

# Monetary policy and disinflation on the way to the euro in Slovenia<sup>1</sup>

## Abstract

*This article examines the monetary policy framework put in place by the Bank of Slovenia before the introduction of the Euro. To cope with the increase in inflation, coupled with a weakened external position in 1999, BoS implemented a policy strategy that could be best described as inflation targeting within a managed float regime, with a disinflation trend and price stability objective later providing a nominal anchor for the economy. Quite uniquely, interest rate setting was complemented by an exchange rate policy guided by uncovered interest parity, aiming at maintaining the external position of the economy in equilibrium. We find a strong interest rate transmission while the inflation response to demand, price, exchange rate and credit shocks is found to be highly persistent in the case of no restrictive policy reaction. We also show that the sharp increase in real interest rates after 2000 strongly contributed to a resumption of the disinflation trend in 2001, while the contribution of the exchange rate was roughly neutral up to 2004. A moderately negative output-gap, oil price decreases and lower inflation expectations also contributed to a disinflation trend, which was characterised by high macroeconomic stability.*

**Keywords:** *monetary policy, exchange rate policy, interest rate policy, price stability, policy co-ordination, adoption of the euro, ERM II*

## Introduction

After reaching below 5 % at the beginning of 1999, a combination of shocks pushed inflation in Slovenia back to close to 10 %. This marked a break in the disinflation process, starting from the hyper-inflation at the time of Slovenian independence in 1991. The increase in inflation in 1999 and 2000 was due to the simultaneous effects of the introduction of VAT, an oil price shock, strong wage increases and a surge in aggregate demand. The extensive presence of wage indexation produced second round effects as regards inflation. The risk of the persistence of inflation at high levels was further reinforced in sectors sheltered from foreign price competition, with presumed strong price responsiveness to domestic demand. At the same time, the Slovenian external position appeared fairly fragile, as the current account surplus of 12 % of GDP at the beginning of the transition progressively reversed to a deficit in excess of 3 % of

1 The views expressed by the authors do not necessarily correspond to those of the Bank of Slovenia.

GDP in 1999. In that perspective, policy-makers expressed fears of an excessively appreciated currency.

These economic developments coincided with important institutional changes. The new Bank of Slovenia (BoS) Law, in preparation and passed during 2001, made price stability the primary objective, replacing the objective of a stable currency. In addition, 1999 marked the full liberalisation of the capital account, including abolishing controls on foreign capital inflows. Finally, with the application for the accession of Slovenia to the EU, it became compulsory for Slovenia to adopt the euro at one point in time, requiring that Slovenia eventually fulfil the Maastricht criteria, including price stability.

To cope with that challenging situation, BoS formally introduced a new monetary policy strategy in April 2001. In our view, the BoS monetary policy strategy could be best described as inflation targeting within a managed float regime, where the disinflation trend and low subsequent inflation provided a nominal anchor for the economy. Interest rate setting was inspired by a two-pillar framework of the ECB, covering both monetary and real developments. Quite uniquely, however, rate setting was complemented by an exchange rate policy guided by uncovered interest parity. Its role was to keep the interest rate differential *vis-à-vis* the euro area, necessary to support disinflation, while preventing interest-elastic capital inflows. At the same time, such exchange rate management aimed at achieving a high degree of real exchange rate stability and, thereby, at contributing to maintaining the external equilibrium of the economy. Finally, an important advantage of the BoS framework was its capacity for operational continuity during ERM II participation, for a straightforward full integration into the Eurosystem.

This article has three objectives. Besides presenting and motivating the BoS monetary policy framework and its operational aspects, it assesses the basic macroeconomic transmission mechanism in the Slovene economy in a small scale dynamic macro model. This in turn enables an examination of the effectiveness of the BoS policy framework and an evaluation of its contribution to the disinflation process.

In examining the macroeconomic transmission of monetary policy, we find that an increase in the policy rate by 1 percentage point decreases inflation by slightly less than  $\frac{1}{2}$  a percentage point in the first year and more than 1 percentage point in the third year. This transmission compares to the results presented in the ECB (2004) for the euro-system, and argues in favour of an interest rate rule to achieve disinflation and price stability. The estimated exchange rate pass-through is strong, albeit far from complete in the short run (roughly 30 % in the first year and somewhat more than 60 % in the third year). Furthermore, the inflation response is highly persistent to demand, price and credit shocks where no restrictive policy reaction is set in place to counter it. This calls strongly for macroeconomic management in the case of (asymmetric) inflationary shocks. In particular, after the abandonment of independent monetary policy, such shocks may erode real interest rates and add to the persistence of inflationary cycles, which are potentially costly in terms of competitiveness.

In accordance with the estimated transmission mechanism, the sharp increase in real interest rates after 2000 significantly contributed to a resumption of the disinflation trend in 2001. In addition, positive real interest rates at around 2 %, accompanied by the decreasing nominal exchange rate depreciation, thereafter supported the disinflation

trend. The restrictive monetary policy stance could be progressively removed as a moderately negative output gap, oil price decreases and lower inflation expectations, also reflected in decreasing wage growth, contributed to maintaining the disinflation trend. Inflation decreased steadily from a peak of almost 10 % in 2000 to around 2.5 % after 2004, but the disinflation process was characterised by high macroeconomic stability: output growth was in line with its potential on average over the period; there was stable employment growth; the real exchange rate moved in line with the estimated long-term equilibrium appreciation trend; and the current account balance turned into surplus in 2004.

The article is structured as follows: the next two sections present the BoS monetary policy framework introduced in 2001 and its operational design, following which we empirically estimate the macroeconomic transmission and put the BoS framework into the perspective of the obtained results. The conduct of monetary and exchange rate policy against the background of the disinflation process after 2000 is discussed next. Finally, the conclusion briefly addresses the question as to the extent to which the monetary policy implemented by BoS is specific to the Slovenian institutional and macroeconomic environment.

### The Bank of Slovenia's monetary policy framework introduced in 2001; its concepts and premises

In the light of the EU accession process and the objective of bringing inflation down in a sustainable way, BoS introduced a new monetary policy framework in April 2001. This monetary policy strategy could best be described as inflation targeting, with a managed float exchange rate regime. A reconsideration of the monetary policy framework coincided with a new BoS Law, giving BoS full independence and enshrining price stability as the primary goal. The framework therefore included the primary objective of price stability, combined with a two-pillar analytical framework, covering both monetary and real developments, inspired by the monetary framework of the ECB (presented in ECB (2004)). In addition, the framework had to be compatible with the conditions of a small open economy, given Slovenia's high openness to trade, with a ratio of exports and imports to GDP in excess of 120 %, and the full capital flow liberalisation which had been introduced in 1999.

#### *The framework in line with the concept of inflation targeting*

Conceptually, an inflation targeting regime is a monetary policy strategy aimed at achieving and maintaining price stability by focusing on deviations in published inflation forecasts from an announced inflation target. BoS chose a medium-term inflation target, defined as an inflation rate consistent with the Maastricht criteria, which was recognised as a precondition for ERM II entry. In this way, Slovenia would fulfil the required criteria for the adoption of the euro, by achieving an adequately low inflation rate in a sustainable way.

By implementing a strategy inspired by the two-pillar approach, BoS affirmed its adherence to the importance of money and credit developments for medium-term inflation stabilisation. The underlying monetary policy strategy principle was to prevent an expansionary monetary stance which could arise due to the necessary convergence

of interest rates in Slovenia. This was particularly relevant as the credit and interest rate channel of the transmission mechanism have been deemed to be potentially strong in Slovenia since the financing of the economy has been dominated by the banking sector. Therefore, BoS had to consider the risk that interest rate convergence would have increased credit demand and, in turn, lead to demand-led inflationary pressures. Furthermore, capital inflows would have been triggered in order to satisfy the enlarged credit needs of the economy, hence putting appreciation pressures on the currency. BoS therefore kept domestic interest rates appropriately high for as long as needed and proceeded with the convergence of policy interest rates only when ECB rates were consistent with the required domestic policy stance.

A notable difference with the ECB was that BoS operated its monetary policy in the framework of a managed floating exchange rate, without a predefined exchange rate path. The exchange rate path was set jointly with domestic interest rates and independent of the ECB's main refinancing interest rate, following the UIP rule (as explained later on). The UIP condition enabled monetary policy to maintain sufficiently high interest rates to support disinflation, while facilitating a real exchange rate path consistent with external equilibrium. In this way, exchange rate policy was supportive of BoS's primary objective of achieving price stability. At the same time, the internal and external equilibrium of the economy could be maintained, crucially contributing to the sustainability of the disinflation process. Fixing the exchange rate and adopting the euro would then come naturally when nominal convergence and a sufficient degree of real convergence had been achieved, and when an adequate macroeconomic policy framework, taking into consideration the abandonment of independent monetary policy, had been set in place.

