The Multi-Regime Bank Lending Channel and the Effectiveness of the Polish Monetary Policy Transmission During Transition[1]

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Abstract

In this paper, we examine the consequences of interactions between the bank lending channel and the traditional interest rate and exchange rate channels on the effectiveness of monetary policy transmission in Poland since 1994. Using a dynamic small open-economy model, we show that the bank lending channel may either amplify or attenuate the impact of monetary policy shocks. The direction of change in the spread between a loan rate and a policy rate is a useful indicator of different regimes. Empirically, we find evidence of an attenuation regime from 1996 to 1998 and of a neutral effect of the bank lending channel on average, after that time.

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1 Introduction

Monetary policy actions transmitted through various interrelated transmission channels have a significant impact on real economic activity, at least in the short run, and on inflation. After more than a decade since the beginning of transition, Polish capital markets are still relatively thin compared to international standards and the Polish financial system is dominated by banks. Given these stylized facts, we investigate the role played by the banking sector in the transmission of monetary policy in Poland from 1994 until the beginning of 2002. More specifically, we study the consequences of interactions between the bank lending channel and the traditional interest rate, or money, and exchange rate channels. The difficulties encountered by the authorities in seeking to control credit aggregates indicates that the Polish banking sector plays a key role in the effectiveness of monetary policy actions during the 1990s (Polański, 1998).

The main conclusion of the seminal model of the bank lending channel by Bernanke and Blinder (1988) is that this transmission channel amplifies monetary policy actions when compared to the traditional interest rate channel. As Bernanke (1993), Kashyap et al. (1993) and Bernanke and Gertler (1995) emphasize, the model predicts that 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) if monetary policy is restrictive (expansionary). Following Dale and Haldane (1993 and 1998) and using the model of Bernanke and Blinder (1988), Kierzenkowski (2003) shows that the bank lending channel may either amplify or attenuate the effects of the traditional interest rate channel because the result of systematic amplification of monetary policy impulses is dependent on several specific assumptions made by Bernanke and Blinder (1988).[2] This author also establishes that, after a monetary policy shock, the direction of change in the spread between loan and bond interest rates tends to be a good indicator of attenuation and amplification regimes. Following a monetary tightening (expansion), the interest rate spread increases (decreases) in the event of amplification effects and decreases (increases) if monetary policy shocks are attenuated.

However, these testable implications are not valid for Poland because the National Bank of Poland

[2]The existence of these additional assumptions is indicated in the published American Economic Review Papers and Proceedings version and details are provided in the NBER No. 2534 working paper version.

(hereafter, NBP) controls the interest rate while the model in Bernanke and Blinder (1988) assumes a base money targeting. In this paper, the impact of an interest rate control within a Bernanke - Blinder framework is examined. We consider a dynamic small open-economy model with sluggish price adjustment, imperfect nominal wage indexation, and capital mobility under two different exchange rate systems, namely, a fixed one with sterilized intervention and a floating one. Within this framework, a multi-regime bank lending channel evolves. Our main objective in section 2 is to derive the theoretical conditions that are necessary so that the direction of change in the interest rate spread between a loan rate and the central bank's intervention rate is an indicator of the different regimes. In section 3, we investigate empirically the impact of the bank lending channel on the potency of monetary policy transmission to the corporate sector during the Polish transition based on testable hypotheses from the model. A detailed analysis of the Polish loan market indicates that the bank lending channel is likely to be an important component of the transmission mechanism. Hence, the pass-through of the headline rate to loans rates is used to examine the bank lending channel. We identify two regimes, the existence of which is supported by the results of empirical studies and also several stylized facts. Finally, dynamic simulations of the model provide further insight into the transmission of monetary policy impulses. Section 4 concludes with policy implications.

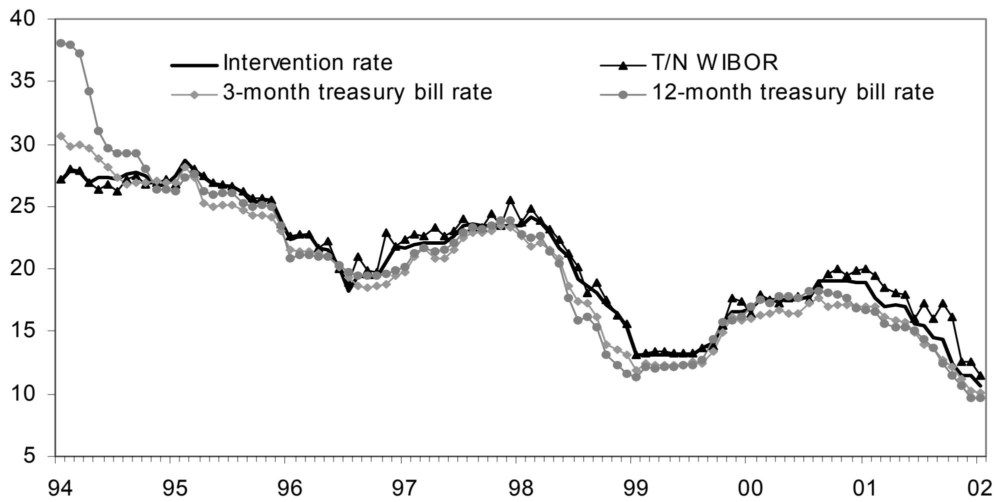
2 The Model

In the closed-economy model developed by Bernanke and Blinder (1988), monetary policy is characterized by the authorities' control over banking reserves, assuming fixed prices. In a deterministic environment without any stochastic disturbances, we invert the policy rule, by modeling the central bank as operating on interest rates rather than controlling base money. The interest rate control assumption reflects the actual conduct of monetary policy in Poland since 1994 and is often used in empirical studies on Poland, e.g., Gottschalk and Moore (2001). According to Osiński (1999) and Sławiński and Osiński (1997 and 1998), the NBP was setting a one-day reverse repo interest rate, and was controlling the tomorrow to the next day Warsaw Interbank Offer Rate (T/N WIBOR) in the 1994 to 1995 period.[3]

[3]A reverse repo operation is a means of absorbing banking reserves temporarily by selling securities under an agreement subsequently to repurchase them. The tomorrow to the next day Warsaw Interbank Offer Rate is the interbank rate charged to borrowers for two-day loans.

During the 1996 to 1997 period, the main interest rate instrument was a 14-day reverse repo rate. Since February 1998, the Monetary Policy Council has set the minimum yield of the NBP's securities. For the period under study from February 1994 to February 2002, these interest rates were used in open-market operations to absorb the excess liquidity of the banking system created by a combination of strong capital inflows and the fixed exchange rate policies followed until the late 1990s.[4] We calculated a single NBP intervention rate as a weighted average of 1 to 14-day reverse repo rates and that of the central bank securities issued for different maturities between February 1994 and January 1998 and, after that, we set the rate equal to the actual rate on 28-day NBP bills.[5] As Figure 1 shows, our indicator of monetary policy stance is almost equal to the tomorrow to the next day interbank interest rate; since August 1994, it has been very close to the yield of three-month and one-year treasury bills.

Figure 1. Intervention, T/N WIBOR, and Treasury Bill Interest Rates



Source: National Bank of Poland and own calculations.

Given these observations, we assume, for the sake of simplicity, that the bond interest rate of the model[6] is equal to the intervention rate. In the model, we use both terms interchangeably.

[4]We define excess liquidity as a positive net level of banks' holdings of central bank debt.

[5]The indicator also includes the average rate of outright sales, which were used systematically since September 2000 but seldom before that date. An outright sale is a permanent sale of securities by the central bank in the open market intended to reduce banking reserves. Kokoszczyński (1999) uses a comparable indicator of the monetary policy stance.

[6]Bernanke and Blinder (1988) use the three-month treasury bill interest rate as a proxy for the bond interest rate.

To take account of policy differences during the period under study, we model two exchange rate systems. The fixed-rate system with sterilized intervention applies to the period ranging from 1994 to June 1999. It was characterized by capital inflows and large sterilization operations under the crawling-peg, and from May 1995 onwards, the crawling-band exchange rate system. The gross official reserves of the central bank increased by \$ 23 billion between 1995 and 1998. In addition, Bofinger and Wollmershäuser (2002) find an absolute value as high as 0.89 for the sterilization coefficient from December 1991 to September 1998 in Poland. The second exchange rate system modeled is a pure float. Although pinpointing the precise date of its implementation is difficult, the float was adopted officially in April 2000. Nevertheless, several stylized facts suggest that the system was actually adopted earlier than this date. The range of the fluctuation band of the zloty was widened to $\pm$10% in February 1998, to $\pm$12.5% in October 1998, and finally to $\pm$15% in March 1999, with the monthly rate of crawl being equal to 0.8%, 0.5% and 0.3%, respectively. At the same time, the central bank stopped its direct interventions on the foreign exchange market from the end of July 1998 onwards and its indirect interventions by abolishing fixing transactions starting in June 1999. For our purpose, we consider the floating exchange rate system to have been instituted in July 1999, although some other date between October 1998 and June 1999 would also be reasonable because of the additional exchange rate flexibility allowed during that period.

