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Foreign Exchange Intervention:
The Theoretical Debate and the Czech Koruna Episode

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1. Introduction

In the last twenty years, a large amount of literature emerged on whether and how sterilized foreign exchange intervention can affect the exchange rate. However, the whole debate still lacks clear and unambiguous conclusions. As a result, without having sound arguments for or against its use, monetary authorities often decide about official intervention in the foreign exchange market according to some kind of "flair".

The recent strong appreciation of the Czech koruna and foreign exchange interventions conducted by the Czech central bank in 2001–2002 provide an opportunity to summarize existing arguments and assess this controversial monetary policy instrument in the light of the current theoretical debate and the empirical evidence on foreign exchange intervention.

The paper is organized as follows: in section 2, the "appreciation episode" of the Czech koruna is described. Section 3 is devoted to the theoretical debate on foreign exchange intervention, discussing motives and channels through which intervention can influence exchange rates. Section 4 shortly surveys the literature about empirical evidence on foreign exchange intervention and section 5 concludes by reinterpreting the Czech experience in the light of the current debate.

2. The "Appreciation Episode" of the Czech Koruna

During the last quarter of the year 2001 and in 2002, the central bank of the Czech Republic (the Czech National Bank, CNB) intervened several times in the foreign exchange market to reduce the value of the Czech koruna that began to appreciate sharply in September 2001 against the euro in nominal as well as in real terms. Since 1999, the appreciation trend at

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about 4 % annually in nominal terms was an obvious fact that could have been easily explained by means of the textbook theories on the basis of economic fundamentals (including the Balassa-Samuelson effect). The trend was generally accepted by most economists as well as by the central bank and government officials. However, between September 2001 and July 2002 the koruna strongly appreciated another 15 % against the euro nominally, representing considerable risks for the export-oriented Czech economy.

Central bank economists and other economic experts considered this acceleration as being driven mainly by market expectations of significant increase in privatization revenues in euro in the Czech Republic and their conversion into the domestic currency on the foreign exchange market, i.e. by a temporary one-off event and not by economic fundamentals or interest rate differentials. In the media, the CNB representatives called the upward path of the koruna an irrational "speculative bubble" that must burst sooner or later. As the koruna was appreciating, export-oriented firms that had not hedged their euro revenues were suffering huge losses and the pressure on the central bank and government to stop the appreciation increased. According to the official central bank statement, a strong koruna and the coincident downturn of economic growth in the EU in that period could "harm the competitiveness of Czech exports, significantly decrease economic growth in the Czech Republic and cause the GDP to depart from its balanced level again. The present combination of factors also presents a risk for the current account, i.e. for the external balance of the Czech economy. Sooner or later the exchange rate would have to weaken back to its fundamentally justified value, but the aforementioned exchange rate fluctuations would have negative consequences for the economy." (Czech National Bank, 2002).

Under the term "negative consequences" we have to understand not only a temporary decrease in economic growth or even an economic decline, but as well a risk of higher inflation volatility and the resulting multiple miss of the inflation target, set by the central bank as a primary monetary policy objective in the inflation targeting regime. As stated by Wadhwani (2000), without any policy measures taken against it, an overvaluation of the domestic currency in terms of deviation from the equilibrium trend could have a strong "hysteresis" effect. An overvalued currency will cause a number of firms to go out of the business because of losses from export revenues or lower domestic sales due to cheaper imported goods. A decline in economic activity results in higher unemployment and a lower rate of inflation that can be deeply under the target or target band. At some uncertain date in the future when the exchange rate comes back to the fundamentally justified level the economy will go upwards with the risk of inflationary overshoot in this recovery phase.

The resulting volatility in the inflation rate could be very damaging to the credibility of the central bank as well, raising further inflation risks through the channel of inflation expectations. For all the above-mentioned reasons a consensus between the central bank representatives and the government was reached about the necessity to weaken the koruna back to the more fundamental value. The government was interested in the weakening not only because of a threat of an economic decline and a rise in un-

employment in export-oriented sectors but also because of a decline of expected privatization revenues when converted from the euro into the very strong koruna.