To minimise the costs of disinflation, BoS endeavoured to increase its credibility and, therefore, improved transparency and communications. Credibility helps in the meeting of inflation expectations in line with the inflation objective and, therefore, minimises the short-run loss of output, as in Nicolae and Nolan (2006). In this respect, a focus on a longer-term inflation target is particularly beneficial in an environment of adverse supply shocks where inflation expectations are not well anchored (Alichi *et al.*, 2009). BoS's medium-term inflation objective was clearly communicated in terms of 'a progressive disinflation trend' and price stability thereafter, in place of short-term inflation targets. In line with inflation targeting, the introduction of a medium-term inflation objective, eventually bound by the criteria necessary for the adoption of the euro, was meant to provide a nominal anchor to guide inflation expectations. BoS published its forecasts of the main macroeconomic variables in regular biannual reports, presented publicly by the governor. It provided the public with BoS's own diagnosis of macroeconomic trends and its forecasts, and explained the conduct of monetary policy against the background of achieving a disinflationary trend and thereafter maintaining price stability.

### *The rationale for inflation targeting with a managed float*

At that time, when BoS was reforming its policy framework, the 'corner solutions', i.e. pure floating and completely fixed exchange rates, were widely perceived as the only viable alternatives for exchange rate regimes. The 'impossible trinity' argument

clearly opposed independent control of both interest and exchange rates in an environment of free capital flows. Also, it was argued that, in transition countries, the conditions for using the interest rate as the main monetary policy instrument were not met due to the insufficient development of the financial market and the relatively inactive interest rate channel. Fixed exchange rate regimes were, therefore, often argued as best suited for these economies, as can be found, for example, in Sachs (1996).

Why a managed float? The common answer of managed floaters would probably be that they want to rely on monetary policy to achieve some definition of price stability while they fear potential problems with a freely-floating exchange rate.

A managed float was seen as enabling BoS to give priority in monetary policy to the stabilisation of inflation (and output), which has wide support in theory and in practice. In a prevailing New Keynesian<sup>2</sup> approach, Clarida *et al.* (1999) argue in favour of an interest rate rule for acting on inflation by managing aggregate demand, which directly affects inflation but which also provides an appropriate long-term context with which to guide inflation expectations. In an open economy environment, the academic literature generally acknowledges a preference for monetary to exchange rate policy as, for example, in Clarida *et al.* (2001) and in the open economy interpretation of Aoki (2001), with a free adjustment of exchange rates. In an extension of a two-country small open economy model, Clarida *et al.* (2002) find that central banks should react to domestic inflation by adjusting interest rates while, in a context of co-operation, they should respond to foreign inflation as well.

At the same time, a managed float regime represents an attempt to avoid high volatility and amplitude in exchange rate movements which might cause macroeconomic instability, including distortion in sectoral relative prices, disruption in the financial markets and instability in financing conditions. Also, a high volatility in the exchange rate might generate a higher price level due to hedging by foreign producers and, therefore, a sub-optimally low level of output, as in Corsetti and Pesenti (2005).

In contrast to most other small transition economies, Slovenia never opted for a fixed exchange rate regime but retained an independent monetary policy. The BoS rationale for making use of an independent monetary policy, with interest rate management as opposed to exchange rate stabilisation, has been documented for example in Bole (2003). The argument was based upon his empirical finding that a restrictive exchange rate policy is much more effective at curbing prices in the tradable than in the non-tradable sector, thus causing significant relative price distortions. In turn, the sustainability of such inflation stabilisation could be questioned. On the other hand, monetary tightening influences prices in both the tradable and the non-tradable sector, thus having a much more balanced effect on overall prices in the economy. Furthermore, Bole argued that this was particularly relevant in Slovenia, where the relative price of services is already very high, and substantially higher than in the other central and eastern European countries.

Finally, an important argument in favour of the introduced framework was its compatibility with EMU principles. In the optics of the announced ultimate goal of the adoption of the euro, it embodied a natural exit strategy which, in turn, contributed to

2 Also called the New Neoclassical Synthesis, or New Wicksellian theory.

its credibility. The framework therefore provided operational continuity from its introduction through ERM II and also enabled a smooth transition to the Eurosystem's monetary strategy and operational framework.

*The choice of an UIP-consistent rule for exchange rate management*

Once the decision was taken to manage the exchange rate within a predominantly monetary framework, the question was how to ensure consistency between the interest rate and the exchange rate setting: inconsistent setting of the two instruments would create arbitrage opportunities and trigger market speculation, eventually causing the collapse of the framework.

BoS therefore aimed at achieving a consistent pricing of the two simultaneously-set instruments by relying on a UIP rule. Defining  $i$  as the domestic interest rate,  $i^*$  as the foreign interest rate and  $Ede$  as the expected rate of change in the nominal exchange rate, while  $RP$  represents a risk premium, the UIP can be represented as:

$$i = i^* + Ede + RP \tag{1}$$

If UIP holds, an investor gets an equal return on his or her investment at home and abroad. Closing the UIP with a commitment to future exchange rate dynamics therefore prevents interest-rate-elastic capital flows from neutralising the restrictiveness of monetary policy and enables the maintenance of a nominal interest rate differential *vis-à-vis* the foreign country. Such exchange rate management therefore circumvents the 'impossible trinity' limitations, but only if the exchange rate follows a particular dynamic, given the level of interest rates at home and abroad. However, implementing a UIP-consistent management of the exchange rate does not necessarily *per se* lead to the achievement of some macroeconomic goal.

Bofinger and Wollmerschaeuser (2001) show within a theoretical framework that central banks could simultaneously control the exchange rate and the short-term interest rate, in line with the UIP. In that framework, the monetary conditions index (MCI) plays a central role. A simple and intuitive representation of an MCI can be written as:

$$MCI = \alpha_1(i - p) - \alpha_2(de + p^* - p),$$

where  $p$  and  $p^*$  are the domestic and foreign inflation rate, and  $\alpha_1$  and  $\alpha_2$  the coefficients representing the strength of the direct and indirect effects of the real interest rate and real exchange rate on inflation. If  $\alpha_1 > \alpha_2$ , then a similar increase of  $i$  and  $de$ , which would keep the UIP unchanged, would act restrictively on inflation while not generating a capital inflow, thereby preserving external equilibrium. Bofinger and Wollmerschaeuser derived monetary policy rules for two operating targets, the interaction between the exchange rate and the interest rate policy simultaneously guaranteeing external and internal equilibrium. Nevertheless, if  $\alpha_1$  is close to  $\alpha_2$ , the effect of such a policy might be limited, at least in a range of realistic interest rate settings.

BoS's policy implementation was more pragmatic, however, in particular because the effects on inflation of potential increases in the depreciation rate might be strong. In practice, one might want to use the room for manoeuvre provided by the premium  $RP$  to disentangle interest rates from the dynamics of the exchange rate. In particular,

it makes it possible to maintain, on average, a moderately restrictive monetary stance, or a temporarily increased restrictive stance, while keeping the exchange rate on an inflation-neutral path on average, consistent with achieving or maintaining external equilibrium in the medium-term. In its policy documentation, the BoS clearly stated that it will:

Give signals of the dynamics in the foreign exchange rate being consistent with the long-term trend of a real appreciation [...] on the basis of the faster growth in productivity.<sup>3</sup>

In the context of a credible medium-term inflation-neutral exchange rate path, there is, in principle, no reason why exchange rate expectations should affect inflation (whatever the size of the exchange rate pass-through). Namely, there is no additional information in the exchange rate trend enabling a prediction of the inflation trend. Along these lines, one advantage BoS saw in such an approach to exchange rate management was the possibility of fully accommodating the disinflation trend, if required, so as to prevent losses in competitiveness due to excess real appreciation and, in turn, preserve external equilibrium. In a similar vein, Williamson (2000) proposed active crawling band regimes which would be used to neutralise the inflation differential and to help in steering inflation down over time.

One mistaken interpretation of such a managed float exchange rate regime is that of real exchange rate targeting. The crucial difference is in the use of the nominal interest rate with respect to the central bank objective, which was medium-term price stability in the case of BoS while it is a stable real exchange rate for real-exchange rate targeting central banks. In a response to an inflationary shock, appreciating the real exchange rate, a pure real exchange rate targeter would decrease nominal interest rates to trigger nominal depreciation, thereby to try to achieve real exchange rate equilibrium. In that case, the central bank subordinates price to exchange rate stability, with a further possibility of macroeconomic instability due to self-fulfilling expectations, as in Uribe (2003). Conversely, in a managed float regime such as implemented by BoS, the interest rate would be increased to curb inflation, supported by a depreciation of the exchange rate. A stable real exchange rate is, therefore, a (desirable) consequence and not an objective of the UIP-based managed float.<sup>4</sup>

### The operational framework for the Bank of Slovenia's monetary and exchange rate policy implementation

BoS's monetary policy stance to send a signal to the markets was determined by the simultaneous setting of its two main instruments: the interest rate; and the exchange

- 3 See BoS (2001). Note that, as already discussed, in the case of a fully credible disinflation path, a restrictive policy stance is not needed, which prevents the costs of disinflation. However, a credible capacity for policy reaction in case inflation deviates from the objective is, on the other hand, crucial.
- 4 The co-movement between inflation in prices generated by the policy framework might, nevertheless, produce spurious exchange-rate pass-through estimates. See comments on the pass-through estimates in a later section.

rate. The two corresponding instruments of the BoS operational framework were the monetisation of net capital inflows via euro currency swaps and sterilisation via tolar bills.<sup>5</sup> A supportive element of this framework was the Agreement between BoS and the commercial banks which provided the latter with unlimited access to tolar liquidity through euro swaps in exchange for their obligation to trade the euro at a given rate, where BoS wanted to signal a particular euro exchange rate path.