In addition, we assume that the prices of goods are perfectly flexible at the steady-state. However, since we intend to analyze the medium-run impact of monetary policy, we assume imperfect indexation of nominal wages to the consumer price level.[7] As is standard in the literature, we introduce a bank lending channel in the aggregate-demand-and-supply framework (hereafter, AD/AS) that functions in addition to the interest rate and the exchange rate channels. Bonds and loans are assumed to be imperfect substitutes both on the asset side of the banks's balance sheets and on the liability side of the firms' balance sheets.

The loan supply is derived from the following simplified banks' balance sheet, which ignores net worth:

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

[7]When the nominal interest rate is the monetary instrument, as in our case, the latter assumption avoids any indeterminacy problems in modeling the flexible exchange rate system.

where R^b denotes nominal reserves, B^b is nominal bonds, L^s is nominal loans, and on the liability side, D^s represents nominal deposits. 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 given by:

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

where Γ is the proportion of deposits out of required reserves that banks wish to hold in credit form. Loan supply is an increasing function of the loan interest rate I_l, which implies that the price of loans is perfectly flexible and clears the loan market. Due to the substitution effect, loan supply is a decreasing function of the bond interest rate I_b. In order to simplify the formula, each variable is written as a deviation from its trend.[8] Therefore, for a given reserve requirement coefficient, the linear form of the loan supply function (3) is written as:

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

with γ_l and γ_b representing the loan interest rate and the bond interest rate elasticities of loan supply, respectively. In the credit market, borrowers choose between loans and bonds depending on the interest rates on the two instruments. Thus, nominal loan demand is given by:

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

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. In addition y is the real output and p is the domestic output price index. The positive dependence on income captures the transaction demand for credit, which arises from working capital or liquidity considerations.

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

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

[8]For example, for variable X, x is a deviation in percentage, or in logarithm, such that: $x = \log(\frac{X}{X_0}) \simeq \frac{X - X_0}{X_0}$.

The nominal demand for deposits, denoted d^d, depends positively on real income and negatively on the bond interest rate so that we write:

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

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

With foreign income exogenous, the real demand for domestic goods is given by:

$$y = \mu[g - \theta_l i_l - \theta_b i_b + \rho(e - p)], \tag{8}$$

with $\mu \equiv 1/(1-c) > 0$. In addition, c characterizes the multiplier process, g is a shift parameter and θ_l and θ_b are the loan interest rate and bond interest rate elasticities of output demand, respectively.[9]

Following Dibooglu and Kutan (2001), we assume imperfect capital mobility. Thus, the equation of the overall balance of payments is written as:

$$b \equiv \rho(e - p) + k(i_c - i_c^* - \dot{e}^E), \tag{9}$$

with e denoting the nominal exchange rate expressed as the domestic currency price per unit of foreign currency and i_c^* representing the foreign interest rate.[10] The foreign price level is normalized to zero in logs. The term denoted $\dot{e}^E$ is the expected rate of depreciation; the dot over the variable denotes its time derivative. In the case of a credible fixed exchange rate system, $\dot{e}^E = 0$. Under the floating exchange rate system, we assume a rational expectations formation for the rate of change of the exchange rate, which amounts to perfect foresight in a deterministic setting, so that we have $\dot{e}^E = \dot{e}$. Moreover, $\dot{e}$ is proportional to the gap between the spot exchange rate, e, and its steady-state value, denoted by $\bar{e}$:[11]

$$\dot{e} = \Theta(\bar{e} - e) \qquad \text{with } \Theta > 0. \tag{10}$$

Following Frenkel and Rodriguez (1982), the current account is assumed to be determined in equation (9) only by the real exchange rate.[12] The positive coefficient on the real exchange rate, ρ, assumes that the Marshall-Lerner condition holds.[13] The capital account is determined by the discrepancy between

[9] If the interest rates are entered in level form, γ_l, γ_b, λ_l, λ_b, β_b, θ_l and θ_b are semi-elasticities. When calibrating the model, we treat these parameters as semi-elasticities.

[10] Foreign country variables are marked with an asterisk.

[11] As demonstrated by Dornbusch (1976), the perfect foresight assumption implies that the coefficient of exchange rate expectations, Θ, in equation (10) must be consistent with the structure of the entire model.

[12] The assumption that the current account is independent of the level of domestic and foreign demand avoids issues of stability without modifying the qualitative results of the analysis.

[13] Aglietta et al. (2003) confirm the validity of this assumption in the Polish case. The sum, in absolute value, of import and export price elasticities is estimated to be 1.9 over their sample period from first quarter 1993 to first quarter 2001.

net capital returns and the parameter representing the degree of capital mobility, which is denoted k in equation (9).

For a purely flexible exchange rate system, the balance of payments converges towards zero in equilibrium, i.e., $b = 0$, because no foreign exchange intervention is allowed by definition. However, in a fixed exchange rate system with sterilized intervention, $b = \dot{r}_c^*$ where $\dot{r}_c^*$ is the rate of change of international reserves in terms of foreign currency necessary to clear the foreign exchange market.[14] To illustrate sterilization policy, we take the following simplified balance sheet of the central bank:

$$R^c = R^b + B^c, \tag{11}$$

with R^c representing foreign reserves and B^c denoting central bank securities, implying net indebtedness of the central bank towards commercial banks. Let η denote the initial share of B^c in banking reserves R^b. Recalculating equation (11) in terms of deviations from the steady-state, we have:

$$r_c = \frac{1}{1+\eta}\left(r_b + \eta b_c\right). \tag{12}$$

As we will show below, monetary tightening leads to a decrease in output, in prices, and, given (6) and (7), an endogenous decrease in banking reserves. We assume that the central bank neutralizes completely 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 $db_c = \frac{1+\eta}{\eta}dr_c - \frac{1}{\eta}dr_b$.

Applying Walras's law, we ignore the bond market.

Regarding aggregate supply, the corresponding function is derived from the following four equations:

$$y_p = a + \alpha n \qquad \text{with } \alpha \in]0;1[, \tag{13}$$

$$p = w - a + (1-\alpha)n, \tag{14}$$

$$w = \sigma p_c \qquad \text{with } \sigma \in [0;1[, \tag{15}$$

$$p_c = \chi p + (1-\chi)e, \tag{16}$$

where n designates labor, w is wages, a is total labor productivity, p_c is the consumer price index, and σ measures the degree of nominal rigidities in the labor market. Equation (13) is a production function, while (14) is a price-setting equation derived from profit maximization in a perfect competition

[14] Due to lack of space, details of the log-linearization of the balance of payments equation is not developed; but Wdowiński and van Aarle (2001) provide details.

framework. In addition, (15) is a wage–setting equation and (16) defines the consumer price index as a weighted average of the price of home goods and the price of imported goods. We assume that price variations affect real wages because of imperfect adjustment of nominal wages so that $\sigma < 1$. The bigger are the nominal rigidities, the smaller is σ. Using (13), (14), (15), and (16), the aggregate supply curve can be written as:

$$y^s = \kappa_0 + \kappa_1 p - \kappa_2 e, \tag{17}$$

with $\kappa_0 = \frac{a}{1-\alpha}, \kappa_1 = \frac{\alpha(1-\sigma\chi)}{1-\alpha}$, and $\kappa_2 = \frac{\alpha\sigma(1-\chi)}{1-\alpha}$. Assuming a sluggish adjustment of the price of output to any divergence between aggregate demand and supply, the rate of increase in the price level, denoted $\dot{p}$, can be written as:

$$\dot{p} = \pi(y - y^s), \tag{18}$$

where the parameter π is a measure of short-run price stickiness.

Under the assumption that the bond interest rate is equal to the intervention rate, i.e. $i_b = i_c$, the model is solved for (y, p, i_l, r_b) and e, under a flexible rate system, or $\dot{r}_c^*$, under a fixed rate system with sterilized intervention, using the following five equations:

$$\begin{cases} \text{(IS)} \quad y = \mu[g - \theta_l i_l - \theta_b i_c + \rho(e - p)], \\ \text{(LM)} \quad p + \beta_y y - \beta_b i_c = r_b, \\ \text{(CR)} \quad p - \lambda_l i_l + \lambda_b i_c + \lambda_y y = \gamma_l i_l - \gamma_b i_c + r_b, \\ \dot{p} = \pi\left[y - (\kappa_0 + \kappa_1 p - \kappa_2 e)\right], \\ b \equiv \rho(e - p) + k(i_c - i_c^* - \dot{e}). \end{cases} \tag{19}$$

Any steady-state multiplier in either exchange rate system can be expressed as a function of the variations in the interest rate spread between the loan and intervention rates.