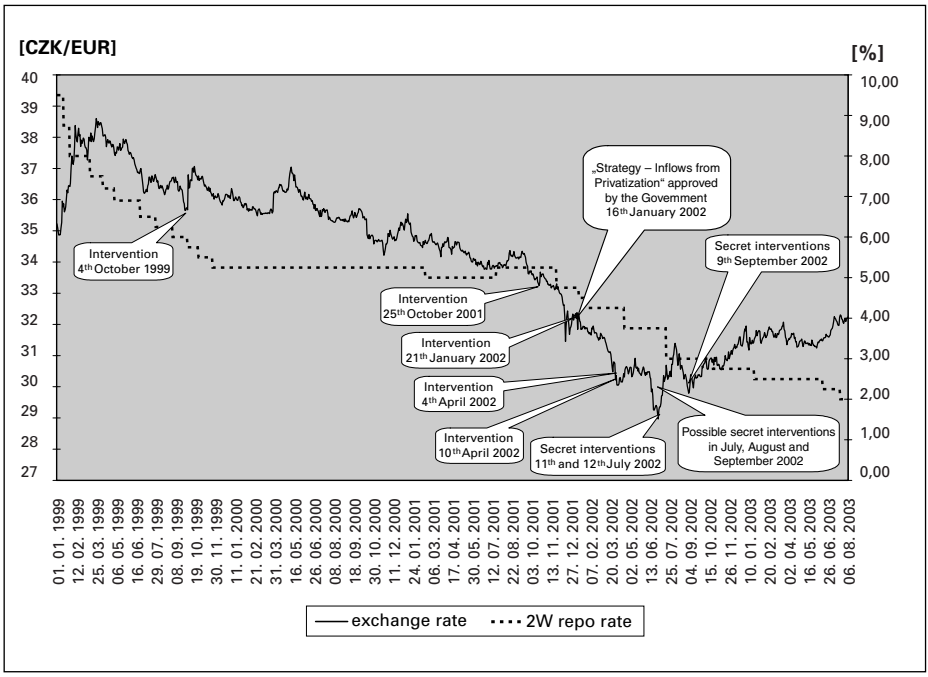
The effort to reduce the value of the koruna does not have to be a deviation from the monetary policy's primary goal. In the inflation-targeting regime, the primary aim of the monetary authority is to hit the inflation target expressed in terms of a point or a band. Such a single objective of the monetary policy does not mean that the central bank does not pay attention to the other macroeconomic variables like the GDP, the exchange rate or unemployment. On the contrary, because of interdependencies in economy and different transmission channels through which the monetary policy operates, such aggregates are very important to consider, when maintaining the price stability. Thus, although it may look like trying to prevent an economic decline by helping the exporters to restore their revenues, measures taken against further appreciation of the koruna with the aim to reduce the hysteresis effect are consistent with maintaining price stability as the primary goal of the monetary policy.

The consensus reached between the central bank and government about weakening the domestic currency does not have to mean giving up the independence of the central bank either. The nature of the appreciation based mainly on expectations of government behavior prevents the central bank from using the standard monetary policy instrument – the interest rates – to combat excessive appreciation. Additional tools are required that can directly alter the expectations of traders in the foreign exchange market. The *Strategy for Dealing with the Exchange Rate Effects of Capital Inflows from Privatization of State Property and from Other Foreign Exchange Revenues of the State* (the Strategy, hereafter), proposed by the central bank, approved and really followed by the government, represents not only such a tool but as well a kind of contract between two equally independent bodies. Such an act is then to be interpreted as the actual exercise of the central banks' independence rather than its failure.

The "action plan" against excessive appreciation, of course never called such a way and considered ex post rather than ex ante, consisted of three elements: the Strategy, the decline in central bank's interest rates and the foreign exchange intervention ((Holub, (2003, p. 17) identifies these three "policy measures" as well)). In the Strategy, the government promised not to convert the current and future privatization proceeds into the koruna in the foreign exchange market but to sell them directly into the CNB's foreign exchange reserves.[1] As we can see from *Figure 1*, the approval of the Strategy by the government did not have a substantial effect on the exchange rate trend. One of the reasons could be that the market did not believe that the government would meet its obligations stated in the Strategy. However, the government surprisingly followed the Strategy in May 2002,

[1] The Strategy comprises more arrangements and provisions that the government should meet, all of them relating to the foreign exchange revenues. For example, there is an obligation of the government not to issue bonds denominated in foreign currencies – see (CNB, 2002). Some kind of agreement between central bank and government about neutralizing foreign exchange revenues of the state existed and was followed already before the new Strategy was approved.