Foreign exchange swaps formed the main liquidity-providing operations in which BoS temporarily, for seven days, swapped euros for tolar.<sup>6</sup> The key feature was that monetisation was based on the temporary, rather than the outright, purchases of foreign exchange which made an important difference from the monetary policy perspective.

First, while the swap instrument enabled the banks efficiently to manage their liquidity, it did not allow them fully to use these short-term assets as a basis for longer-term credit expansion due to the constraints of prudential regulation. Namely, the liquidity ratio instrument regulated banks' short-term assets and liabilities according to their maturity, which prevented long-term credit expansion on the basis of short-term assets. The result was that credit growth remained limited in an environment of large capital inflows and despite the swap instrument being, to a major extent, rolled-over.

Second, the swap instrument was provided on the basis of the intervention policy being (close to) cost neutral for BoS, hence making the interventions financially sustainable over the medium-term. In particular, BoS set the price for using the swaps in line with uncovered interest rate parity, taking into account the main refinancing rate at the ECB, representing the approximate cost of euro liquidity; while the interest rate of BoS tolar bills represented the price of sterilisation and the change in the euro/tolar exchange rate. Moreover, the shorter term of the swap instrument and its cost-dependence on *ex post* exchange rate dynamics, as shown below, represented some degree of uncertainty about the price of these operations and contributed to a discouragement of potential speculative capital flows.

To absorb excess liquidity, mainly resulting from net financial inflows, BoS conducted liquidity-absorbing operations by issuing tolar bills. These enabled the Bank of Slovenia to absorb most of the excess liquidity by the issue of tolar bills with a maturity of up to one year. 60-day tolar bills were made available to commercial banks at any time and in any amount. Occasionally, mainly in the case of sizable interest-inelastic inflows of capital (e.g. FDI-related capital inflows), BoS withdrew liquidity with tolar bills of maturities of 270 days and 360 days, and a premium over the 60-day tolar bill. Monetary policy had mainly to be conducted in an environment of a structural liquidity surplus, so the interest rate on this instrument represented the most relevant BoS interest rate, i.e. it played the role of the main reference rate.<sup>7</sup>

5 See Banka Slovenije (2002) *Monetary policy implementation report*.

6 There was also a reverse swap instrument (banks could temporarily sell tolar liquidity to obtain euros), but it was used only to a limited extent in the course of the ERM II period, due to the overall structural excess of foreign liquidity.

7 In contrast to the ECB (and most other major central banks), where the main interest rate is the one referring to the liquidity providing instrument.

To make the UIP framework operational and credible, a supportive element was a contractual agreement between BoS and the commercial banks on access to tolar liquidity through the foreign exchange swap facility. It was formally introduced in 2000 and completed with an annex in 2001, and was also retained in place during ERM II participation (henceforth, the ‘Agreement’). Participation in the Agreement was voluntary but, due to its attractiveness, nearly all banks participated. Namely, the participating banks had exclusive and unlimited access to the foreign exchange swap facility and, hence, to tolar liquidity – it was a standing facility instrument. Another incentive for participation was a relaxation of the strict prudential regulation regarding currency matching.<sup>8</sup> In return, during periods of direct ‘price’ interventions, the banks were bound to set the market exchange rate (at which they conducted deals with other parties) within the band around the exchange rate signalled in the swap operations. BoS usually used these ‘price interventions’ to signal a change in the desired depreciation dynamics, and then let the markets operate freely on the new depreciation path. The last time such an intervention was used was upon ERM II entry as a means of signalling BoS’s intention to keep the exchange rate stable.

It was mentioned above that the pricing of the operational instruments was constrained by the UIP relationship in order to prevent arbitrage opportunities or speculation among investors on the BoS instruments. Given the short maturities of these instruments, BoS had to price the 60-day tolar bill and the swap rate within the following UIP-based relationship:

$$\text{BoS 60-day tolar bill rate} \leq \text{ECB main refinancing rate} + \text{swap rate} + \text{risk premia} \quad (2)$$

In principle, an investor with access to main refinancing operations at the ECB could have bought tolar bills from the BoS. If such operations had been costless, they would have triggered an arbitrage opportunity if the yield on the tolar bill exceeded the cost represented by the *swap rate* and the *ECB refinancing rate*. However, in general BoS could maintain a somewhat smaller *swap rate* than the interest rate differential. This is permitted because such an operation is associated with various costs, embodied in the *risk premia* element of equation (2): the exchange rate risk premium; the country risk premium; the liquidity premium; the term premium, where the tolar bill term was longer than that of the swap; the information premium; transaction costs; etc.

The *swap rate* was used to steer exchange rate dynamics. When using the swap facility, the *swap rate* determined the price for commercial banks, while their return in foreign currency was the *ex post* dynamics in the nominal exchange rate. The difference between the two represented the cost for the banks, i.e. the *swap fee*:

$$\text{swap fee} = \text{swap rate} - \text{change in the exchange rate} \quad (3)$$

As shown in (3), the banks actually favoured a depreciating exchange rate, all the more so if the *swap rate* was high as they wanted to minimise the *swap fee*. Alterna-

8 For participating banks, the liquidity requirement was not bound to a separate match of tolar- and foreign currency-denominated liabilities by assets of the same currency, but jointly for the sum of tolar- and foreign currency-denominated assets and liabilities.

tively, banks always had the possibility of buying toolars on the spot market with, however, a degree of exchange rate risk, which was particularly large due to the shallow Slovenian foreign exchange market. By increasing (decreasing) the cost of the swap (the *swap fee*), BoS could have discouraged (encouraged) the banks to use it and, as a result, pushed them in or out of the spot market to sell foreign currency.<sup>9</sup> The adequate pricing of BoS's instruments therefore had a stabilising role on the foreign exchange market, and substantially smoothed short-term exchange rate dynamics. However, since it was *ex post* exchange rate dynamics that determined the actual cost of the swap for the banks, the credibility of BoS to commit *ex ante* to a certain (signalled or implicitly signalled) exchange rate path was crucial. This exchange rate path had to be consistent with a sufficiently low swap cost. In other words, the desired depreciation path was self-fulfilling and stable, and in the interest of the markets (the banks), as long as it was consistent with the UIP and the swap cost was sufficiently low for the banks. This has also been acknowledged by the European Commission (2006):

The mechanism would be unlikely to survive a strong misalignment of the nominal exchange *vis-à-vis* an exchange rate preferred by the markets.

This operational framework gave BoS a powerful tool with which to exert control over the exchange rate within the range determined by the UIP and contributed to a smoothing of its dynamics. It also gave some room for manoeuvre to the BoS macroeconomic policy stance, as discussed in the following section. It facilitated, if it was required, the maintenance of a moderately restrictive interest rate without necessarily inflating exchange rate dynamics, due to  *premia* in (2) and the  *swap fee* in (3) that, together, constitute the risk premium  *RP* in (1).

### Macroeconomic transmission and the Bank of Slovenia policy framework

The way that macroeconomic shocks and the monetary policy stance transmit to the economy is crucial for the design of the monetary policy framework. In the attempt to evaluate the macroeconomic transmission, we examine the dynamic interactions of the real policy interest rate  *ir* and the nominal tolar/euro exchange rate  *eur* with prices  *p*, output  *gdp* and total economy credit  *cred*. The interactions among these variables are described in the form of an estimated linear econometric model. The model variables are augmented by the international price of oil  *oil* to control for its impact in particular on domestic prices.  *Oil* is expressed in euros, thus including the most important way that the dollar exchange rate affects the domestic economy. The variables  *eur* and  *oil* thus together account fairly well for the effective nominal exchange rate effects.

9 This would, in turn, cause the appreciation of the domestic currency in the case of net financial inflows. Manipulating the swap rate could, therefore, in principle, be used (temporarily) to push the exchange rate towards appreciation, if needed, at the expense of higher exchange rate variability. Also, that might, in turn, reduce the inter-temporal credibility of BoS in maintaining the pricing of its instruments in the interests of the market, as well as in lowering the attractiveness of using the swap.

A short available data sample, often exhibiting high frequency volatility due to several one-off shocks and possible measurement errors, led us to implement a potentially more robust approach by weighting together plausible alternative model specifications and setting aside the identification choices one usually makes in standard Structural Vector Autoregression (SVAR) settings, which is generally implemented for the analysis of the transmission mechanism. In what follows, we formally outline the method, motivate the methodological choices and present the results in the form of typical model experiments.

The last part of this section puts the results into the perspective of the framework implemented by BoS.