Consider the fixed exchange rate system with sterilized intervention. The steady-state multipliers issued from model (19) can be written as:[15]

$$\left(\frac{di_l}{di_c}\right)_{sa} = \frac{\left[(\beta_y - \lambda_y)\theta_b\mu + \lambda_b + \gamma_b + \beta_b\right]\kappa_1 + \mu\rho(\beta_b + \lambda_b + \gamma_b)}{\Delta\kappa_1 + \mu\rho(\lambda_l + \gamma_l)}, \tag{20}$$

$$\left(\frac{dy}{di_c}\right)_{sa} = -\frac{\mu\kappa_1\left[\theta_l\left(\frac{di_l}{di_c}\right)_{sa} + \theta_b\right]}{\mu\rho + \kappa_1}, \tag{21}$$

$$\left(\frac{dp}{di_c}\right)_{sa} = -\frac{\mu\left[\theta_l\left(\frac{di_l}{di_c}\right)_{sa} + \theta_b\right]}{\mu\rho + \kappa_1}, \tag{22}$$

[15] We adopt the following convention regarding subscripts. The subscript s refers to the fixed exchange rate system with sterilized intervention, f is used for the floating exchange rate system, a designates the credit-augmented model, and m is used for the standard model.

$$\left(\frac{d\dot{r}_c^*}{di_c}\right)_{sa} = -\rho\left(\frac{dp}{di_c}\right)_{sa} + k. \tag{23}$$

where $\Delta = (\lambda_y - \beta_y)\theta_l\mu + \lambda_l + \gamma_l$.

For a pure floating exchange rate system, the comparative statics results of a monetary shock at the steady-state can be written as:

$$\left(\frac{di_l}{di_c}\right)_{fa} = \frac{(\beta_y - \lambda_y)(\theta_b + k)\mu + \lambda_b + \gamma_b + \beta_b}{\Delta}, \tag{24}$$

$$\left(\frac{dy}{di_c}\right)_{fa} = -\mu\left[\theta_l\left(\frac{di_l}{di_c}\right)_{fa} + \theta_b + k\right], \tag{25}$$

$$\left(\frac{dp}{di_c}\right)_{fa} = -\frac{\mu\rho\left[\theta_l\left(\frac{di_l}{di_c}\right)_{fa} + \theta_b + k\right] + k\kappa_2}{\rho(\kappa_1 - \kappa_2)}, \tag{26}$$

$$\left(\frac{de}{di_c}\right)_{fa} = -\frac{\mu\rho\left[\theta_l\left(\frac{di_l}{di_c}\right)_{fa} + \theta_b + k\right] + k\kappa_1}{\rho(\kappa_1 - \kappa_2)}. \tag{27}$$

The steady-state multipliers in both exchange rate systems have ambiguous signs in general. If the income elasticity of deposit demand, denoted β_y, is different from the income elasticity of loan demand, denoted λ_y, the signs of the interest rate multipliers in (20) and (24) are indeterminate. Moreover, signs of all other multipliers are indeterminate as well. Theoretically, we can resolve these ambiguities directly by assuming that the initial impact of monetary policy on the loan interest rate in the fixed exchange rate system, derived for a given price level and denoted by $(di_l/di_c)^0_{sa}$, and the steady-state impact of monetary policy on the loan interest rate in the floating exchange rate system given by (24) are positive:

$$\left(\frac{di_l}{di_c}\right)^0_{sa} = \frac{(\beta_y - \lambda_y)\theta_b\mu + \lambda_b + \gamma_b + \beta_b}{\Delta} > 0, \tag{H1}$$

$$\left(\frac{di_l}{di_c}\right)_{fa} > 0. \tag{H2}$$

Both assumptions imply a comovement between the loan rate and the policy rate, which is a highly probable outcome. Assumption (H1) is a sufficient condition for the interest rate multiplier given in (20) to be positive. Moreover, both conditions ensure that $\Delta > 0$. More generally, if (H1) and (H2) hold, the signs of all multipliers are consistent with the expected effects of monetary policy.

To distinguish between different bank lending channel regimes, we define the standard AD/AS model as a benchmark by assuming perfect substitution between bank credit and bonds. Then, the augmented model in (19) collapses to the following form:

$$\begin{cases} \text{(IS)} \quad y = \mu[g - (\theta_l + \theta_b)i_c + \rho(e-p)], \\ \text{(LM)} \quad p + \beta_y y - \beta_b i_c = r_b, \\ \dot{p} = \pi\left[y - (\kappa_0 + \kappa_1 p - \kappa_2 e)\right], \\ b \equiv \rho(e-p) + k(i_c - i_c^* - \dot{e}). \end{cases} \tag{28}$$

Under the fixed exchange rate system, the steady-state multipliers for this model are:

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

$$\left(\frac{dp}{di_c}\right)_{sm} = -\frac{\mu(\theta_l + \theta_b)}{\mu\rho + \kappa_1} < 0, \tag{30}$$

$$\left(\frac{d\dot{r}_c^*}{di_c}\right)_{sm} = -\rho\left(\frac{dp}{di_c}\right)_{sm} + k > 0. \tag{31}$$

With regard to the floating exchange rate system, the steady-state multipliers are:

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

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

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

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

Results 1: The bank lending channel can generate several regimes in the transmission mechanism. Following a monetary policy shock, the direction of change in the spread between the loan and intervention interest rates is a relevant indicator to distinguish between amplification and attenuation regimes of the bank lending channel at the steady-state of the economy in both the floating exchange rate system and the fixed exchange rate system with sterilized intervention.

The proof follows from comparing the multipliers. For output, prices, and the international reserves growth rate in the fixed rate system with sterilized intervention, use expressions (21), (29), (22), (30), (23) and (31). For output, prices, and the nominal exchange rate in the floating rate system, use expressions (25), (32), (26), (33), (27) and (34).

In the amplification regime, the impact of monetary policy on the above variables in both systems is higher in the augmented model than in the standard AD/AS model. Solving these inequalities[16], this

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

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 as Table 1 indicates.

Table 1. An Amplification Regime at the Steady-State

Fixed rate system with sterilized intervention	Flexible rate system
$\begin{cases} \left(\frac{dy}{di_c}\right)_{sa} - \left(\frac{dy}{di_c}\right)_{sm} < 0 \\ \left(\frac{dp}{di_c}\right)_{sa} - \left(\frac{dp}{di_c}\right)_{sm} < 0 \quad \Rightarrow \left(\frac{di_l}{di_c}\right)_{sa} > 1 \\ \left(\frac{d\dot{r}_c^*}{di_c}\right)_{sa} - \left(\frac{d\dot{r}_c^*}{di_c}\right)_{sm} > 0 \end{cases}$	$\begin{cases} \left(\frac{dy}{di_c}\right)_{fa} - \left(\frac{dy}{di_c}\right)_{fm} < 0 \\ \left(\frac{dp}{di_c}\right)_{fa} - \left(\frac{dp}{di_c}\right)_{fm} < 0 \quad \Rightarrow \left(\frac{di_l}{di_c}\right)_{fa} > 1 \\ \left(\frac{de}{di_c}\right)_{fa} - \left(\frac{de}{di_c}\right)_{fm} < 0 \end{cases}$

In the attenuation regime, the impact of monetary policy on the above variables is smaller in the augmented model than in the standard AD/AS model. Solving these inequalities, 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 as Table 2 indicates.

Table 2. An Attenuation Regime at the Steady-State

Fixed rate system with sterilized intervention	Flexible rate system
$\begin{cases} \left(\frac{dy}{di_c}\right)_{sa} - \left(\frac{dy}{di_c}\right)_{sm} > 0 \\ \left(\frac{dp}{di_c}\right)_{sa} - \left(\frac{dp}{di_c}\right)_{sm} > 0 \quad \Rightarrow \left(\frac{di_l}{di_c}\right)_{sa} < 1 \\ \left(\frac{d\dot{r}_c^*}{di_c}\right)_{sa} - \left(\frac{d\dot{r}_c^*}{di_c}\right)_{sm} < 0 \end{cases}$	$\begin{cases} \left(\frac{dy}{di_c}\right)_{fa} - \left(\frac{dy}{di_c}\right)_{fm} > 0 \\ \left(\frac{dp}{di_c}\right)_{fa} - \left(\frac{dp}{di_c}\right)_{fm} > 0 \quad \Rightarrow \left(\frac{di_l}{di_c}\right)_{fa} < 1 \\ \left(\frac{de}{di_c}\right)_{fa} - \left(\frac{de}{di_c}\right)_{fm} > 0 \end{cases}$

Finally, if variations in different variables are exactly the same in both frameworks, we should observe an unchanged interest rate spread after a monetary shock as Table 3 indicates.

