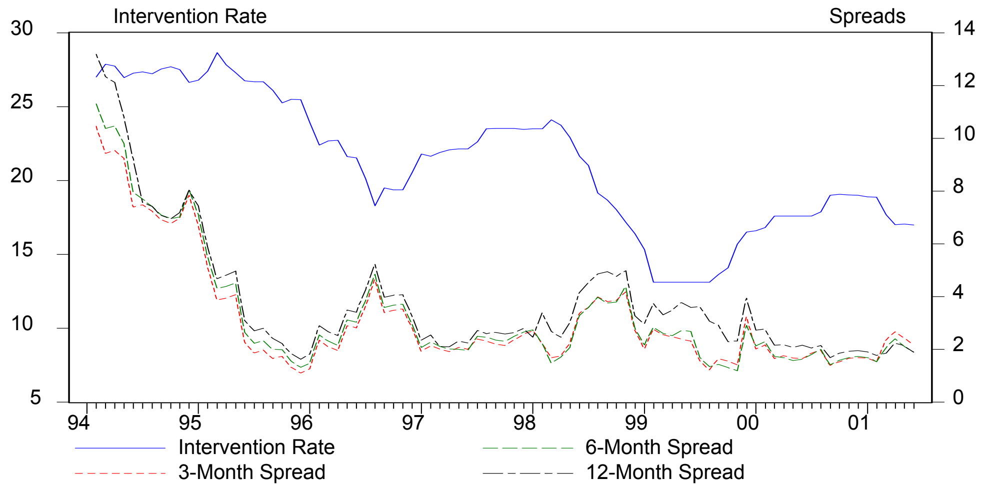
As we can see, there is a positive correlation of monthly changes in the intervention rate with monthly changes in all loan rates. Hence, the assumption (H1) of the model is satisfied.

Concerning the transmission lag, we notice the maximum correlation is obtained for $k = 0$: this indicates an instant (within the month) pass-through of policy-controlled interest rates to loan interest rates. This finding enables us to study the reaction of the spreads calculated between current loans and intervention rates to changes in the intervention rate.

4.2 Results

The visual inspection of Figure 6 shows that the period under study is not homogeneous. Recall that a scissors-like evolution of the spreads, as compared to the policy rate, indicates an attenuation regime of the bank lending channel: the spreads decrease after a rise of the central bank's rate and rise otherwise. On the other hand, a co-movement between the spreads and the intervention rate indicates an amplification regime: the spreads go up after an increase in the central bank's rate and diminish in the other case. Using this simple rule, we can distinguish three periods.

Figure 6. Intervention Rate and Interest Rate Spreads, II/94 - VI/01 (Nominal Variables)



Sources: National Bank of Poland and own calculations.

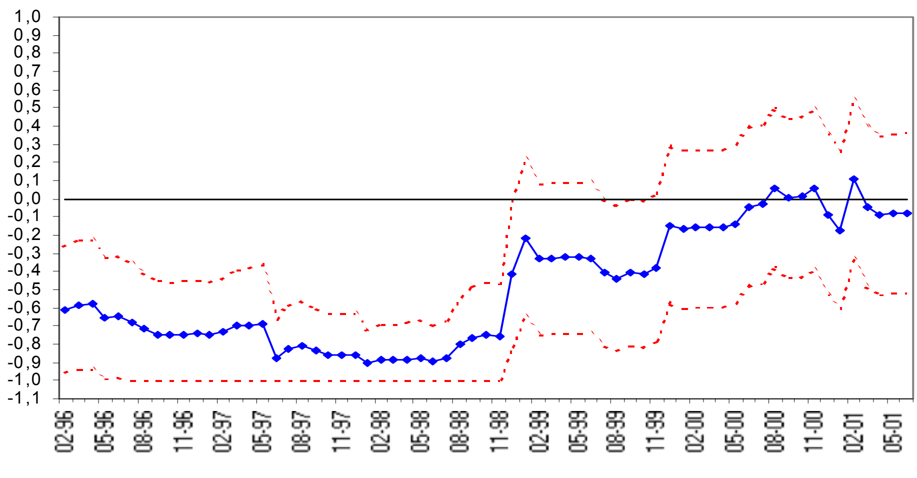
According to Osiński (1999), in 1994-1995, the reverse repo rate was the most important policy instrument acting on banking interest rates. Our analysis shows possible amplification effects of the bank lending channel in April and May 1994 and from June to December 1995 because of the observed co-movement between the spreads and the policy rate. Yet, one must take care when dealing with the first sub-period. Indeed, the important decline in all spreads resulted probably rather from the structural overliquidity of the banking system which pushed down the yield of Treasury bills (see Figure 5) and subsequently the loan interest rates, than from an enhanced monetary policy effectiveness, although there was a reduction of the intervention rate in April and May 1994. There was also an intermediate, 8-month lasting period from October 1994 to May 1995 characterized by possible attenuation effects of monetary policy. However, the February 1994-December 1995 period must be analyzed with cautiousness since in several cases, the loan rates moved significantly in the opposite direction as compared to the intervention rate (see the lefthandside of figure 10 in Appendix B).