*The model identification, sign restrictions on the coefficients and estimation*

A standard dynamic simultaneous equations model in structural form can be represented as:

$$A(L)Y = B(L)X + \Xi, \tag{1}$$

where  $L$  is a lag operator,  $Y$  a  $T \times N$  matrix of endogenous variables,  $X$  a  $T \times K$  matrix of exogenous variables,  $\Xi$  a  $T \times N$  matrix of structural shocks, and  $A^l$  and  $B^l$  respectively  $N \times N$  and  $K \times N$  matrices of model coefficients to be estimated at each considered time lag  $l$ .  $T$  is the sample range,  $N$  the number of endogenous variables, determining also the number of equations in model (1), and  $K$  the number of exogenous variables. Normalising the diagonal elements of  $A^0$  (the matrix of simultaneous effects) to 1, letting  $-a_i^l$  be the vector of elements in the  $i$ th column of  $A^l$ ,  $b_i^l$  the vector of elements in the  $i$ th column of  $B^l$ , and  $\xi_i$  the vector of elements in the  $i$ th column of  $\Xi$ , one can rewrite the  $i$ th equation of model (1) as:

$$y_i = \sum_l Y_l^l a_i^l + \sum_l X_l^l b_i^l + \xi_i, \tag{2}$$

where  $Y_l^l$  and  $X_l^l$  are  $X$  and  $Y$  postmultiplied by  $-a_i^l$  and  $b_i^l$ , respectively. In each equation  $i$ ,  $y_i$  is termed as the explained variable while the  $y_j$ s for  $j \neq i$  and  $x_j$ s are explanatory variables. Adding up vectors  $a_i^l$  and  $b_i^l$  across  $l$  gives the vector of coefficients to be estimated  $(a_i, b_i)$ . Eventually,  $(a_i, b_i)_s$  defines the coefficient values in the specification  $s$  of equation (2), where  $s$  specifies the set of exclusion restrictions on the coefficients of equation (2).

Overall, our approach is as follows. We estimate several plausible specifications of model (1) equation by equation, directly in structural form (2). The different specifications of each equation are weighted together to construct the final estimate of  $(a_i, b_i)$  if they satisfy the sign restrictions imposed on some of the coefficients. These sign restrictions impose the direct (and initial) effect of one variable on another to be either positive or negative, according to some theoretical prior. For the purposes of the model estimation, the endogenous variables  $y_i$  are  $p, gdp, cred, ir$  and  $eur$ , while the exogenous variables  $x_i$  are  $oil$ , the lags of all the variables intervening in the model and a constant term. Given the way we present the results, we only need to estimate the equations for  $p, gdp$  and  $cred$ . Important steps in this approach are now presented in further detail.

The estimated equation specifications differ in their distributed lag structure. We restrict the model so that, in each equation specification, all explanatory variables exert a direct effect on the explained variable for two, and only two, periods either at lags 0 (simultaneous effect) and 1, or at lags 1 and 2.<sup>10</sup> In addition, for each explanatory variable we consider the case where it is excluded from the equation; thus having no direct effect at any lag. This gives three alternative specifications for the lag structure of explanatory variable  $j$ ; coefficients  $a_{v,j}^l$  if  $j$  is endogenous and coefficients  $b_{v,j}^l$  if  $j$  is exogenous, with exclusion restrictions:

lag specification 1 for explanatory variable  $j$ :  $a_{v,j}^l, b_{v,j}^l = 0$  for  $l > 1$

lag specification 2 for explanatory variable  $j$ :  $a_{v,j}^l, b_{v,j}^l = 0$  for  $l > 2$  or  $l = 0$

lag specification 3 for explanatory variable  $j$ :  $a_{v,j}^l, b_{v,j}^l = 0$  for all  $l$ .

For the lags of the explained variable  $i$  we consider all specifications, including up to four own lags:

lag specification 1 for explained variable  $i$ :  $a_{v,i}^l = 0$  for  $l > 1$

lag specification 2 for explained variable  $i$ :  $a_{v,i}^l = 0$  for  $l > 2$

lag specification 3 for explained variable  $i$ :  $a_{v,i}^l = 0$  for  $l > 3$

lag specification 4 for explained variable  $i$ :  $a_{v,i}^l = 0$  for  $l > 4$ .

The four structural dynamic specifications for the lags of the explained variable, and three for each explanatory variable, yield altogether  $4 \times 3^{N-1+K}$  specifications, 972 in our case. The constant term is included in all considered specifications.

Each equation specification is estimated by the General Method of Moments (GMM) examined, for example, in Hansen (1980). It requires, for formal identification purposes, that the number of instrumental variables at least matches the number of coefficients to be estimated in each equation specification. The number of estimated coefficients, including constants, amounts to up to 15 (in the case of no full exclusion specification for the explanatory variable and specification 4 for the explained variable). Using the set of exogenous variables  $x_i$ , (*oil*, the lagged values of all present variables, 2 for each of the five explanatory and 4 for the explained variable, and a constant term) provides 16 instruments. The rank condition therefore always holds with inequality and the parameters are over-identified.

Estimating directly the structural form (2) enables a simple check for the sign of the direct (and initial) effect that the explanatory variable  $j$  exerts on the explained one. This is done by:

checking the sign of  $a_{v,j}^0, b_{v,j}^0$  if the lag specification for  $j$  is 1, and checking the sign of  $a_{v,j}^1, b_{v,j}^1$  if the lag specification for  $j$  is 2.

To check for the sign of the direct effect, we examine only the first included lag term of  $j$ . Leaving the second lag term unconstrained enables the data to shape the dynamic effects among the variables. Effects of own lags  $a_{v,i}^1$  are also unconstrained.

10 The number of lags is thus imposed to be two for explanatory variables and up to four for the explained variable, as follows. This is in line with the optimal lag length in studies of the transmission mechanism in the Euro area. See, for example, Peersman and Smets (2001); or Mojon and Peersman (2001).

Imposing sign restrictions on the coefficients brings the qualitative model behaviour closer to some common theoretical priors we would like it to match. Considering the three estimated equations, we assume that a specification  $s$  satisfies the sign restrictions of set  $S^*$  on the direct effects among variables,  $s \in S^*$ , if the direct effect of the explanatory variable in the equation is as set out in Table 1:

**Table 1 – Sign restrictions on the direct effect of explanatory variable**

	$p$	$gdp$	$cred$	$ir$	$eur$	$oil$
$gdp$	-		+	-	+	-
$p$		+	+	-	+	-
$cred$	+	+		-		

Note: an increase in  $eur$  means a depreciation of the domestic currency.

Relating our model to a typical macro model, we interpret the equation for  $gdp$  as an IS curve, and therefore  $\xi_{gdp}$  represents an aggregate demand (‘demand-pull’) shock. Similarly, the equation for  $p$  is related to the standard Phillips curve, and so shocks  $\xi_p$  represent supply (or ‘cost-push’) shocks. Following the conventional theoretical priors, we therefore assume a positive effect of  $gdp$ ,  $cred$ ,  $eur$  and  $oil$  on prices, while higher  $ir$  exerts a deflationary effect due to increased monetary restriction.

In the second equation, an increase in  $p$ ,  $ir$  and  $oil$  produces a negative effect on  $gdp$ , while  $eur$  and  $cred$  generate a stimulatory effect. The equation for  $cred$  is included to take into consideration the direct transmission to the macroeconomic variables of (shocks to) credit. In such situations, nominal credit  $cred$  increases with prices  $p$ , although possibly less than one-to-one, generating a decrease in real credit, as well as with  $gdp$ ; while it decreases with the cost of funding  $ir$ . We leave the sign of the direct effect on  $cred$  of  $eur$  and  $oil$  unconstrained, due to the lack of a convincing prior.

Finally, the estimated equation specifications are weighted together to construct the equation parameters used in simulations  $(a_i, b_i) = \sum_s w_s (a_i, b_i)_s$ , where the weights on specification  $s$  take the form:

$$w_s = I[s \in S^*] (\bar{R}_s^2 - \bar{R}_{min}^2) / (\bar{R}_{max}^2 - \bar{R}_{min}^2) / \sum_s I[s \in S^*] (\bar{R}_s^2 - \bar{R}_{min}^2) / (\bar{R}_{max}^2 - \bar{R}_{min}^2)$$

$I[z]$  is an indicator function taking the value 1 if the relation  $z$  holds true and 0 if not, stating that only specifications  $s \in S^*$  have a non-zero weight. Instead of simply averaging across specifications, we wanted the weights  $w_s$  to be higher for specifications with a higher explanatory power, but with a penalty for the number of the degrees of freedom used. The focus is not on selecting the lag length, being set to 2 for the explanatory variables, so we selected the adjusted  $R^2$  measure  $R^2_s$  to weight different specifications together. To differentiate among specifications, we construct the *ex ante* weighting of each specification so that the specification with the highest  $R^2_s$  (max) is 1 and that with the lowest  $R^2_s$  (min) is 0. The *ex ante* weights of other specifications are linearly interpolated between the two extremes and are represented in the numerator

of the ratio defining  $w_s$ . Dividing each *ex ante* weight by the sum of all the weights ensures that weights  $w_s$  add up to 1.

The estimation sample spans from 1995 to 2008, comprising fourteen years of usable quarterly data. This requires data from 1994 onwards, since up to four lags are present in the equation specifications. All the variables enter the model in log-differences, except for *ir* which enters in levels. The data source is the Statistical Office of the Republic of Slovenia for *p* and *gdp*; the BoS monthly Bulletin for *eur*, *cred* and the nominal interest rate; and Reuters for the international price of oil. For *p*, the HICP is used, combined with CPI prior to 1996. The real interest rate is obtained by subtracting the quarterly inflation rate at a yearly level from the nominal policy interest rate for 60-day BoS tolar bills.<sup>11</sup>

All the variables are adjusted for seasonal effects and high frequency variability (due to the irregular component in some series), deemed not relevant for the medium-term economic transmission. More specifically, we use a combination of the x12 US Census cyclical trend and seasonally adjusted component, weighting the former by three-quarters and the latter by one-quarter. This appears to be a sensible compromise between not filtering enough noise and filtering too much useful information out of the data, and generates a relative variability in the dataset comparable to the year-on-year figures, most often of interest to economists where log-difference dynamics are very volatile.