FIGURE 1 The CZK/EUR Exchange Rate, Foreign Exchange Interventions, 2W Repo Rates and Strategy in the "Czech Koruna Episode"



Source: Czech National Bank (www.cnb.cz); Czech economic press, especially

when the revenues from the first privatization deal thereafter[2] of an amount of more than four billions euro were purchased by the CNB directly into its foreign exchange reserves. But the market expectations as the main cause for koruna appreciation was altered much more by the announcement of the cancellation some big privatization deals in October and November 2002 that were previously regarded as a certainty (with expected revenues of more than two billions euros).

The second instrument in the fight against the strong koruna was a decline in the interest rates, which were reduced five times in a period of nine months. The key central bank's interest rate – the two-week repo rate – was cut from 5.25 % in November 2001 to 3 % at the end of July 2002.[3] The reasons for the decline in interest rates were of course presented in a way usual for the inflation targeting communication: the rapid koruna appreciation creates a sudden tightening of monetary conditions that, according to the new inflation forecast, situates the annual inflation below the targeted band, thus providing reasons for cutting interest rates. Beyond these words,

[2] Transgas, a. s., an European natural gas transporter and importer of natural gas to the Czech Republic, was sold to the German company RWE Gas AG.

[3] Since July 2002, the interest rates were further lowered, standing at 2 % since August 2003.

we have to understand that the export firms, their sub-suppliers and producers for the domestic market affected with a sudden decline in their competitiveness are put under pressure to quickly increase their productivity or to lower costs. Because of the relative downward rigidity of wages and other inputs (loans with fixed interest, for example), the central bank faces the following choices: to either let the firms go out of business, which could have strong effects on the macroeconomic stability of the very open Czech economy, or to help them a little by cutting interest rates and reduce the burden that they bear.

The third instrument used by the central bank, which is much more ambiguous and without clear empirical evidence, was the foreign exchange intervention. There were two phases of interventions. In the first phase, starting in October 2001 and ending in April 2002, the central bank intervened four times in the foreign exchange market (see Figure 1) in a very similar way. After an ordinary or extraordinary meeting, the Bank Board announced to the press not only its decision to intervene, but as well the fact that – at the time of announcement – it was already intervening. However, this kind of intervention had only a very small and temporary impact on the exchange rate (see again Figure 1), thus a change of intervention strategy came. In the second phase of interventions, beginning in July 2002 and ending in September 2002, the central bank intervened secretly, without any announcement to the public. Some of the interventions were immediately confirmed by dealers in the foreign exchange market (when the central bank bought the euro itself) or subsequently revealed by publishing the Bank Board meeting minutes, which are regularly put on the central bank's web site with a lag of 12 days (when the central bank intervened through some foreign banks). During both phases, a number of verbal interventions made by the Bank Board members accompanied the official interventions.

The effect of the secret interventions on reversing the exchange rate development was not small, mainly because the central bank managed to keep the traders in uncertainty about future interventions and exchange rate development. On the other hand, it is not easy to confirm empirically that the desired depreciation of the koruna, starting in August 2002, was due to the interventions. The expectations of traders were further influenced by other factors like the process of government building in July 2002, announced changes in government economic policy, resulting in canceling some privatizations later in October and November 2002, as well as by the expected economic effects of the flood that surprised the Czech Republic in August 2002.

Looking at the exchange rate development in Figure 1, we can see the "appreciation bubble" at the time axis somewhere between November 2001 and December 2002. We could imagine a stable koruna appreciation of 4 % annually in this "bubble" period as well, resulting in the same exchange rate values in the first months of 2003. Thus, one can argue that the central bank succeeded not only in reversing the very sharp appreciation, but as well in "putting" the contemporary exchange rates on the "right" values, i.e. consistent, according to the central bank's opinions, with economic fundamentals.