Table 3. A Neutrality Regime at the Steady-State

Fixed rate system with sterilized intervention	Flexible rate system
$\begin{cases} \left(\frac{dy}{di_c}\right)_{sa} - \left(\frac{dy}{di_c}\right)_{sm} = 0 \\ \left(\frac{dp}{di_c}\right)_{sa} - \left(\frac{dp}{di_c}\right)_{sm} = 0 \quad \Rightarrow \left(\frac{di_l}{di_c}\right)_{sa} = 1 \\ \left(\frac{d\dot{r}_c^*}{di_c}\right)_{sa} - \left(\frac{d\dot{r}_c^*}{di_c}\right)_{sm} = 0 \end{cases}$	$\begin{cases} \left(\frac{dy}{di_c}\right)_{fa} - \left(\frac{dy}{di_c}\right)_{fm} = 0 \\ \left(\frac{dp}{di_c}\right)_{fa} - \left(\frac{dp}{di_c}\right)_{fm} = 0 \quad \Rightarrow \left(\frac{di_l}{di_c}\right)_{fa} = 1 \\ \left(\frac{de}{di_c}\right)_{fa} - \left(\frac{de}{di_c}\right)_{fm} = 0 \end{cases}$

Considering these results, we can easily deduce that variations in the interest rate spread also enable us to distinguish between amplification and attenuation effects of the bank lending channel on banking reserves. A close inspection of the interest rate multipliers in expressions (20) and (24) reveal that the relationship between own-price elasticities and cross-price elasticities on the loan market plays a crucial role in determining the type of regime, everything else being equal. If firms are bank-dependent borrowers having more difficulty accessing the bond market than the loan market, we should have $\lambda_l > \lambda_b$. Similarly, if $\gamma_l > \gamma_b$, banks are more reactive in their credit decisions to loan interest rates as compared to monetary policy-led bond interest rates. If the agents' behavior indicates that one or both of these inequalities apply, we have a weaker response of loan rates to a change in the intervention rate everything else being equal and, ultimately, a higher probability of an attenuation regime. The second crucial component is the value of λ_y, i.e., the income elasticity of loan demand. All things equal, the more firms rely on credit to finance their current activity, i.e., the stronger is λ_y, the lower is the change in the loan rate and, as a result, the more likely is the attenuation regime. Finally, result 1 is obtained by assuming a steady-state equilibrium for the economy. However, when considering the impact effect of a monetary policy impulse derived for a given price level, as prices adjust only over time, we can show that the direction of change in the spread between loan and intervention interest rates is a good indicator of different regimes in the fixed exchange rate system with sterilized intervention but we cannot make any simple generalization for the floating exchange rate system, except when $\lambda_y = \beta_y$.

3 An Empirical Assessment of the Bank Lending Channel Regimes in Poland

Bank lending is an important component of the transmission mechanism in Poland because the banking sector is the core of the financial system. The ratio of banking assets to financial system assets was 94.5% in 1996 and 87.4% in 2000. Moreover, stylized facts about the behavior of banks and borrowers reveal that the bank lending channel plays a crucial role in the transmission mechanism in Poland. Consider the demand side of the market first. Poland's capital markets are fairly thin so that they play a secondary role in financial intermediation. At the end of 2001, the capitalization of the Warsaw Stock Exchange amounted to only 13.9% of GDP as compared with total banking system assets representing 66.3% of GDP. In March 2000, commercial bonds represented only 1.2% and commercial papers amounted to only 5.8% 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 NBP's monthly surveys of companies, 81.1% of Polish firms were highly dependent on bank credit for their investment activity in 1998: 25.9% were able to cover only a smaller part of their investment spending without bank credit whereas 55.2% were entirely dependent on bank financing. Moreover, the share of firms using bank credit grew from approximately 80% in 1995 to more than 85% in 1999 (Łyziak, 2001). These stylized facts emphasize the special role of bank loans and render attenuation effects more likely because they suggest that the value of λ_l should be large while the value of λ_b should be close to zero.

The expected value of the income elasticity of loan demand in Poland is an open question. On the one hand, according to the NBP's statistics, 77.4% of Polish firms were dependent on bank credit to finance their current activity in 1998. In the same vein, Ghatak et al. (2003) find that the difficulty or ease of finding credit in late 1999 was among the most important determinants of the decision to expand production by small Polish firms. On the other hand, Wróbel and Pawłowska (2002) demonstrate that although output declines over a given period of time following an increase in the interest rate, short-term bank credit changes very little. This credit adjustment may be due to buffer-stock behavior of banks but it may also indicate a weak loan demand elasticity with respect to output. Overall, for the purpose of our simulation analysis, we assume that λ_y is less than unit elastic.

Regarding the supply side of the loan market, Table 4 presents a breakdown of banking income and assets. The share of loans is equal to, or up to 1.4 times higher than, the share of securities in banking assets. At the same time, the percentage of interest earned on credits is almost 2.5 times higher in banking income than the percentage of interest yielded by securities. Thus, we deduce that bank loans have special characteristics for banks as well. Polish commercial banks appear to be able to exercise quasi-monopoly power in the loan market and earn a higher than expected rate of return. Łyziak (2000) corroborates this characteristic by finding buffer-stock behavior exhibited by the banking sector. Another salient feature of the Polish banking sector since 1994 is its permanent excess liquidity, which is defined as the net indebtedness of the central bank towards commercial banks. The consequence for the transmission mechanism is that banks became less reactive to policy measures. The policy rate, i.e., the rate of open market operations, plays the role of a marginal investment rate rather than determining the marginal cost of banks' liabilities. Both buffer-stock behavior and structural excess liquidity are important characteristics of the strong monetary tightening pursued between mid-1996 and the beginning of 1998. The central bank was attempting to reduce the growth rate of credit aggregates by raising its intervention rate and increase the rate of required reserves. However, these measures did not yield the expected results so that the NBP was forced to undertake an unprecedented action. In September 1997, it began to accept six and nine-month deposits directly from the public at above-market rates. The objective was to force banks to increase substantially their deposit rates and, subsequently, their lending rates. Taken together, these different pieces of evidence lead us to expect that the interest rate elasticity is higher for the loan interest rate than for the bond interest rate, i.e. that $\gamma_l > \gamma_b$ holds, in the loan supply equation. Hence, the response of loan rates to a change in the intervention rate is smaller and the probability of an attenuation regime is higher.

Table 4. Breakdown of Banking Income and Assets

	1996	1997	1998	1999
Sources of banking income (in %)				
Interest on loans	48.9	52.6	44.0	34.4
Interest on securities	29.5	19.1	17.9	11.8
Fees and commissions	6.2	7.0	5.7	6.3
Positive exchange rate differences	4.6	12.5	22.4	35.7
Release of provisions	7.5	5.1	5.3	5.6
Other	3.3	3.7	4.7	6.2
Structure of banking assets (in %)				
Due from financial institutions	9.1	13.2	11.3	13.2
Loans	38.3	40.9	40.7	44.6
Securities	42.5	34.7	38.3	31.6
Other (including foreign assets)	10.1	11.2	9.7	10.6

Source: Wyczański and Gołajewska (1998) and Gołajewska et al. (2000).

The analysis of loan demand-side and supply-side factors, conditioned on the action of the bank lending channel suggests a relatively ineffective monetary policy transmission. Hence, we expect only a limited reaction of the loan interest rate to changes in the policy rate. To assess the role of the bank lending channel in the transmission mechanism, we analyze monthly data obtained from the NBP. The sample period runs from February 1994 to February 2002.[17] We use three-month, six-month and one-

[17]The choice of the sample period depends on two considerations. First, although interest rate series are available from January 1993, the intervention rate exhibited a strong volatility in the period prior to 1994. Subsequently, only

year minimum loan rates applied to Polish firms and calculated as weighted averages for the major banks. The sample includes 20 banks in February 1994 and 11 in February 2002; the lower number is due to bank consolidation during that period. For the period under consideration, our sample constitutes 75.3% of the banking system in terms of total corporate bank loans and 84.7% in terms of total deposits. These data are employed to construct three different interest rate spreads, which are defined as the differences between three-month, six-month, and one-year loan rates with the intervention rate of the central bank.