### *The motivation behind the method*

The method tries as far as possible to circumvent the difficulties due to the small sample of usable data. We thus view it as a pragmatic means of evaluating the transmission mechanism in such circumstances. In particular, the idea of averaging, or weighting, across different model specifications and imposing sign restrictions has been an attractive way to gain robustness or to provide alternative identification schemes in structural VARs as can be seen, for example, in Faust (1998) or Uhlig (2005).

Nevertheless, imposing sign restrictions directly on structural coefficients is closer to the way that traditional structural econometric models are estimated, while Faust (1998), Canova and De Nicolo (2002) and Uhlig (2005), for example, impose sign restrictions on structural model impulse-responses to shocks. Structural econometric models are most often used in institutions such as central banks, as presented in Fagan and Morgan (2005), for the purposes of forecasting and experimentation, similar to those we conduct in the next section. In this article, the purpose of such models is not to test some theory, but to try to evaluate the magnitude of policy interventions or economic shocks, while the information content of the data still determines the magnitude of these direct effects. Note that the sign of the direct effect does not necessarily determine the sign of the impulse-response of a given variable, since the shocked variable might affect other variables that have a converse, and potentially stronger, effect on that given variable.

Besides the sign restrictions on some coefficients, however, the shape of the model is closer to a structural VAR than a traditional structural econometric model. All equa-

11 For the period after the adoption of the euro, the ECB main refinancing rate is used.

tions contain all variables and their lags, with the useful properties argued for in Sims (1980). VARs are often seen as a useful summary of the information content of the data. This is obtained without *a priori* excluding variables from some of the equations in the model, which is difficult to motivate if economic agents form their expectations rationally. The presence of lagged values of the model variables enables the model to account for a progressive reaction to shocks to the underlying economic structure, informational lags, time to build, etc.

Furthermore, the estimation procedure of each model equation is symmetric, where all equation specifications are examined on equal grounds. No variable in any of the equations is favoured. The data decides on the specification's weight, given the sign on some of the coefficients and its ability to fit. In terms of exclusion restrictions on the matrix of simultaneous effects  $A^0$ , all specifications generally considered in VARs are included in the set of evaluated equation specifications. The GMM technique is supposed to avoid the endogeneity bias in the estimation of coefficients for endogenous variables in each equation specification. A sufficient number of available instruments enables us to confront with the data, pragmatically, any number of exclusion restrictions on  $A^0$ , including zero. In such a way, standard identification or ordering problems are set aside from the estimation procedure.

### Results

In line with the tradition in the analysis of dynamic models, the macroeconomic transmission is described in terms of the model response functions to relevant macroeconomic shocks or experiments. We start by examining the macroeconomic responses of interest rate and exchange rate interventions and then turn to the shocks to aggregate demand  $\zeta_{\text{gdp}}$ , supply  $\zeta_p$  and credit activity  $\zeta_{\text{cred}}$ . Note that oil is expressed in euros, so that all changes in *eur* transmit in the same proportion to *oil*. The short-term resulting dynamics of the macroeconomic variables are summarised in tables representing the effects on levels for the first year (or, equivalently, the percentage deviation in the year-on-year growth rate). The medium-term dynamics are represented by average yearly growth rates for the first three years after the start of each experiment.

The estimated responses to a 1 percentage point nominal interest rate increase over the simulation horizon are presented in the left-hand half of Table 2. The levels of output, prices and credit progressively decrease during the first year of the shock, with an effect of -0.73, -0.55 and -0.82 respectively, four quarters after the shock. The transmission is rather strong and gains momentum in the subsequent years, since lower inflation increases real interest rates. Inflation decreases by 0.30 percentage points in the first year, somewhat below 1 percentage point in the second year and more than one percentage point afterwards. The decrease in real output growth is stronger at the beginning of the simulation, reaching around one percentage point in the third year. The medium-term effect on nominal credit growth is roughly in line with the combined effect on inflation and real GDP growth, decreasing by two percentage points in the third year.

The right-hand half of Table 2 shows the estimated responses to an increase in the real interest rate accompanied by a nominal exchange rate adjustment (appreciation with respect to the baseline), keeping the real exchange rate unchanged. This could be

seen as a simple representation of the BoS disinflation strategy. The effects on inflation are reasonably comparable to the previous experiment, while the effects on output and credit are much lower. This is because the real interest rate remains constant over time instead of increasing with a fall in inflation, which moderates the effect on output. At the same time, the nominal exchange rate adjusts to inflation (i.e. it appreciates) to keep the real exchange rate unchanged, thereby supporting disinflation. Furthermore, credit growth is positively affected by nominal exchange rate appreciation, so the total effect is only a minor decrease in nominal credit growth.

We further discuss the effects of the nominal exchange rate on credit in the next section.

**Table 2 – Central Bank (CB) policy rate transmission channel**

Re- sponse to	CB nominal rate 1p.p. increase, constant nominal ER					CB real 1p.p. increase, constant real ER				
	of	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>ir</i>	<i>eur</i>	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>ir</i>
1 quarter	-0.132	-0.074	-0.054	1.294	0.000	-0.102	-0.063	-0.049	1.000	-0.063
2 quarters	-0.326	-0.200	-0.206	1.508	0.000	-0.237	-0.173	-0.170	1.000	-0.173
3 quarters	-0.525	-0.361	-0.466	1.642	0.000	-0.363	-0.318	-0.344	1.000	-0.317
4 quarters	-0.732	-0.549	-0.815	1.752	0.000	-0.487	-0.490	-0.538	1.000	-0.490
1 year	-0.429	-0.296	-0.385	1.549	0.000	-0.297	-0.261	-0.275	1.000	-0.261
2 years	-0.875	-0.864	-1.571	0.479	0.000	-0.494	-0.793	-0.659	0.000	-0.794
3 years	-1.024	-1.251	-2.190	0.342	0.000	-0.476	-1.171	-0.300	0.000	-1.171

*Quarterly responses are contained in year-on-year growth; yearly responses reflect average yearly growth.*

Turning to the exchange rate effects, the left-hand half of Table 3 represents a typical exchange rate pass-through experiment in the context of a neutral interest rate stance. A one per cent depreciation in the nominal exchange rate, accompanied by an increase in the nominal interest rate, has a temporary effect on output growth and inflation, and a permanent effect on prices. The effect on output appears to be small (less than 5 % of the exchange rate change after one year). A pass-through on the price level is roughly 40 % after one year and somewhat more than 60 % in the third year (cumulating the impact on inflation).<sup>12</sup> As expected for a small open economy, the exchange rate pass-

12 This finding is in line with the general assessment that the pass-through is less than complete; being highest for import prices, lower for producer prices and lowest for consumer prices (see, for example, Coricelli, Égert and MacDonald, 2006). The estimate is also broadly in line with most empirical studies for Slovenia – Banerjee and Haiyan (2010); Žumer (2005); and

through is fairly strong, although far from complete in the short-to-medium term, at least in the case of a passive policy response to the increase in inflation. Conversely, the impact on credit is strongly negative and this effect is unconstrained in the model. This could contribute some evidence on the importance of the effect of exchange rate dynamics on capital inflows which, in turn, affect the intermediating capacity of the banking sector. In that respect, an interesting direction for further research would be the way that interest rate changes affect the net foreign financial position and the current account.

BoS used the nominal changes in exchange rates (depreciation at a time of disinflation) in pursuing its strategy, so the right-hand half of Table 3 shows a pass-through of a continuous 1 % depreciation at the yearly level. The impact on output is again moderate, while the nominal depreciation is progressively passed through to prices. The average nominal exchange rate depreciation of 0.62 percentage points in the first year produces a 0.15 percentage point increase in inflation, while after three years the pass-through of the nominal exchange rate dynamics is 60 %. The effect on credit growth is, again, negative.