The question that remains is that of the role of the foreign exchange in-

terventions in this episode. Should a central bank under inflation targeting make use of foreign exchange intervention when facing sharp and undesirable changes in the exchange rate of the domestic currency? If the "action plan" of the Czech National Bank had failed, the answer would have been obviously no. However, the plan succeeded, providing further arguments to the contemporary theoretical debate about the efficiency and desirability of foreign exchange intervention, even if the size of the intervention effect, in comparison with other factors contributing to the reversion of the koruna appreciation, is unknown. The debate is described in the next section.

3. The Debate about Foreign Exchange Intervention[4]

The debate about efficiency and desirability of foreign exchange intervention started predominantly with the break-up of the Bretton Woods System in 1971 when the participating countries decided to abandon fixed exchange rates and moved one after the other to managed floating. Of course, foreign exchange intervention as a central bank's tool had already been practiced before.[5] However, in the era of gold standard, gold exchange standard or in the Bretton Woods System, i.e. in regimes with adherence to some kind of fixed exchange rate, intervention was not viewed as a discretional policy instrument available in policy tool kits of monetary authorities. It was rather a passive act of buying or selling foreign currency used to help maintain the exchange rate within prescribed margins and as such, it was largely practiced in the Bretton Woods era (Dominguez – Frankel, 1993a), (Edison, 1993), (Lehment, 1980).

With the introduction of floating exchange rates in 1971–1973, the scale of intervention even increased (Edison, 1993), (Bopp, 1982), (Lehment, 1980). Because in the floating-rate regime the central bank is not obliged to purchase or sell foreign currency to maintain some level of exchange rate, one has to ask why central banks intervened at all.

3.1 Motives for Intervention

Edison (1993) in his often-cited study lists four possible motives given by monetary authorities for intervening in the floating-rate regime: (1) to calm disorderly markets, (2) to influence exchange rate movements, (3) to target exchange rates, or simply (4) to support other central banks' exchange-rate operations (for example, to help settle large transactions). Re-

[4] Frait (1997) already introduced the theoretical debate on foreign exchange intervention to the Czech economic audience. In this paper, however, the section brings additionally some new arguments relating intervention and the inflation-targeting regime, discusses some new channels of influence, and covers new literature since 1997 as well.

[5] In the case of the Czech Republic, for example, the predecessor of the National Bank of Czechoslovakia and first monetary authority in the Czechoslovakia in the period 1919–1926 – the Banking Department of Ministry of Finance – made a large use of foreign exchange intervention with the aim to strengthen the new currency (Czechoslovak koruna). The monetary regime of that period was a kind of managed floating with heavy exchange restrictions on current and capital account transactions.

garding the first goal, there is a long-lasting consensus that disorderly foreign exchange market conditions (low liquidity, high bid-ask spreads or even missing transaction counterparties, for example no buyers of some currency) can justify the using of intervention (Jurgensen, 1983), (Emminger, 1986, p. 307). However, the definition of "disorderly" is naturally ambiguous: some countries intervened almost daily in order to prevent even an emergence of "disorderly conditions", other countries waited till some "crisis" or a large liquidity shortage in the foreign exchange market actually had appeared.

Most of the studies on foreign exchange intervention emphasize the second motive, i.e. influencing the exchange rate development (Jurgensen, 1983), (Edison, 1993). Neely (2001) discusses empirical evidence from a survey of foreign exchange practices: 89.5 % of 22 surveyed authorities intervened sometimes or always to resist short-run volatility in exchange rates and 66.7 % of the authorities used intervention to correct medium-term "misalignments" of exchange rates away from "fundamental" values. Baillie and Osterberg (1997) cite some other studies and public statements in which central banks stand ready to influence the level of an exchange rate and/or to reduce its volatility.

Dominguez and Frankel (1993a) ask more generally whether monetary authorities need an independent policy tool for influencing exchange rates at all, thus restating the problem in terms of the classic debate over costs and benefits of two polar cases, fixed rates and floating rates.[6] If a country chooses the floating, why should its monetary authority further aim to affect the exchange rate development?