Beginning with January 1996, it is a rather lengthy period, that lasted more than two years and a half, until November 1998, clearly indicating an almost systematically reduced potency of monetary policy. Since December 1996, the central bank tried to curb the credit and demand expansion raising its intervention rate and the rate of required reserves. Since these measures did not yield the expected results on banks' behaviour, the NBP undertook an unprecedented action. In September 1997, it began to accept 6 and 9-month deposits directly from the public at above market rates. The goal of this move was to force banks to substantially increase their deposit rates and, subsequently, their lending rates. Our analysis confirms the existence of a period of monetary policy weakness between December 1996 and April 1997.

The third and rather ambiguous period started in December 1998. We can depict several amplification episodes which occurred between December 1998 and January 1999 and sporadically for example in December 1999, February 2000 and August 2000. However, the banking sector was clearly reducing the impact of monetary shocks for instance in February 1999, March and September 2000, and in the March-April 2001 period.

To summarize and generalize our empirical results, we compute a series of rolling correlations of monthly changes in the intervention rate with monthly changes in the spread between the average of 3-month, 6-month, and 1-year loan rates and the intervention rate. All variables are stationary (cf. Appendix A). For each month in our sample we estimate a correlation coefficient using a 24-month moving window of data. For instance, the first window covers the 1994:03-1996:02 sample period. We move it one observation ahead for both the initial and last observations in order to form the second window corresponding to the 1994:04-1996:03 sample period. Altogether, this method generates 65 two-year windows.

Figure 7. Correlations of Changes in the Spread with Changes in the Intervention Rate Over Time, III/96 - VI/01 (Nominal Variables)



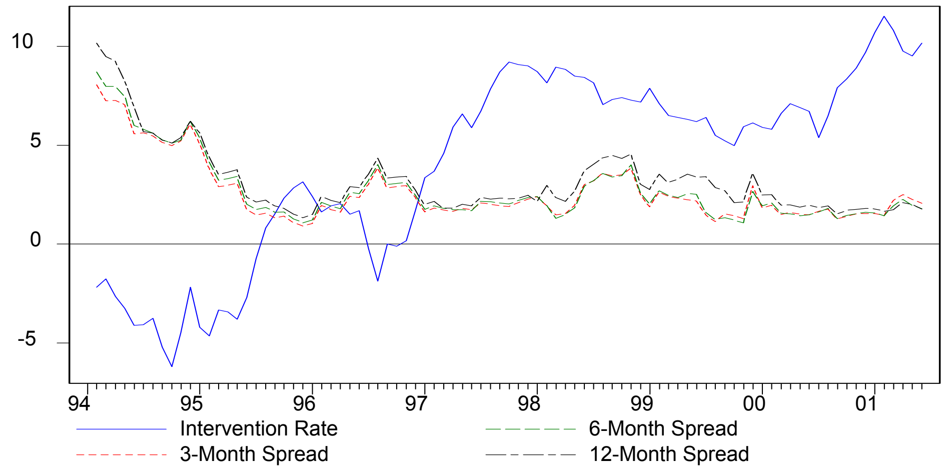
Source: Own calculations.

Notes: a) 95 per cent confidence bands. b) The lower band has been bounded at -1.

As can be seen from Figure 7, the estimated correlation coefficient remains significantly negative and stable until November 1998, signalling on average a substantially reduced monetary policy transmission. Since then, the correlation coefficient is virtually never significantly different from zero, indicating on average the existence of a neutral bank lending channel regime.