**Table 3 – Exchange rate transmission channel**

Response to	1 % nominal ER increase, constant <i>ir</i>					1 % nominal ER yearly growth increase, constant <i>ir</i>				
	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>ir</i>	<i>eur</i>	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>ir</i>	<i>eur</i>
1 quarter	0.002	0.092	0.120	0.000	1.000	6E-04	0.023	0.030	0.000	0.250
2 quarters	0.029	0.280	0.066	0.000	1.000	0.008	0.093	0.047	0.000	0.500
3 quarters	0.048	0.387	-0.177	0.000	1.000	0.020	0.190	0.002	0.000	0.750
4 quarters	0.047	0.438	-0.464	0.000	1.000	0.032	0.300	-0.114	0.000	1.000
1 year	0.031	0.300	-0.114	0.000	1.000	0.015	0.151	-0.009	0.000	0.625
2 years	-0.008	0.234	-0.740	0.000	0.000	0.034	0.471	-0.612	0.000	1.000
3 years	-0.015	0.094	-0.099	0.000	0.000	0.012	0.598	-0.942	0.000	1.000

*Quarterly responses are contained in year-on-year growth; yearly responses reflect average yearly growth.*

Note that the pass-through estimates might be biased upwards, due to the presence of reverse causality between inflation and nominal exchange rate dynamics, especially if there is an omitted variable in the model. It was shown above that the BoS exchange rate policy has resulted in a highly stable real exchange rate path. This implies a strong correlation between exchange rate dynamics and inflation, which might produce an

Darvas (2001) – while Coricelli, Jazbec and Masten (2006) estimate the pass-through to be already complete within one year by estimating it within a co-integrating framework.

overestimation of the effect of the exchange rate on inflation. This might be checked, for example, by adding structure to the model: in particular a forward-looking dimension accounting for expectations; labour cost, to isolate the persistence that may be generated by wage rigidity; an explicit output gap; etc.<sup>13</sup>

The estimated responses of the model economy to other shocks are represented in Table 4. The top half shows responses without nominal adjustment of the monetary policy instruments, while the lower half shows the responses with an unchanged real interest rate, in which the dynamics of the nominal interest rate follow the path of annual inflation exactly. The first case might be interpreted as a shock without a policy reaction, such as an asymmetric shock associated with a currency union; while the second case is a neutral interest rate scenario, giving some insight on the effects of the monetary policy reaction to shocks.

To read the experiments easily, all shocks are normalised so that the level (and thus the year-on-year growth) of the shocked variable is 1 % higher in the first year after the shock in the first case, where the nominal interest rate and exchange rate remain unchanged. We then use a shock of the same magnitude in the second case.

**Table 4 – Transmission of main macroeconomic shocks**

Case 1: Nominal CB rate and nominal ER unchanged									
Response to:	shock to <i>gdp</i>			shock to <i>p</i>			shock to <i>cred</i>		
of:	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>gdp</i>	<i>p</i>	<i>cred</i>
1 quarter	0.432	0.022	0.030	0.092	0.278	0.098	0.008	0.011	0.235
2 quarters	0.748	0.125	0.172	0.231	0.583	0.307	0.029	0.034	0.534
3 quarters	0.898	0.264	0.420	0.344	0.813	0.572	0.054	0.062	0.804
4 quarters	1.000	0.392	0.707	0.428	1.000	0.841	0.078	0.090	1.000
1 year	0.770	0.201	0.332	0.274	0.668	0.454	0.042	0.049	0.643
2 years	0.367	0.455	0.940	0.339	0.765	0.960	0.073	0.100	0.563
3 years	0.141	0.337	0.505	0.235	0.559	0.704	0.032	0.073	0.113

13 This is particularly true in a co-integration framework, where one would estimate the co-integration relationship between the price level and the nominal exchange rate (with inclusion a trend). Given the (trend-)stationarity of the real exchange rate, the estimated co-integration coefficient is very likely to be very close to 1 due to the common trend in both variables. However, if the common trend is a result of monetary policy, it might be erroneous to interpret this coefficient as a long-term exchange rate pass-through.

Case 2: Real CB rate and nominal ER unchanged									
Response to:	shock to <i>gdp</i>			shock to <i>p</i>			shock to <i>cred</i>		
of:	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>gdp</i>	<i>p</i>	<i>cred</i>	<i>gdp</i>	<i>p</i>	<i>cred</i>
1 quarter	0.423	0.017	0.026	-0.021	0.215	0.052	0.004	0.008	0.233
2 quarters	0.695	0.094	0.145	-0.041	0.415	0.133	0.013	0.025	0.525
3 quarters	0.776	0.187	0.335	-0.047	0.537	0.200	0.025	0.043	0.782
4 quarters	0.814	0.261	0.531	-0.049	0.623	0.240	0.035	0.059	0.957
1 year	0.677	0.140	0.259	-0.040	0.447	0.156	0.019	0.034	0.624
2 years	0.151	0.242	0.545	-0.017	0.341	0.116	0.026	0.052	0.474
3 years	-0.008	0.109	0.089	-0.008	0.152	0.016	5E-04	0.023	0.022

Quarterly responses are contained in year-on-year growth; yearly responses reflect average yearly growth.

The transmission from an aggregate demand shock, a shock to *gdp*, is outlined in the left-hand side of Table 4. In a situation where nominal monetary policy instruments remain unchanged, the response of output after one year is roughly twice the size it was at the impact. Output keeps increasing even three years after a shock, with the effect on growth halving in each year.

The response of inflation is very progressive, but strong and persistent. One year after a shock, when year-on-year output growth has increased by 1 percentage point, the year-on-year inflation rate has increased by almost 0.4 percentage points, while the effect on yearly average inflation is higher. In the first three years, the cumulative growth effect of around 1.2 percentage points generates a cumulative effect on inflation of almost 1 percentage point.<sup>14</sup>

Higher demand and output, in turn, also produce a strong increase in nominal credit, with a cumulative growth effect of roughly 1.75 points and a maximum effect on growth in the second year. An increase of the nominal interest rate in line with inflation makes the shock significantly less persistent, with a growth effect on output less than twice as low in the second year, and growth turning to negative in the third year. Similarly, the effect on both inflation and credit growth slows down much faster.

A strong persistence in the inflation response is also apparent in response to a price shock, as shown in the central part of Table 4. In a situation where the nominal policy instruments remain unchanged, the effect of inflation is even higher in the second year than in the year of the impact, and decreases only slowly thereafter. It is interesting to note that both output and credit also increase after a price shock, even though such a negative supply shock is constrained to generate a negative direct effect on prices.

14 A similar effect is found in Banerjee and Haiyan (2010).

However, keeping real interest rates constant, as shown in the lower half of Table 4, reverses this feature: a price shock produces the expected negative response concerning real output and real credit, as the increase in nominal credit is lower by far than the increase in prices. This indicates that a shock to prices has strong amplifying effects where monetary policy reaction is absent. Unchanged nominal exchange rates and real interest rates are eroded by the increase in inflation which, besides the direct effect on inflation, generates a strong positive impact on demand and credit and, in turn, adds significantly to the persistence of higher inflation. Keeping the stance on interest rates at an unchanged level evidently prevents the inflation rate from rising for two consecutive years and generates a roughly twice lower cumulative response to the same price shock when examined over a three-year horizon.

Finally, a shock to credit produces a potentially relevant effect on output and inflation which is, again, strongly dependent on the interest rate reaction. The effect of this shock, shown on the right-hand side of Table 4, represents a change in financing conditions independent of the change in financial cost embodied in  $ir$ . The transmission is progressive, so an autonomous shock to credit has only a limited effect on output and prices in the short-term but, on the other hand, a quite relevant one in the medium-term. The cumulative effect on growth, over three years, is roughly 15 % for output and roughly 20 % for prices (expressed as a share of cumulative credit growth). It is shown in the lower half of Table 4 that the effect of a credit shock on output and prices is almost halved if the monetary stance remains unchanged in terms of real interest rates. This reconfirms a strong and effective interest rates channel and the effectiveness of a policy reaction to counter the undesirable effects of shocks.

#### *An assessment of the BoS monetary framework*

These results are obtained in the context of a very simple model, which can certainly be extended in many directions. Nevertheless, the estimated transmission dynamics enables us to draw some findings which we believe are important to an assessment of policy design.

To a large extent, the estimates support the potential of the BoS monetary policy framework to control the medium-term inflation dynamics and ensure the targeted disinflation path. The relatively strong interest rate transmission on output and inflation can generate both a progressive disinflation and price stability, such as has been announced by BoS as its primary objective. This can be achieved by using the room provided by the UIP-managed exchange rate to increase interest rates as long as inflation and inflation expectations deviate from the desired disinflation path (or a stable inflation target). In addition, the risk premium  $RP$ , embodied in the UIP relationship (1), enables the maintenance of a moderately restrictive stance on average, if required, while keeping the real exchange rate on an inflation-neutral path, as discussed above.

On the other hand, the exchange rate pass-through on inflation is far from negligible. This might limit the scope for following a strict UIP rule, as Bofinger and Wollmerschaeuser (2001) comment, in circumstances where the exchange rate (at a yearly level) increases on a one-to-one basis with the interest rate. In the estimated model, inflation decreases by 0.3 percentage points in the first year subsequent to a simultaneous increase in the nominal interest rate by 1 percentage point and an increase in exchange

rate depreciation by 1 percentage point on a yearly level. This represents roughly two-thirds of the effect without additional exchange rate depreciation, and indicates a stronger interest rate than exchange rate channel in acting on inflation and output. However, the effect on inflation does not increase after the first year, indicating that, after the first year, the effects of interest rates and exchange rate depreciation roughly cancel each other out. Depreciation (or lower appreciation) is revealed, however, as a very powerful tool against (excessive) credit growth, whereas appreciation could trigger an acceleration in credit growth. Besides its effect on international competitiveness and the current account, exchange rate dynamics might, therefore, have important bearings for the stability of the financial conditions.