There are two answers usually held by advocates of intervention. In the short run, floating exchange rates tend to be volatile and create uncertainty about their future development, thus discouraging international economic activities. Stabilization of exchange rates via daily interventions, for example by "leaning-against-the-wind" strategy, i.e. attempting to move an exchange rate in the opposite direction from its current trend, can help promote exports, imports and international lending. Short-run fluctuations of exchange rates were often included in the disorderly market conditions by policy makers (Jurgensen, 1983), (Emminger, 1986).

In the medium-term, imperfections in the foreign exchange market can prevent the exchange rate from playing its appropriate role as a signal. Some practitioners (Emminger, 1986, p. 325), (Jurgensen, 1983) as well as some theoreticians (Dominguez – Frankel, 1993a, p. 38) in the field often argue that foreign exchange markets are far from being efficient. Bandwagon effects, herding behavior and self-fulfilling expectations may cause speculative bubbles and large exchange rate misalignment from fundamental values. This creates a false signal for economic subjects and may lead to misallocation of resources that can turn into large real costs after the speculative bubble bursts. Thus, interventions aiming to bring the ex-

[6] For a discussion of cost and benefits of fixed-rate versus floating-rate regime see (Krugman – Obstfeld, 2000, pp. 569–577), (Husted – Melvin, 2001, pp. 483–485) or (Lawler – Seddighi, 2001, pp. 247–249).

change rate back to a fundamental value decrease possible real costs of misalignment and raise market efficiency.

Targeting some exchange rate level or trend seems like compromising fixed and floating rates: the exchange rate is floating, thus allowing market forces to do their work, i.e. create signals, accommodate external shocks and prevent sudden balance of payment crises, but at the same time monetary authorities stand ready to defend a particular exchange rate level, thus lowering uncertainty about exchange rate development. However, there are at least three problems associated with such an exchange rate policy.

First, if monetary authority targets an exchange rate that is not based on economic fundamentals, including monetary conditions, a conflict may soon arise between external and internal economic policy goals.

Second, even if the central bank tries to target a fundamental-based level there is the problem of how to find this level. Third, targeting some exchange rate level can bring economic subjects into the moral hazard situation: firms involved in international transactions may give up protecting themselves against exchange risk by hedging on the forward markets, relying on the ability of the central bank to defend the announced level. When the central bank fails to defend a particular exchange rate level by means of intervention, firms suffer huge losses as in the case of financial crises in the fixed-rate regime. As a result, countries adopt this strategy often as a temporary stage between fixed-rate and floating-rate regime.[7]

Another approach to the motives for intervening, highly relevant for the Czech case, emerged in the last years with the inflation-targeting framework.[8] Because the main goal of monetary policy is price stability, defined in terms of moderate annual inflation and interpreted often in terms of small volatility around the inflation target (Wadhwani, 2000), any measure that helps reach the goal without having undesirable side effects is allowed (see as well the discussion of the "hysteresis" hypothesis mentioned above). Heikensten and Borg (2002, pp. 31–32) from the inflation targeting central bank of Sweden (Riksbank) justify using intervention in the inflation targeting regime to influence the exchange rate "as a means of contributing to a future development of the exchange rate that aided the inflation rate to develop in line with the Riksbank's target". Intervention as a monetary policy tool can be further used in those cases when the traditional interest rate instrument no longer functions effectively. For example, if the nominal interest rate is close to zero, or if the effect of interest rate change is considered to be small, or if it can help support the general objectives of economic policy (for example GDP growth and low unemployment), without neglecting the inflation target, the intervention is allowed.

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[7] The "crawling-peg" regime adopted by some post-socialist countries like Hungary or by Israel is a good example of such policy – see (Krugman – Obstfeld, 2000, p. 486), for the case of Israel see (Klein, 2001) or the web-site of the Bank of Israel (http://www.bankisrael.gov.il/).

[8] For the discussion of inflation targeting regime see (Bernanke et al., 1999), (Mishkin – Schmidt-Hebbel, 2001), (Svensson, 1999), or from the monetary rules point of view (McCallum, 1997).