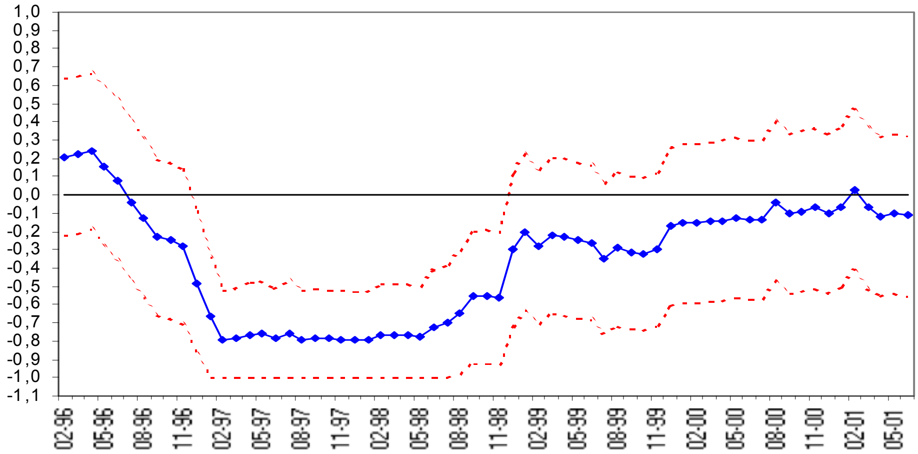
When using real ex post spreads and intervention rates, the analysis does not yield systematically identical results to the nominal specification (see Figures 8 and 9). The reason for this is that given the evolution of the inflation rate, the real and nominal intervention rates did not necessarily move in the same direction, especially in the 1994-1995 period. As shown in Figure 9, the correlation coefficient is positive and increases until April 1996, which would indicate on average a rather amplified action of the bank lending channel. Yet, the estimates are not significantly different from zero. Then, the results presented in Figure 9 mainly confirm what is predicted by the nominal rate analysis, i.e. the existence of an attenuation regime until the end of 1998 and on average a neutral effect of the bank lending channel in the transmission mechanism since then.

Figure 8. Intervention Rate and Interest Rate Spreads, II/94 - VI/01 (CPI Adjusted Variables)



Sources: National Bank of Poland and own calculations.

Figure 9. Correlations of Changes in the Spread with Changes in the Intervention Rate Over Time, III/96 - VI/01 (CPI Adjusted Variables)



Source: Own calculations.

Notes: a) 95 per cent confidence bands. b) The lower band has been bounded at -1.

5 Conclusion

In this paper we have developed an open-economy credit-augmented model of the transmission mechanism. The extensions include an interest rate control with flexible prices, an imperfect nominal wage indexation and capital mobility under two different exchange rate systems: a fixed rate with sterilized intervention and a pure floating rate. Our results appears to yield an important information for policymakers, eager to find out the desired level of monetary conditions. We established that in both exchange rate arrangements, the bank lending channel may amplify as well as attenuate the action of the traditional interest rate and exchange rate channels. We found that the change in the interest rate spread between a loan rate and a policy rate is a good indicator of the bank lending channel regimes since it enables ultimately to gauge the effectiveness of monetary policy impulses. If the pass-through of policy-controlled interest rates to loan rates is less (more) than one, this implies a reduced (increased) impact on prices, output, banking reserves, and the real exchange rate in both systems and on central bank's foreign reserves in the fixed rate system: the bank lending channel will therefore weaken (strengthen) the working of the "classic" interest rate and exchange rate channels. An important explanatory factor of amplification and attenuation regimes is the sensitivity of banks and firms to loan and market interest rates. Even though these results require a positive relationship between loan rates and the policy rate, this is a highly probable outcome. Empirically, treating the subject of short-term bank lending to firms, we sought to give an insight into the interactions between the commercial banking sector and the monetary authorities in the transmission of monetary policy during Polish transition. Our analysis shows that the bank lending channel was reducing the overall potency of monetary policy from the beginning of 1996 to the end of 1998 and had on average a neutral effect since then. This could indicate that the effectiveness of monetary policy transmission increases as the transition process develops.