These results can also provide some brief insight into the potential performance of alternative policy arrangements, in particular corner solutions. Certainly, a free float has potential for much faster disinflation. In the case of monetary tightening, real appreciation would add to the interest rate channel in acting on inflation, at least in the short-term. Nevertheless, the shallow exchange rate market could trigger high exchange rate volatility, with unfavourable consequences for macroeconomic stability and possibly too much real appreciation in the medium-run, with unfavourable consequences for the country's competitiveness. Furthermore, such developments might lead to risky 'stop-go' policies under which the central bank might keep interest rates at excessively low levels to generate exchange rate depreciation. This might, in turn, affect the sustainability of the achieved disinflation.

In comparison to a free float, the BoS monetary policy framework could be seen as trading some of its restrictive power, in terms of acting against inflation, for a more stable macroeconomic environment and, therefore, possibly more sustainable disinflation. On the other hand, fixing the nominal exchange rate might not even guarantee a better outcome in terms of inflation, although there would be a sizable real appreciation in the short-to-medium run due to inflation inertia. Indeed, the latter would crucially depend on the real interest rates path. If BoS was forced to maintain interest rates close to those prevailing in the euro area, these might enter a negative phase and generate a typical boom-bust cycle.

Of course, the discussion on alternative policies must be cautious, in terms of their quantitative effects, as such policy changes (may) alter the transmission mechanism estimates, in line with the critique of Lucas (1976).

In any case, the obtained results point to a strong need for effective macroeconomic policy management. Given the potentially strong and persistent effects on inflation after a price shock, a strong macroeconomic policy counteraction is essential. This goes in line with the strong calls from BoS in support of fiscal and wage policy in its objective of minimising the potential costs of disinflation. This assessment has even been reinforced after the introduction of the euro and the abandonment of independent monetary policy. This view was widely shared by policy-makers ahead of entry into ERM II. This led to a new policy mix in which fiscal policy was put in charge of macroeconomic policy, together with a sustainable wage policy. Kozamernik (2004) discusses that the joint programme for ERM II entry and the adoption of the euro, agreed by the government and BoS in November 2003, was indispensable in ensuring sustainable price

stability within broader macroeconomic stability over the medium-term in ERM II, but also after the adoption of the euro.<sup>15</sup>

The conduct of monetary and exchange rate policy, the disinflation trend and the exit strategy

After 2000, Slovenia experienced a continuous and stable disinflation trend, followed by inflation stabilisation in 2005. Inflation decreased from close on 10 % to around 2 % in mid-2005 and then fluctuated at levels below 3 % up to 2007. An analysis of the main drivers of the disinflation process can be found in regular BoS monetary policy implementation reports and, for example, in Banerjee and Haiyan (2010) or Kozamernik (2005).

#### *The conduct of BoS monetary and exchange rate policy*

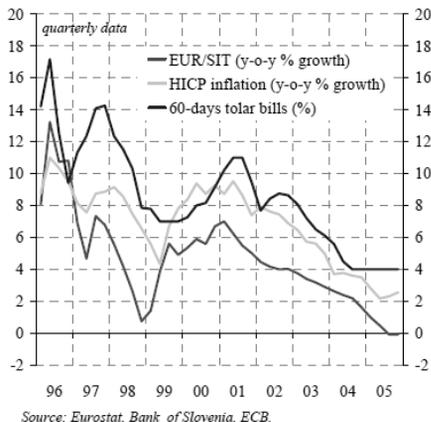
BoS interest rate increases lagged behind increases in inflation and were, in real terms, in negative territory throughout the second half of 1999 up to the end of 2000. The slow initial reaction, apparent in Figure 1, was mainly due to the shocks being deemed to be only short-term ones. At the same time, lower interest rates provided some room within which to slow appreciation in the real exchange rate to prevent a further deterioration in the current account. Nevertheless, Figure 2 shows that the depreciation was mainly towards non-euro area countries, as it was the time of an appreciating US dollar. In 2001, real interest rates peaked above 3 % and then progressively moderated to around 2 %, only to be further increased after the increase in inflation in the first half of 2002.

Between the introduction of the new framework in April 2001 and the adoption of the euro, BoS reduced the main policy interest rate in several steps by a cumulative 750 basis points, from 11 % to 3.5 %, by the end of 2006.<sup>16</sup> Figure 3 shows that, over the same period, the ECB first reduced the main refinancing rate by 275 basis points, from 4.75 % to 2 %, in mid-2003 but increased it again between end-2005 and end-2006 to 3.5 %, yielding a total reduction of 125 basis points.

The decline in nominal interest rates and the need to close interest parity was reflected in a gradual reduction in the depreciation of the tolar. The signalled current depreciation of the tolar was thus gradually reduced, from 4 % in 2001 to 1 % in June 2004, and thereafter to 0 %. The reduction in the rate of depreciation was achieved by exchange rate (price) intervention, which stepwise signalled the desired rate of growth. Upon ERM II entry in June 2004, however, the exchange rate fully stabilised and, during ERM II participation, it traded within a narrow range either side of central parity.

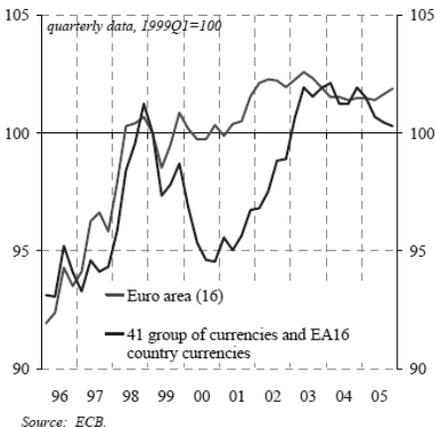
- 15 Along these lines, the strong asymmetric demand shock and inflation cycle immediately after the adoption of the euro, conducive to an overheating of the economy and nominal wage growth rising back to double-digit level, was, to a large extent, due to macroeconomic policy mismanagement.
- 16 Note that, during 2002, BoS temporarily increased its main interest rate in order to maintain a high rate of sterilisation (after large FDI-related capital inflows).

Figure 1: Disinflation and BoS instruments



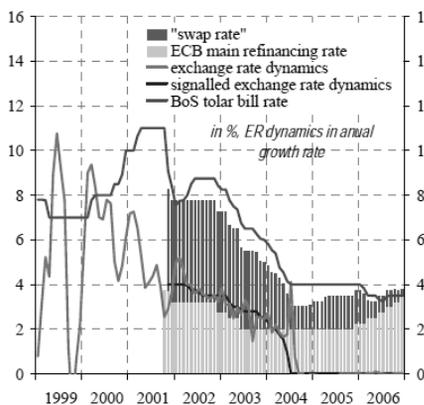
Note: Growth in EUR/SIT indicates a depreciation of the tolar

Figure 2: Real exchange rates of tolar



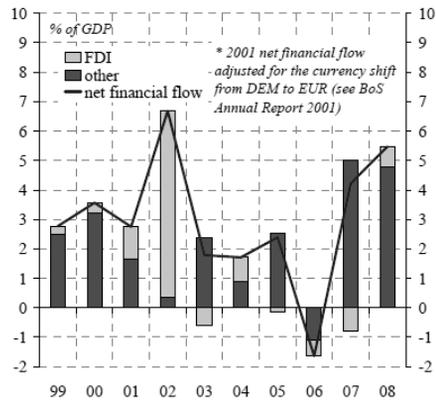
Note: an increase indicates appreciation

Figure 3: BoS and ECB main instruments



Source: Eurostat

Figure 4: Interest-elastic inflows



Source: Bank of Slovenia, SORS

BoS did not always simultaneously lower the desired rate of exchange rate depreciation when it cut its interest rates. Between April 2001 and ERM II entry in June 2004, the annual rate of depreciation was lowered by 4 percentage points while the BoS interest rate dropped by 7 percentage points.

Meanwhile, the cost of the swap, the *swap fee*, which is the difference between the swap rate and the signalled exchange rate dynamics, fluctuated between 0.5 % and

1 %. This was set in order to stimulate or slow down the use of this facility or moderately to disentangle the interest rate from exchange rate dynamics, as discussed above. After ERM II entry, BoS increased the swap fee to 1 % with the aim of making the swap facility less attractive and, in turn, impeding the tendency towards increasing the swap stock. At the same time, this enabled the sustaining of BoS interest rates at a higher level than those of the ECB.

Finally, Figure 4 indicates that the UIP-managed nominal exchange rate did rather well in mitigating interest-elastic inflows, thereby providing room for an active monetary policy. We subtracted net foreign direct investment, as an indicator of interest-elastic flows, from net financial inflow in the years from 1999 to 2008. Approximated in this way, interest-elastic flows appear, on average, to have been significantly reduced between 2001 and 2006 (roughly 1 % of GDP) in comparison both to 1999 and 2000 (around 3 % of GDP) and 2007 and 2008 (almost 5 % on average). Major FDI inflows were sterilised by the issuance of 360-day and 270-day tolar bills, with an interest rate mark-up over 60-day tolar bills and a quota limited to the amount that BoS wanted to sterilise.

### *Disinflation and macroeconomic developments*

Table 5 shows that domestic macroeconomic conditions progressively turned from inflationary ones to conditions supportive of a disinflation trend. Given the transmission mechanism estimated in the previous section, the strong increase in real interest rates in 2001 and the moderately restrictive stance adopted afterwards significantly contributed to this reversal.

GDP growth decreased to very low levels in 2001, in line with the unfavourable foreign environment, while the output gap turned negative after 2000.