3.2 How Can Intervention Work in Theory?

Foreign exchange market intervention is usually defined as "those foreign exchange transactions of monetary authorities designed to influence exchange rates" (Neely, 2001), (Sarno – Taylor, 2001).[9] The central bank thus sells the domestic currency (or domestic assets) for a foreign currency (or foreign assets) if it wants to decrease the value of domestic currency and, likewise, sells foreign assets for domestic assets when aiming to increase the value of domestic currency. Such transactions can influence exchange rates through several channels.

Before we discuss the channels in detail, it is necessary to distinguish between sterilized intervention, which does not affect the money supply, and nonsterilized intervention, which does. According to Sarno and Taylor (2001), official intervention is said to be sterilized when the authorities take action to offset the effects of a change in official foreign asset holdings on the domestic monetary base. For example, when the central bank sells foreign currency for domestic currency, it decreases monetary base and money supply. In order to sterilize this side effect the central bank must provide – simultaneously or within a very short space of time – money of the same size via traditional open market operations (i.e. by providing money against domestic assets as collateral). If it does not do that, the intervention remains nonsterilized and is simply another way of conducting monetary policy, the only difference being that the monetary base is altered through a change in foreign, rather than domestic, asset holdings. As Edison (1993, p. 10) summarizes, "sterilized intervention is a 'pure' change in the relative stocks of domestic and foreign assets held by the public [...] It changes only the currency composition of the assets held by the public by changing the composition of the monetary authorities' portfolio." As such, sterilized intervention constitutes an independent policy tool.

3.2.1 The "Market" Channel

The simplest channel, surprisingly not discussed in the literature perhaps because of its obvious simplicity, is based on the theoretical functioning of foreign exchange markets (hence, I call it the market channel). A central bank that is acting in the foreign exchange market alters the demand or supply of foreign currency and thus the actual price (i.e. the exchange rate) as well. More technically, if the daily official exchange rate is for example computed as the average of all trades that took place that day, then every transaction executed by the central bank and its counterparties at exchange rates different from prevailing one will influence the official rate. How it is possible for the central bank to trade at exchange rates different from the prevailing rate? Because the central bank's motive is not to make

[9] Central banks usually define official foreign exchange intervention more broadly as "any official sale or purchase of foreign assets against domestic assets" (Dominguez – Frankel, 1993a, p. 55). However, this definition also includes operations intended to influence the country's stock of foreign exchange reserves.

profit but to influence exchange rate it does not have to care so much about the profitability of its transactions and can thus "lean against the wind".[10] By offering to buy foreign currency at a price that is higher than the market price (or higher than the lowest market offer to sell foreign currency), the central bank that is aiming to decrease the value of domestic currency immediately executes the trade and moves the daily average exchange rate upwards.

What is wrong with this simple channel? First, the described mechanism may work this way in theory, but in reality, the contacted subject (commercial bank or another market maker) usually offers the price of the contract.[11] However, the contacted commercial bank knows that the central bank is intervening in order to influence the exchange rate and not to make profits, so that a price offer advantageous for the commercial bank and disadvantageous for the central bank will be accepted.

Second, the monetary authority would have to trade an enormous volume of currency if it wanted to alter the (daily average) exchange rate or even to reverse an exchange rate trend. The volumes traded in foreign exchange markets rose considerably in last 20 years: the average daily foreign exchange market turnover worldwide in April 2001 was USD 1,210 billion, which is very large compared to the usual central bank's foreign exchange reserves (Galati – Melick, 2002, p. 2). In the U.S. market, the volume of trading averaged around USD 100 billion a day in 1989 (and rose to USD 192 billion only three years later), whereas the average size of U.S. operations in the 1980s was about USD 200 million a day, i.e. 0.2 % of daily turnover (Dominguez – Frankel, 1993a, p. 89), (Edison, 1993, p. 11). One can hardly imagine that such intervention can have any effects.

The third argument against the market channel challenges the sustainability of the intervention effect: even if the central bank managed to move the official exchange rate in the desired direction via intervention, the effect must be inevitably short-run. If market expectations do not change "in the desired direction", the central bank would have to intervene daily in order to offset the market demand. Such behavior could furthermore create risk-free profit opportunities for speculators, thus raising the volume of intervention needed to maintain the desired level of exchange rate.