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Appendix A. Integration tests

In order to detect the presence of unit roots, we conduct standard Augmented Dickey-Fuller and Phillips-Perron tests (hereafter ADF and PP respectively). The optimal lag number for ADF tests is chosen to account for autocorrelation of residuals (using the Schwartz Bayesian criterion), and for PP tests according to the Newey-West criterion, which points at 3 lags in our case. The results are reported in Table 8. It can be concluded that the monthly changes in all variables are stationary as the null hypothesis of a unit root is rejected at the 1 per cent significance level in each case.

Table 8. Augmented Dickey-Fuller and Phillips-Perron Tests

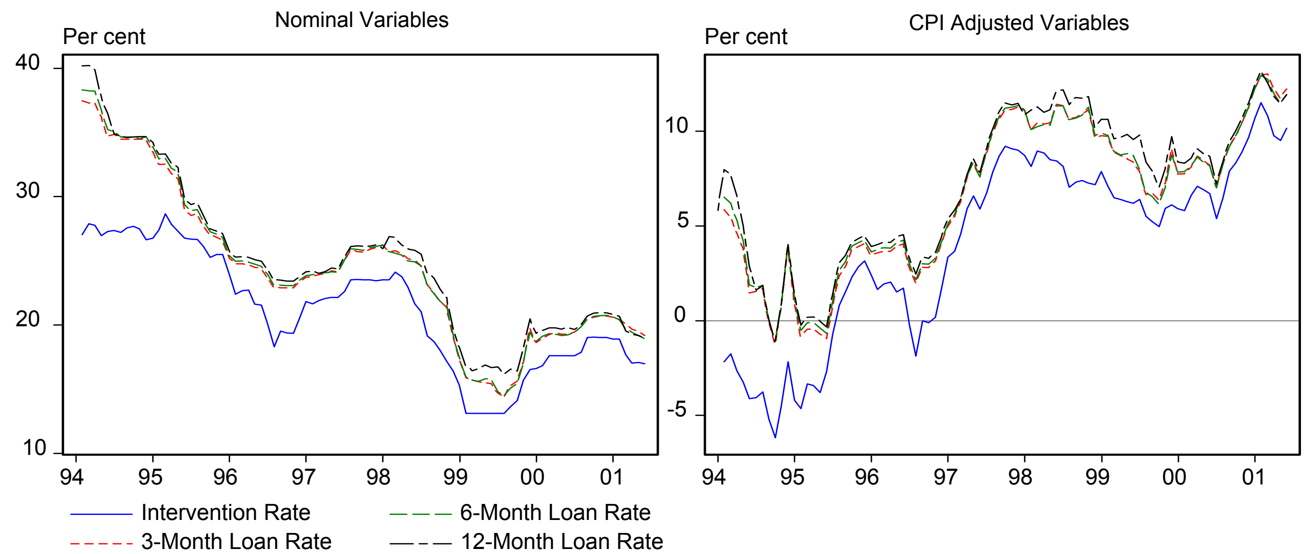
Variable	Period	Number of Lags in ADF Test	ADF Statistics		PP Statistics	
			With Constant	Without Constant	With Constant	Without Constant
ΔIC	III/94-VI/01	0	-6.43	-6.31	-6.46	-6.35
ΔIC	III/94-II/01	0	-6.25	-6.17	-6.29	-6.22
ΔICR	III/94-VI/01	2	-4.15	-3.98	-7.22	-7.13
ΔIB3M	III/94-VI/01	2	-3.52	-3.37	-6.14	-5.98
ΔIB6M	III/94-VIII/98	0	-4.28	-3.85	-4.21	-3.74
ΔIB12M	III/94-VI/01	0	-5.32	-5.08	-5.23	-4.96
ΔIB12M	I/95-XII/98	0	-4.38	-4.06	-4.72	-4.44
ΔSPR	III/94-VI/01	0	-8.52	-8.37	-8.51	-8.37
ΔSPRR	III/94-VI/01	0	-8.78	-8.67	-8.77	-8.67

Source: Own calculations.

Notes: IC(R): nominal (CPI-deflated) intervention rate, IB3M(6M,12M): 3(6,12)-month Treasury bill rate, SPR(R): nominal (CPI deflated) average interest rate spread.

Appendix B. Interest Rate Series

Figure 10. Intervention Rate and Loan Interest Rates, II/94 - VI/01



Sources: National Bank of Poland and own calculations.