Before examining the functioning of the bank lending channel in Poland, we must determine whether loan rates and the intervention rate move in the same direction, i.e., whether assumptions (H1) and (H2) hold. For this purpose, we use advanced and lagged correlations of monthly changes in the intervention rate with monthly changes in the loan rates. We consider two subperiods; the first one runs from February 1994 to June 1999 and corresponds to the fixed exchange rate system and the second one considers July 1999 onwards to reflect the period in which the exchange rate was floating.

Table 5. Correlations of Changes in Loan Rates with the Intervention Rate

h	-3	-2	-1	0	+1	+2	+3
	Fixed rate system: February 1994 to June 1999						
Δthree-month loan rate/Δintervention rate	0.22	0.14	0.26	**0.57**	0.34	0.20	0.09
Δsix-month loan rate/Δintervention rate	0.21	0.14	0.24	**0.56**	0.33	0.18	0.06
Δtwelve-month loan rate/Δintervention rate	0.16	0.12	0.25	**0.54**	0.27	016	0.05
	Floating rate system: July 1999 to February 2002						
Δthree-month loan rate/Δintervention rate	0.28	0.22	0.38	**0.64**	0.55	0.25	0.39
Δsix-month loan rate/Δintervention rate	0.21	0.21	0.38	**0.68**	0.55	0.30	0.42
Δtwelve-month loan rate/Δintervention rate	0.19	0.12	0.31	**0.69**	0.47	0.23	0.37

Table 5 reports 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 month, denoted $h < 0$, the current month, denoted $h = 0$, and the future month, denoted $h > 0$. As the table indicates, the contemporaneous correlation coefficient is positive regardless of the type of exchange rate system, which suggests that assumption (H1) is satisfied. The correlation is largest when $h = 0$ so that the major part of the pass-

a new regulatory framework introduced in January 1994 allowed the NBP to stabilize the short-term interbank interest rates at the desired level starting with February 1994. Second, an important methodological change occurred in the procedures for reporting loan interest rates in March 2002. Until February 2002, the NBP collected data on the lowest loan rates; however, since that time, banks have supplied interest rates with the highest share in their loan portfolio for a given category.

through of policy-controlled interest rates to loan interest rates occurs within the month during which the policy is implemented. Wróbel and Pawłowska (2002) calculate the mean adjustment lag of the full pass-through for the 12-month loan rate to be three months from 1995 to 2002 in Poland. Our findings are consistent with their result because the correlation coefficient between the current policy rate and up to three leads of the loan rate is positive regardless of the maturity of the loan. Hence, we find a positive long-term impact of the policy rate on the loan rate, which validates assumption (H2). Finally, the contemporaneous correlation of monthly changes in the intervention rate with monthly changes in different loan rates is always higher in the floating rate system than in the fixed one. Hence, the transmission of monetary policy through the banking sector was improved in Poland once the exchange rate was allowed to float more freely.

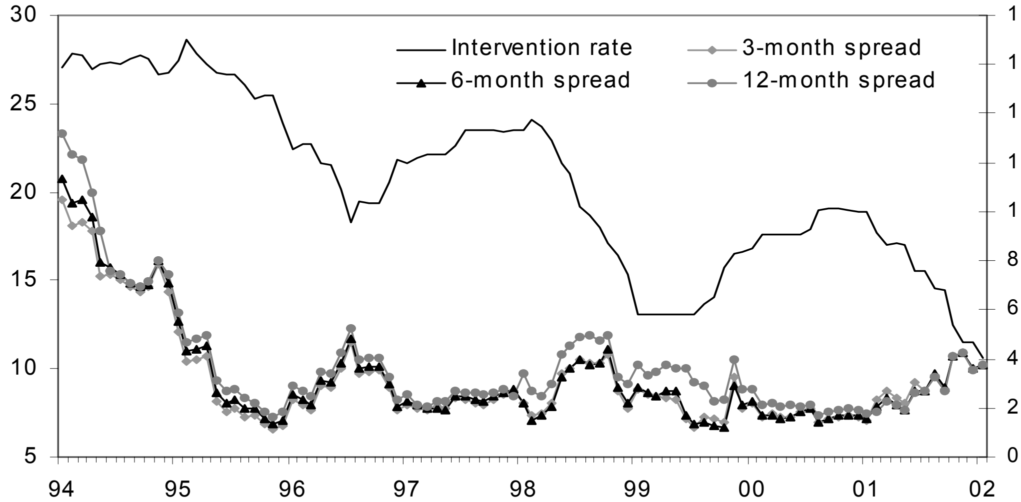
In both exchange rate systems, the scale of the pass-through of policy-controlled interest rates to loan rates provides valuable information about different bank lending channel regimes at the steady-state equilibrium. As Figure 2 depicts, the period under study is not homogeneous. A scissor-like evolution of the spreads 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 increase otherwise. On the other hand, comovement between the spreads and the intervention rate indicates an amplification regime; the spreads increase after a rise in the central bank's rate and decrease after a fall.[18]

To generalize the relationship between the spreads and the policy rate and to summarize the contents of Figure 2, we compute a series of rolling correlations of monthly changes in the intervention rate with monthly changes in the spread between the average of three-month, six-month, and one-year loan rates and the intervention rate using a 24-month moving window of data. As plotted in Figure 3, the estimated correlation coefficient remains significantly negative and stable until November 1998; it is almost never significantly different from zero until the end of the sample period. Hence, we find clear evidence of two distinct bank lending channel regimes, namely, an attenuation regime in the first subperiod and a neutral effect of the bank lending channel in the second one.[19] Empirical studies using vector autoregressive

[18]The important decline in all spreads in the first half of 1994 resulted from structural excess liquidity in the banking system, which decreased the yield of treasury bills, as Figure 1 indicates, and subsequently the loan interest rates, rather than from enhanced monetary policy effectiveness. More generally, the period from February 1994 to December 1995 is difficult to analyze because the loan rates moved in the opposite direction to the intervention rate in several cases.

[19]When using real ex post spreads and intervention rates, the analysis does not yield identical results to the

Figure 2. Intervention Rate and Interest Rate Spreads



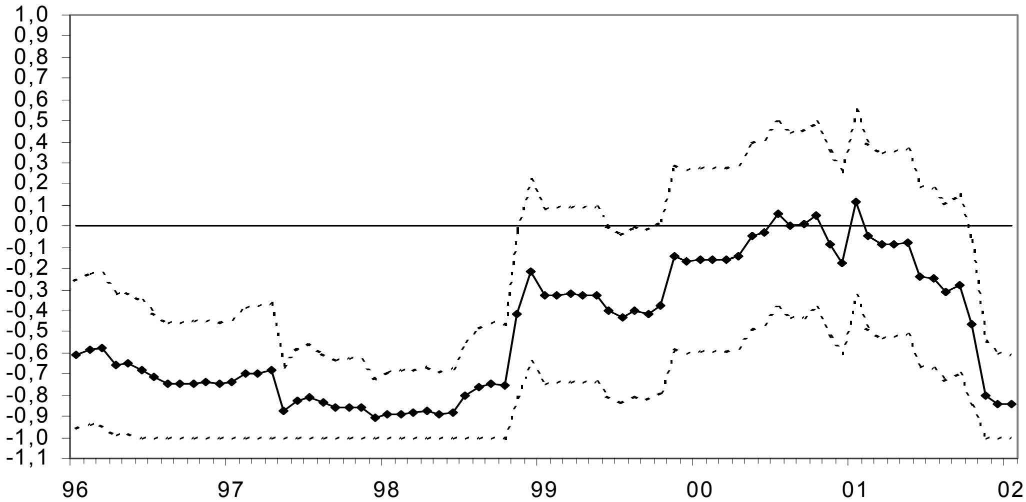
Source: National Bank of Poland and own calculations.
Note: intervention rate (left scale), interest rate spreads (right scale)

models confirm that monetary policy was relatively ineffective during the attenuation regime. Gottschalk and Moore (2001) provide evidence of weak linkages between the policy-influenced three-month treasury bill rate and both industrial production and inflation during the period from January 1992 to August 1999. Considering Granger causality tests with monthly observations from January 1993 to April 1999, Maliszewski (1999) also finds that the money market rate had very limited predictive power in forecasting the Consumer Price Index and industrial production. Finally, Brzoza-Brzezina (2000) shows that using the loan rate instead of a money market rate leads to a stronger and statistically more significant response of industrial production to an interest rate shock. According to the author, this result indicates that an important part of monetary impulses was vanishing in the banking sector from January 1992 to October 1999.