On the other hand, under the following assumptions the market channel can work quite well. First, if the foreign exchange market is "thin" and liquidity is low, the intervention can have at least a short-term considerable effect (a possible long-term effect is discussed later in the part devoted to the noise trading channel). This seems to be also the case of the Czech koruna episode: the average volume of spot trading in the foreign exchange market in April 2002 was about USD 700 million a day (and only USD 375 million of CZK-EUR trading), whereas the average size of intervention could have been about USD 300 million a day. Moreover, the cen-

[10] Profitability, although not being the motive for intervention at all – see (Neely, 2001) – is of course of relevance for the central bank – see for example (Edison, 1993, pp. 42–46).

[11] I owe this comment to one anonymous referee.

tral bank intervened often on Fridays when the market liquidity was supposed to be low.[12]

Second, if the central bank is not bound by the volume of its foreign exchange reserves (i.e. it is buying foreign currency in order to decrease the value of domestic currency), it can theoretically intervene without limit, as opposed to the fight against a depreciation. The only condition is that the costs of sterilization must be sufficiently low or even negative, for example through the negative interest rate differential (higher interest rate on the acquired foreign exchange reserves than on the domestic currency that is bought by the central bank when sterilizing), so that the central bank does not accumulate losses.

3.2.2 The Monetary Channel

The monetary channel, discussed for example by (Galati – Melick, 2002), works only if the intervention is not (or not to the full extent) sterilized. In this case, intervention influences domestic monetary base, money supply in the money market and thus short-term interest rates. The interest rate change affects through the uncovered interest rate parity the demand for domestic assets and the exchange rate, as described in traditional monetary models of exchange rate determination.[13] Suppose that the central bank wants to depreciate the domestic currency and purchases foreign currency, without offsetting the effect of the resulting higher money supply. Short-term interest rates in money market decline, investors sell domestic assets for (now more profitable) foreign assets and the domestic currency depreciates.

There is a strong consensus that nonsterilized intervention can influence exchange rates similarly to monetary policy via affecting money supply, interest rates and market expectation (Sarno – Taylor, 2001), (Edison, 1993). On the other hand, continuing discussion about the precise effects of changes in monetary base on interest rates (for example, in the presence of standing facilities preventing the market interest rates from deviating too much from the central bank's main policy rate) and that of interest rates changes on exchange rates (Bilson – Marston, 1984), (Taylor, 1995) signals some further research into the functioning of this channel – see for example (Borio, 1997).

3.2.3 The Portfolio Balance Channel

Most of the literature emphasizes only two channels through which intervention can affect the exchange rate: the portfolio balance channel and the signaling (or expectations) channel (Edison, 1993). The effects of intervention through the portfolio balance channel are analyzed within the framework of a portfolio balance model of exchange rate determination,

[12] The data and estimates are available on the official web site of Czech National Bank (www.cnb.cz) or in Czech economic press (for example www.ihned.cz).

[13] For a survey and discussion of monetary models of exchange rate determination, see for example (Bilson – Marston, 1984).

a dynamic model based on the interactions of international asset markets and current account imbalances.[14] The key assumption that distinguishes this kind of model from monetary models of exchange rate determination is the imperfect substitutability between domestic and foreign assets. Investors diversify their holdings among domestic and foreign assets as functions of expected rates of return.

Taylor (1995) or Edison (1993) set out a very basic portfolio balance model that, slightly modified here, can be used to explain how the channel works: net financial wealth (in domestic currency) of the domestic private sector (W) is divided into three components: money (M), domestic bonds (B) and foreign bonds (B^*). With foreign and domestic interest rates given by i and i^*, we can calculate simple domestic demand functions and definition of the net wealth as follows:

$$M^D = M\,(i, i^* + \hat{S}^e,\, W), \quad M_i < 0,\, M_{i^* + \hat{S}^e} < 0,\, M_W = 0 \tag{1}$$

$$B^D = B\,(i, i^* + \hat{S}^e,\, W), \quad B_i > 0,\, B_{i^* + \hat{S}^e} < 0,\, B_W > 0 \tag{2}$$