Unit labour costs strongly reacted both to this activity and inflation in 1999, strongly contributing to the persistence of inflation up to 2001, reaching 9.2 % on average and exceeding even the HICP inflation rate. However, they moderated after 2001 and were supportive of the disinflation process by growing at a slower pace than consumer prices, while facilitating a favourable trend in employment.

Bank lending also reversed, from a peak of almost 30 % in 1999 to a trough of roughly 10 % in 2002, and grew afterwards at a pace of less than 20 % up to 2005. Energy prices increased significantly in 2000, contributing to the fall in inflation in 2001.

**Table 5 – Inflation and related indicators**

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HICP	9.9	8.3	7.9	6.1	8.9	8.6	7.5	5.7	3.7	2.5
GDP real growth	3.7	4.8	3.9	5.4	4.1	2.7	3.5	2.7	4.2	3.9
Output gap		0.1	0.2	1.2	1.0	-0.3	-0.5	-1.6	-1.2	-0.9
Unit labour costs	7.3	5.3	4.6	3.6	8.9	9.2	6.5	4.7	3.8	
Bank lending	20.2	14.2	26.9	29.9	18.8	18.7	10.2	16.4	17.0	23.7

Source: ECB (2006)

A reasonably important element in the high-level persistence of inflation was the effect of indirect taxes and non-energy administered prices (growth above headline inflation), which accounted for a cumulative effect on inflation of more than 4 percentage points in 2001 and 2002 (Kozamernik, 2005). However, at the same time, this contributed to a lower fiscal deficit, which decreased from around 4 % in 2000 to 2.5 % in 2002. The progressive decrease in the structural fiscal deficit, shown in Figure 5, in turn points to a restrictive fiscal stance over the period from 2000 to 2005.

Figure 5: Fiscal stance

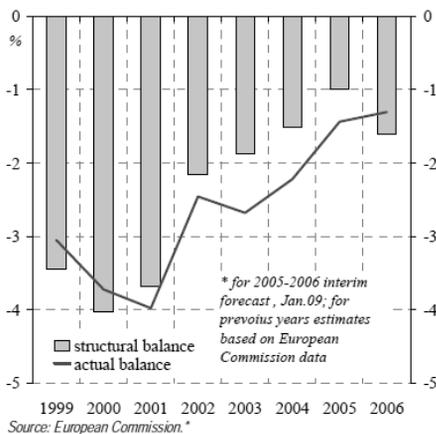
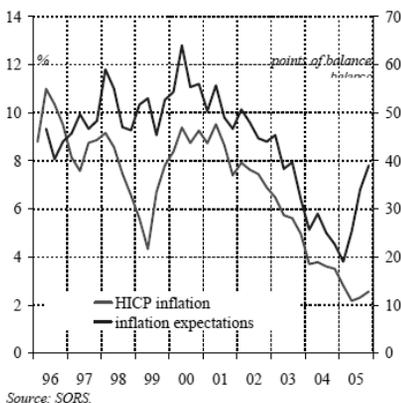


Figure 6: Disinflation trend and inflation expectations



Finally, one important element in the disinflation process was its credibility, indicated by a fall in inflation expectations. Figure 6<sup>17</sup> shows that expectations were well in line with the disinflation trend, displaying a peak in 2000 and decreasing even somewhat faster after 2002. Credibility was important for macroeconomic policy to achieve disinflation at a low cost in terms of output and employment, and necessitated only a moderately restrictive stance to maintain the disinflation trend.

Exit from the BoS monetary policy framework

The BoS operational framework described here was in place for seven years, between March 2000 and the end of 2006, when Slovenia joined the euro area. At that time, the Bank of Slovenia became a part of the Eurosystem and the operational frame-

17 The balance is the difference between positive and negative answers, expressed as a percentage, to the question: ‘In comparison with what is happening now, do you think that in the next 12 months: there will be a more rapid increase in prices, prices will increase at the same rate, prices will increase at a slower rate, prices will stay about the same, prices will fall slightly’. The balance does not show the real size of the economic indicators.

work needed to be adjusted to the operational framework of the Eurosystem, in which the main monetary policy instrument is open market operation.

We have seen already that, in several steps, BoS reduced the main interest rate as well as the rate of tolar depreciation in order to stabilise the exchange rate upon ERM II entry. During ERM II, BoS continued to set interest rates following the UIP rule described above; however, with no changes in the exchange rate. The only rule left for manoeuvre was the swap fee and the room provided by the risk premium. Note that, with exchange rate stabilisation, the swap rate became equal to the swap fee, which BoS kept unchanged at 1 % during ERM II participation. This enabled BoS to maintain the interest rate differential in order to avoid transmitting the, by then, strong stimulatory effect of interest rates within the Eurosystem. Accordingly, the interest rate differential between the main BoS and the ECB rates remained positive until 'the very last moment', as can be seen in Figure 3 above. Actually, it was ECB interest rates, which started to increase alongside the recovery in the euro area at that time, which reached the level of the BoS rates. The level of interest rates upon convergence and entry into the euro system was, therefore, to a large extent in correspondence with the needs of the monetary policy stance, given domestic macroeconomic developments.

The stock of swaps and tolar bills accumulated over these years due to persistent capital inflows and consequent sterilisation needs. However, the largest increase in outstanding foreign exchange swaps occurred in 2001-02, when Slovenia recorded substantial privatisation-related FDI inflows. Later on, in the absence of major FDI inflows, the stock of swaps was gradually reduced by outright purchases of foreign exchange. These were mostly performed by means of regular tenders in the last year before the adoption of the euro and eventually eliminated in October 2006.

In order to prevent a liquidity shock from tolar bills around the time of the introduction of the euro, BoS offered first a long- and, later, a short-term deposit facility with maturity dates beyond the planned adoption of the euro. All tolar instruments, tolar bills and deposits with BoS gradually matured during 2007. In this way, BoS smoothed the provision of the accumulated liquidity into the system.

## Conclusion

As acknowledged in the *Convergence Reports* of the European Commission (2006) and the ECB (2006), Slovene disinflation after 2000 was a success in terms of the achievement of sustainable price stability. Overall, the announced aim by BoS of disinflation without 'shock therapies', within a stable domestic macroeconomic environment and with maintained external equilibrium was fully delivered. The downwards inflation trend was restored in 2001, other than for some interruptions arising from cost-push shocks which were mostly of a fiscal nature. When disinflation was achieved, the external balance was back in equilibrium and growth prospects returned in line with the potential. No relevant macroeconomic disequilibria were apparent in the economy. Finally, the BoS framework made possible a smooth transition to an environment of a stable exchange rate and ERM II entry, also from the operational perspective. This is most evident in the timely adoption of the euro, which was achieved as planned.

Given this favourable outcome, in conclusion we address briefly the question regarding the extent to which the monetary policy implemented by BoS was specific to

the Slovenian institutional and macroeconomic environment. In sum, such a strategy seems to have worked out well for the purpose of disinflation, with a clear commitment and well-defined medium-term policy target. An exit strategy, such as the adoption of the euro, may contribute to the credibility of the commitment. Moreover, broad support for other macroeconomic policies, in particular fiscal and wage policies, is likely to be helpful. From the BoS perspective, such a strategy has been revealed as particularly useful given the appreciation pressures on the nominal exchange rate arising from trends in capital inflow during the period under consideration.

Is this policy experiment replicable in other economies? Overall, we believe that the possibility of replicating the BoS monetary framework crucially depends, firstly, upon the capacity to install a viable operational framework which would enable exchange rate movements to be oriented in line with the UIP; and, secondly, the ability to provide room for monetary policy activity without undoing its restrictive effects on inflation resulting from exchange rate dynamics.

Several characteristics of the Slovenian financial market have facilitated credible UIP-based exchange rate management on operational grounds. One advantage is certainly the Agreement with the banks which, in principle, enabled BoS to signal a given exchange rate. Without such an agreement, the central bank would probably have to intervene quantitatively in the market to orient the dynamics of the exchange rate while using the swap premium more frequently to make swaps more or less attractive. In this respect, the financial market in Slovenia was of great support, as was the absence of trading in the tolar on foreign financial markets, giving strong credibility to the central bank as a major player in the case of quantitative intervention. Lacking these elements, and thus relying only on quantitative and price interventions on the markets, would have probably limited the capacity of the central bank to smooth exchange rate dynamics.

Eventually, the effectiveness of such a monetary policy framework crucially depends on the capacity for avoiding the effects on inflation of exchange rate dynamics. If the central bank wants to guide inflation expectations in accordance with its price stability objective, it must be able effectively to control inflation in the medium-term. Only in that case can its inflation objective play the role of nominal anchor. It has already been discussed that, if the nominal exchange rate pass-through is strong, then closing UIP with nominal exchange rate dynamics must be subject to caution. One way to achieve this is to implement a policy consistent with an inflation-neutral exchange rate dynamic over the medium-term, and to do so credibly. This can be achieved, for example, by using the room in the UIP premium which enables a moderately restrictive stance on average to be maintained. If this scope is insufficient, the central bank must tolerate greater exchange rate volatility. Alternatively, the central bank could commit to a UIP rule only for a limited period of time when it would want to push the exchange rate on to a depreciating path while keeping interest rates high.

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