The period of the neutrality regime is too short to estimate reliably the effects of monetary policy on the economy. However, Łyziak (2002) finds a stronger policy impact on inflation while moving the sample period from 1992 to 1999 to 1994 to 2001. Furthermore, numerous facts indicate that

nominal specification at the beginning of the sample period. Given the evolution of the inflation rate, the real and nominal intervention rates did not move in the same direction, especially in the 1994 to 1995 period. However, these results confirm the predictions from the nominal rate analysis for the most part.

Figure 3. Correlations of Changes in the Spread with Changes in the Intervention Rate



Notes: (i) The confidence bands are constructed using the 95 percent level. (ii) The lower band is bounded at -1.

monetary policy was more effective during the second subperiod. Since September 1999, policy has been characterized by a substantial interest rate tightening, coupled with an appreciation of the exchange rate (OECD, 2002). According to OECD (2002) tight monetary policy in 2000 and 2001 contributed to the substantial fall in investment activity and the desired reduction in inflation. Although the annual rate of inflation experienced an upsurge from 5.6% in February 1999 to 11.6% in July 2000, it decreased steadily afterwards to 8.5% in December 2000 and 3.6% in December 2001. At the same time, the average annual GDP growth had been about 6% from 1994 to 1998, but decreased to 4.1% in 1999, 4% in 2000, and only 1% in 2001, reaching an all-time low of 0.3% in the fourth quarter of 2001. With respect to domestic fixed investment, the real average annual growth rate was 18% from 1995 to 1998 but dropped to 6.8% in 1999, 2.7% in 2000, and collapsed to negative 8.8% in 2001.

To investigate the switch to a neutrality regime at the end of 1998, we simulate the change in the potency of monetary policy that would have resulted from a modification of the exchange rate system.[20] The floating rate system was put in place gradually starting in February 1998 and can be considered to

[20]Theoretically, a regime shift can result from a modification of the structural parameters of the economy. However, even with a shift in the exchange rate system, structural parameters, e.g., the interest rate elasticity of demand, must remain constant or it would be impossible to draw any meaningful policy conclusions. I am grateful to an anonymous referee for making this point.

be in force unofficially since October 1998, or at least from July 1999. Hence, Figure 3 indicates that the timing of the regime change, which occurred in December 1998, matches closely that of the adoption of a new exchange rate system. To assess further the impacts of the identified regimes, we quantify the parameters of the model based on Polish data and use these to compute dynamic simulations.[21]

Table 6. Parameters of the Model

θ_l	θ_b	c	α	ρ	k	λ_l	λ_b	λ_y	γ_l	γ_b	χ	σ	β_b	β_y	π
1	1	0.6	0.7	0.1	2	2.5	0.1	0.7	2.5	0.5	0.6	0.7	1	1	0.3

We record the values of the structural parameters of the model that we use in the simulation analysis in Table 6. To calibrate the model, we have no estimates of the coefficients of the variables related to the loan market. Therefore, criterion imposed is whether the model can replicate the behavior of the interest spread variations observed in Poland. We assume reasonable values that are identical for both exchange rate systems for the unknown coefficients; these are set in accordance with the expected relationships derived at the beginning of the section. However, this exercise is suggestive rather than conclusive because further analysis is necessary to check robustness. Wdowiński and van Aarle (2001) provide information that allows us to quantify the parameters c, ρ, k, β_b, θ_b and β_y. These authors argue that their values are consistent with the characteristics of the Polish economy.[22] Regarding labor elasticity, α, we assume this to equal one as well based on the IMF (2003) study on Poland. We evaluate χ, the share of domestically produced goods in the consumption basket, by assuming that 50% of goods, food, and fuel were imported from 1995 to 2002. Aglietta et al. (1999) provide the value for σ, measuring the degree of nominal rigidities in the labor market. With respect to the measure of short-run price stickiness, π, Wdowiński and van Aarle (2001) suggest a value of 0.2 while Łyziak (2002) gives an estimates of 0.34. As a compromise, we set this parameter equal to 0.3.

The time paths of the change in the interest rate spread and the change in the difference between credit-augmented and standard multipliers for each endogenous variable are shown in Figure 4 of Appendix 1 for the fixed exchange rate system with sterilized intervention and in Figure 5 for the floating

[21]The fixed exchange rate system can be shown to be globally stable and the floating exchange rate system can be shown to be saddlepoint-stable.

[22]Buch (2001) finds money demand in Poland to exhibit unitary income elasticity.

exchange rate system.[23] A modification of the exchange rate system leads to a regime shift in the transmission process. The interest rate multiplier is approximately equal to 0.5 in the fixed exchange rate system, indicating an attenuation regime. However, it is close to unity in the floating exchange rate system, indicating a neutrality regime on average. A direct comparison of the difference between the multipliers of both models for each variable at the steady-state confirms that monetary policy impulses are systematically weaker in the fixed exchange rate system than in the floating one.

Although the direction of change in the interest rate spread allows the type of the bank lending channel regime to be assessed at the steady-state, it does not reflect continuously the scale of monetary policy effectiveness within the regime. In the fixed exchange rate system, the additional weak decrease in the interest rate multiplier is followed by a relatively more ineffectual monetary transmission to prices, banking reserves, and the accumulation of international reserves in the credit-augmented model compared with the standard model. However, the change in income differential provides precisely the opposite information to that given by the variation in the interest rate spread because, according to the former, a reduction in the relative ineffectiveness of monetary policy occurs. The adjustment process towards a new-steady state equilibrium constitutes another determinant of regime change. As depicted by the transmission of a monetary policy impulse in the flexible exchange rate system in Figure 5, a regime switch occurs in the adjustment path.[24]

Finally, we compare the responses in the levels of variables for the two exchange rate systems in Figures 6 and 7 of Appendix 2. Regardless of whether the bank lending channel is active, as indicated by the solid line or inactive, as indicated by the dotted line, the transmission mechanism is stronger in the floating exchange rate system than in the fixed one with sterilized intervention. Indeed, the impact of monetary policy on the level variables is much stronger in a pure float. In particular, the real exchange rate reinforces the transmission process because following a monetary tightening there is an appreciation of the real exchange rate whereas a depreciation occurs in the fixed exchange rate system. In conclusion, our numerical simulations corroborate the view that the effectiveness of the monetary policy transmission has increased with the adoption of the floating rate system. As a result, the interaction between the bank lending channel and the traditional interest rate and exchange rate channels has improved since the switch

[23] The simulations are carried out using Maple 6 software.

[24] A similar conclusion does not hold for the exchange rate differential, which indicates the existence of an attenuation regime from the outset.

occurred from an attenuation to a neutrality regime. Moreover, this policy change has led to an overall strengthening of the transmission mechanism.

4 Conclusion: Policy Implications

In this paper, we develop a dynamic small open-economy credit-augmented model under two different exchange rate systems, namely, a fixed rate with sterilized intervention and a pure floating rate. In both exchange rate arrangements, the bank lending channel may either amplify or attenuate the action of the traditional interest rate and exchange rate channels. For a given exchange rate system, the effectiveness of monetary transmission depends mainly upon the agents' behavior in the loan market. The main issue is whether policymakers have an indicator that enables them to detect which bank lending channel regime is operating. At stake is the potency of monetary policy transmission and, ultimately, the appropriate setting of monetary conditions to achieve macroeconomic objectives. Our main result is that the pass-through of policy-controlled interest rates to loan rates contains useful information for the monetary authorities. The results requires the existence of a positive relationship between loan rates and the policy rate, but, this is a highly probable outcome. However, following a monetary policy impulse, the direction of change in the interest rate spread in the adjustment path may not reflect continuously the effectiveness of monetary policy impulses. Yet, the theoretical analysis indicates that these ambiguities vanish once the economy reaches or remains in a steady-state equilibrium. In a steady-state equilibrium, if the pass-through of policy-controlled interest rates to loan rates is less (more) than one, the impact of monetary policy impulses on the economy is reduced (increased). Therefore, the bank lending channel will weaken (strengthen) the functioning of the classic interest rate and exchange rate channels. As a result, to detect the prevalent bank lending channel regime, the monetary authorities should monitor the medium-term response of loan rates to changes in the policy rate, regardless of the exchange rate system.

Empirically, we investigate the interactions between the commercial banking sector and the monetary authorities in the transmission of monetary policy during the Polish transition to shed light on short-term bank lending to firms. Under the conditions for the operation of a bank lending channel, the interest rate spread is the appropriate indicator of different regimes. The evidence indicates a substantially reduced pass-through of the policy rate to loan rates between the beginning of 1996 and the end of 1998, and a stronger pass-through close to unity after that time. The first period is an attenuation regime, while the second one corresponds to a neutrality regime on average. That the timing coincides with the adoption of a floating exchange rate system in Poland is striking and may be the fundamental result. Dynamic simulations of the model with parameter values set identical for both exchange rate systems reinforce this finding. Additionally, the simulations indicate an overall strengthening of the transmission mechanism once the exchange rate was allowed to float more freely. For further research on the transmission mechanism in Poland, a precise estimation of the parameters related to the loan market could corroborate the robustness of these results.

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Appendix 1: Dynamic Numerical Simulations of a Monetary Shock: Response of Differential of Variables

Figure 4. Effects of a Change in the Policy Rate in the Fixed Rate System with Sterilized Intervention

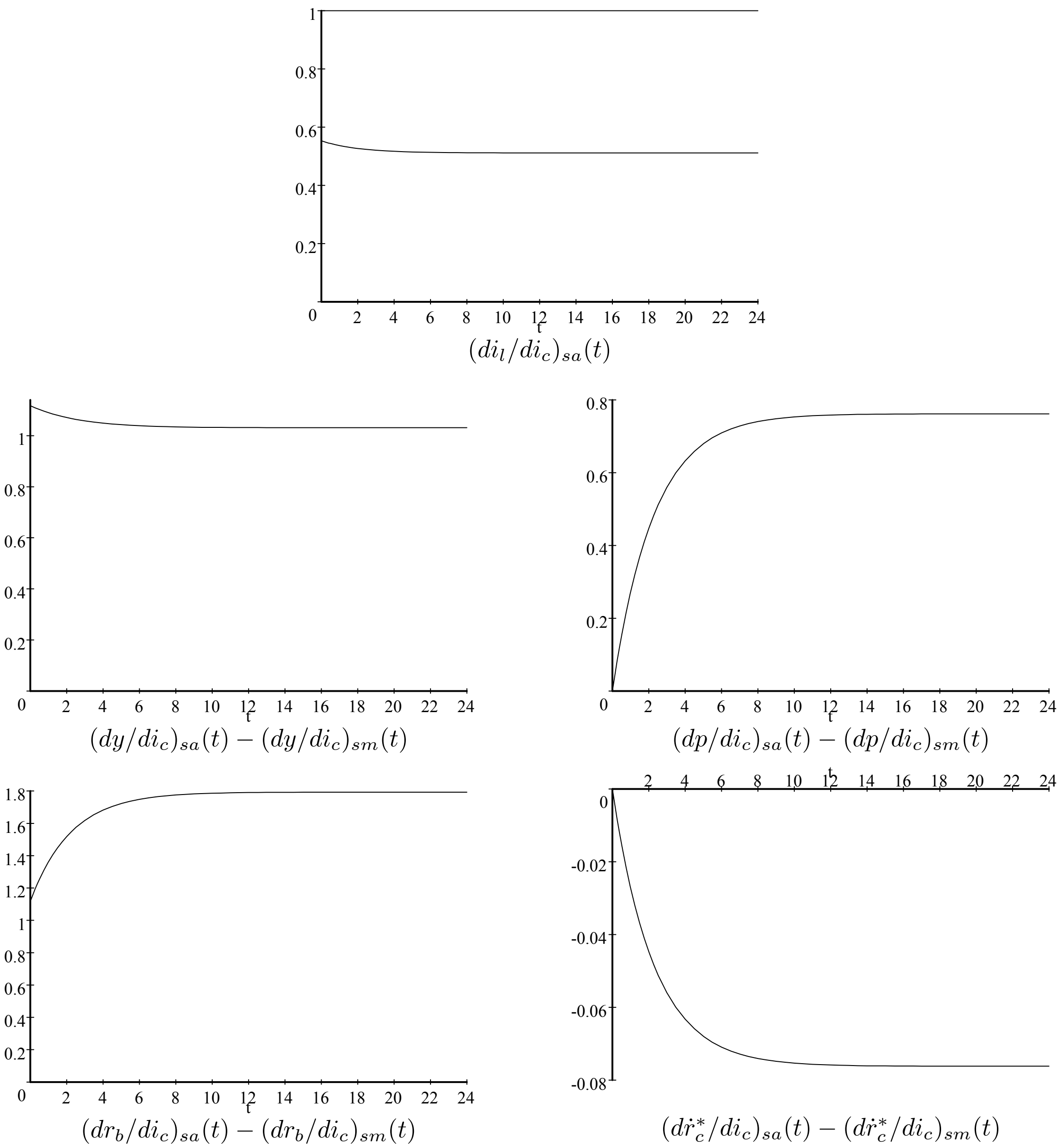
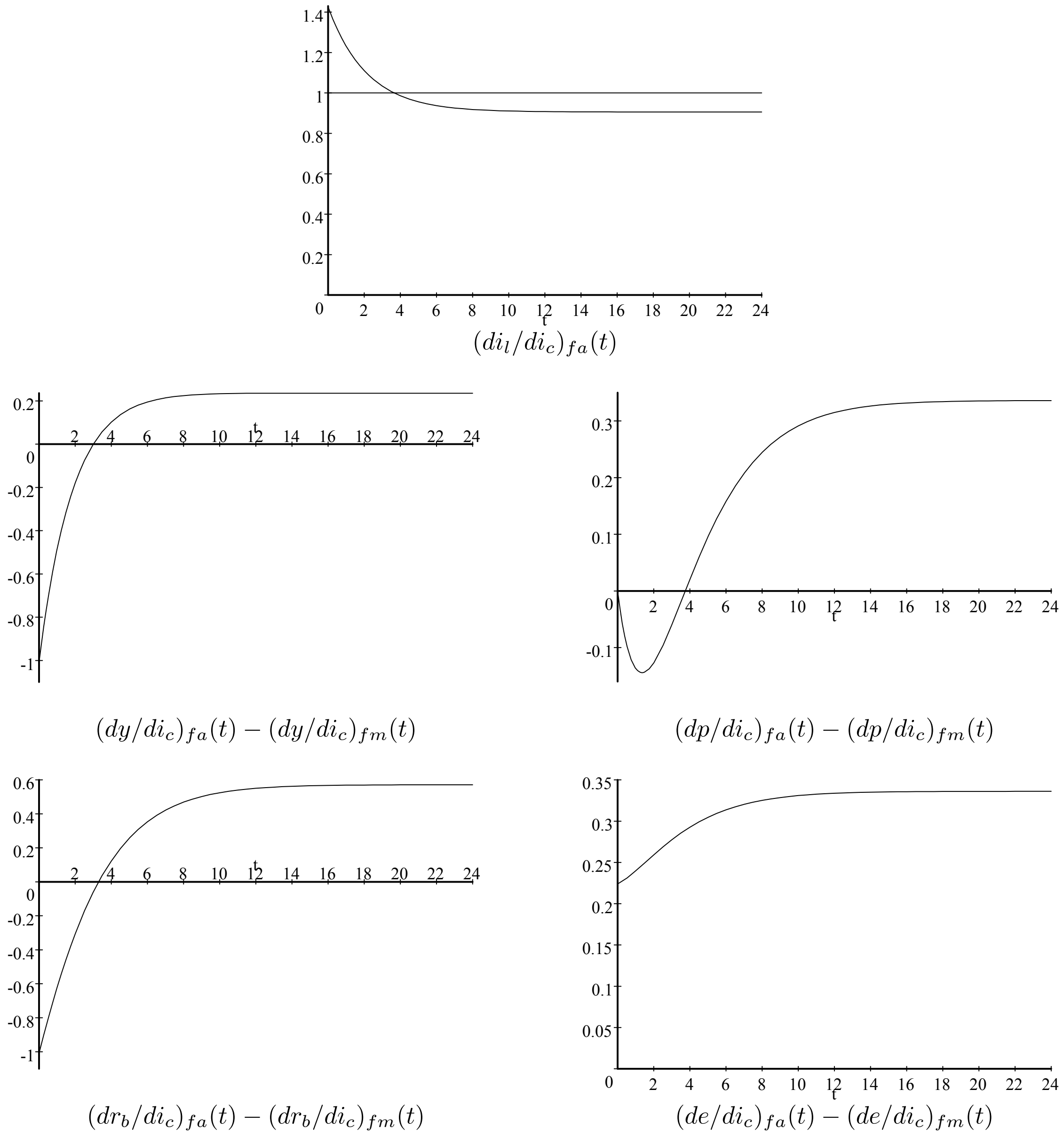
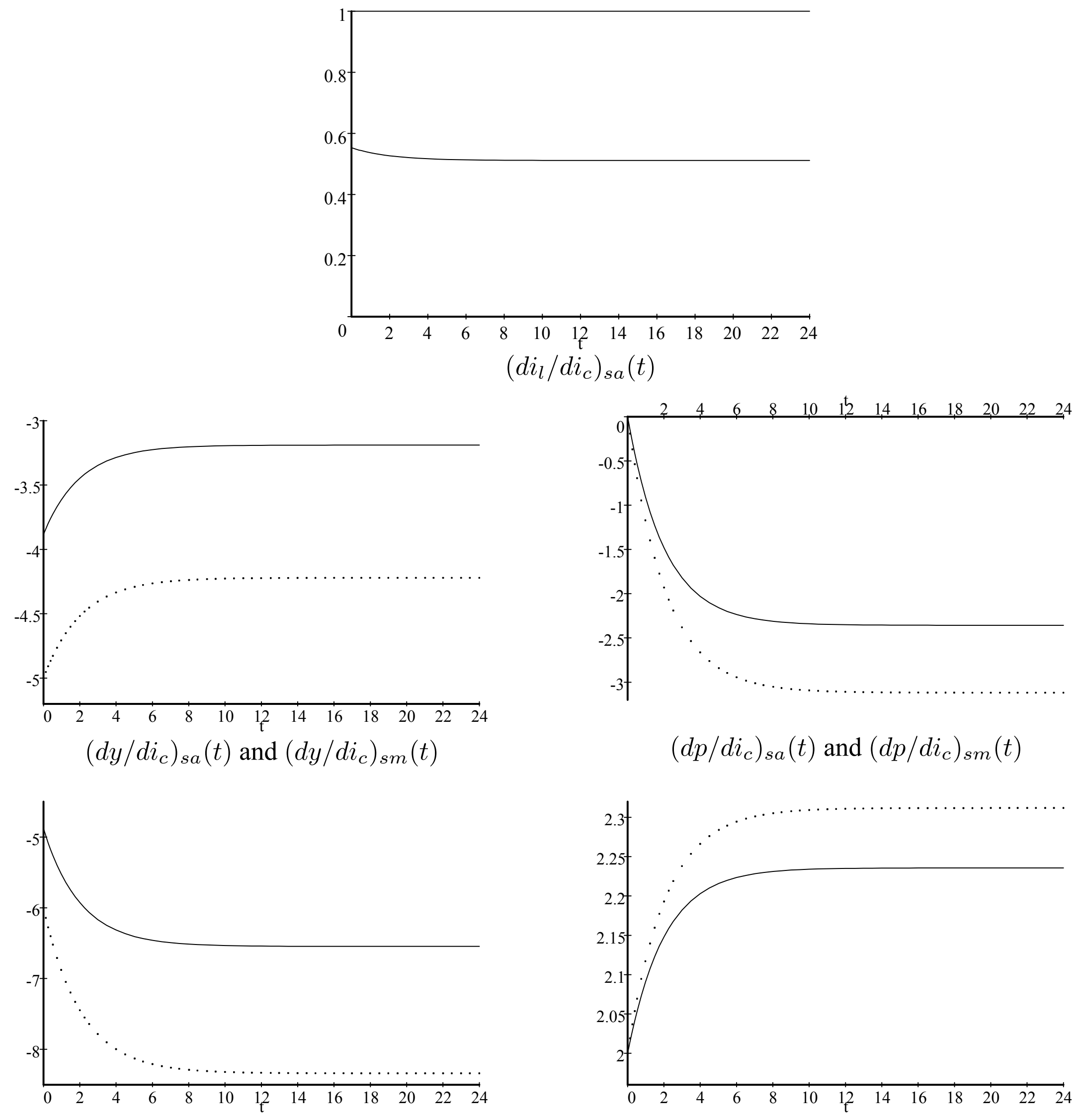


Figure 5. Effects of a Change in the Policy Rate in the Flexible Exchange Rate System



Appendix 2: Dynamic Numerical Simulations of a Monetary Shock: Response of Level of Variables

Figure 6. Effects of a Change in the Policy Rate in the Fixed Rate System with Sterilized Intervention



$(di_l/di_c)_{sa}(t)$

$(dy/di_c)_{sa}(t)$ and $(dy/di_c)_{sm}(t)$

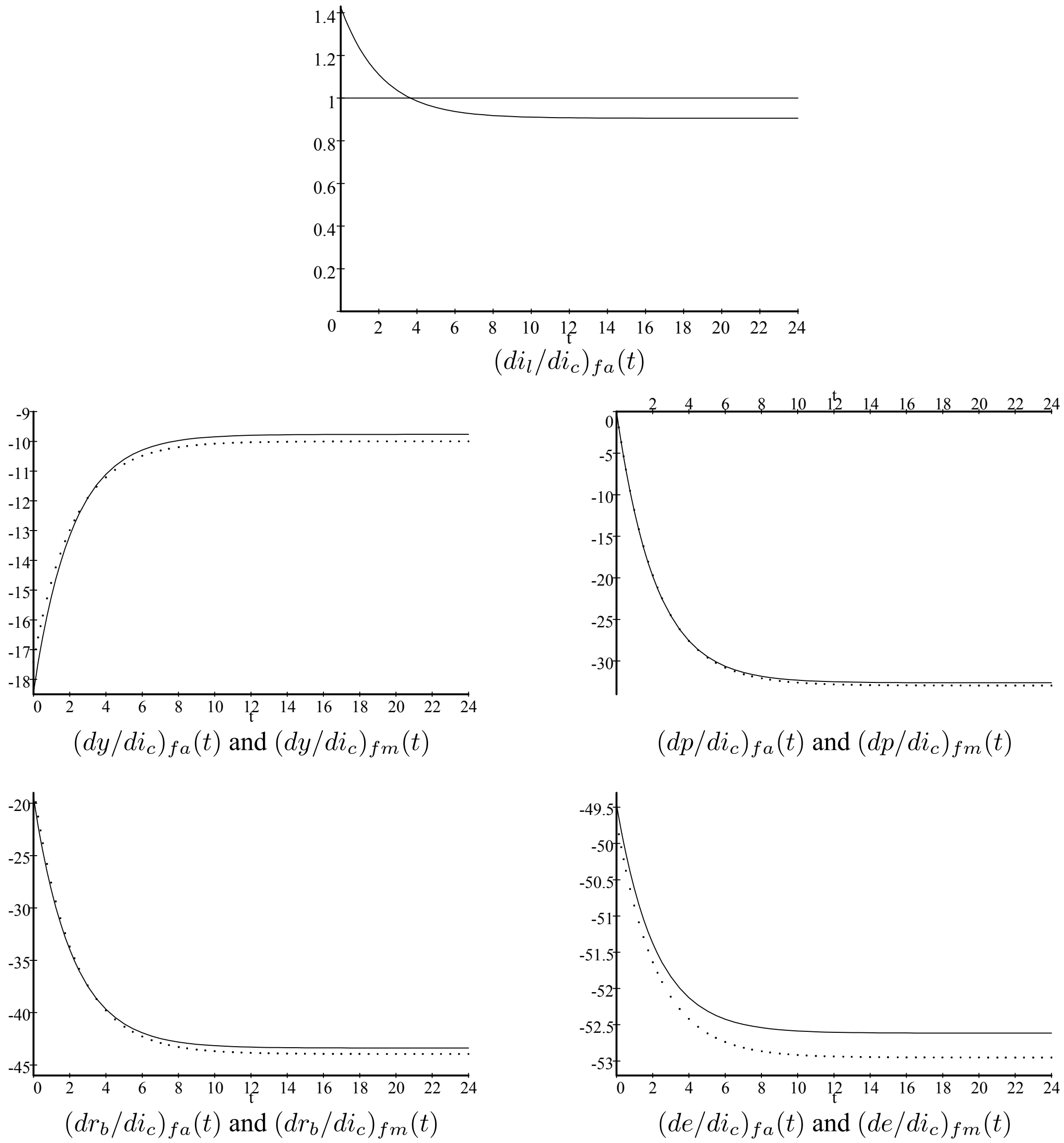
$(dp/di_c)_{sa}(t)$ and $(dp/di_c)_{sm}(t)$

$(dr_b/di_c)_{sa}(t)$ and $(dr_b/di_c)_{sm}(t)$

$(d\dot{r}_c^*/di_c)_{sa}(t)$ and $(d\dot{r}_c^*/di_c)_{sm}(t)$

Note: Solid lines indicate the adjustment process when the bank lending channel is active and dotted ones when it is inactive.

Figure 7. Effects of a Change in the Policy Rate in the Flexible Exchange Rate System



Note: Solid lines indicate the adjustment process when the bank lending channel is active and dotted ones when it is inactive.