$$B^{*D} = \frac{1}{S} B^*\,(i, i^* + \hat{S}^e,\, W), \quad B^*_i < 0,\, B_{i^* + \hat{S}^e} > 0,\, B^*_W > 0 \tag{3}$$

$$W \equiv M + B + SB^* \tag{4}$$

where S denotes the spot exchange rate (domestic currency for unit of foreign currency), $\hat{S}^e$ denotes the expected rate of depreciation of the domestic currency, and X_k denotes the partial derivative of $X(.)$ with respect to k for $X = M$, B and B^*. Assume that the supplies of money (M^S), domestic bonds (B^S) and foreign bonds (B^{*S}) are predetermined and that the domestic economy is in equilibrium (i.e. supply equals demand for money and both kinds of bonds). Now, if the monetary authority wants to depreciate the domestic currency by sterilized intervention, it purchases foreign bonds from private investors and sell them domestic bonds. However, because the economy was already in equilibrium, the private investors will require a higher expected return on domestic assets relative to foreign assets to willingly hold the increased supply of domestic bonds and lower their holdings of foreign bonds. If interest rates, due to their determination in money market and sterilization operations, do not change, then the exchange rate must change, i.e. in our case depreciate, in order to restore equilibrium. Depreciation, in terms of a rise in S, results in a rise in W (equation (4)), which increases the demand for domestic assets, and cuts the demand for foreign assets according to equations (3) and (4).[15]

The portfolio balance channel is much more controversial than the monetary channel. First, according to the standard literature, there is a problem of testing the theory (Edison, 1993), (Dominguez – Frankel, 1993b). All tests, usually estimating the risk premium gained from inverted asset demand functions as a function of asset supplies, are necessarily tests of

[14] For portfolio balance models see (Branson, 1983), (Branson – Henderson, 1985), (Bilson – Marston, 1984) or (Taylor, 1995).

the joint hypothesis on the degree of asset substitutability and on the expectation formation.

Second, a theoretical discussion about the model's assumptions has emerged. If, for example, the Ricardian equivalence holds, i.e. the government bonds entail a public liability of future taxation, investors will not consider bonds as "true" assets forming their wealth, thus swaps in currency composition of investors' portfolios will have no effect on the foreign exchange market equilibrium. Another argument against this channel is that domestic bonds and foreign bonds are perfect substitutes, so that changes in their relative supply may have no effects (Dominguez – Frankel, 1993b), (Sarno – Taylor, 2001).

Third, the whole theory does not explain the mechanism of how the exchange rate changes. The standard macroeconomic explanation, that the exchange rate must have changed because it was necessary to restore equilibrium, lack not only microeconomic or structural foundations, but could be simply wrong. Even if the monetary authority, in our case, managed to purchase from the investors the foreign assets for the domestic assets, the only way in which it can do that is to accept a price (exchange rate) that is profitable for the contacted counterparty. This is nothing else but our simple market channel with all its problems, the one of negligible volume of intervention as compared to the market turnover being perhaps the most relevant here. As Henderson (1984, p. 391) writes, "the argument that intervention policy may not alter the exchange rate when securities are imperfect substitutes represents a more fundamental challenge to [the] theory [...] When the intervention, changing the holdings of private investors, i.e. the composition of their portfolios, does not affect expectation, private agents simply alter their direct holdings in an offsetting way, leaving the exchange rate unchanged."

Because of ambiguous test results and the theoretical critique just described, a consensus slowly emerges that the portfolio balance channel cannot adequately explain how intervention influences exchange rates, without providing a microeconomic mechanism for changing market expectations. We cannot be therefore surprised that Heikensten and Borg (2002) devote in their comprehensive article about intervention just two sentences to the portfolio balance channel, beginning with "historically" and ending with "of little importance".

3.2.4 The Signaling (Expectations) Channel

Through the signaling channel, the intervention (whether sterilized or not) can affect exchange rates via providing new relevant information – or

[15] The demand for domestic money remains by assumption unchanged. Even if the depreciation increases demand for foreign assets B^* (measured in domestic currency) through a rise in W, it reduces also the final demand B^{*D} (measured in foreign currency) through the term $\frac{1}{S}$ in equation (3). The resulting effect is negative by assumptions not noted here – see (Branson – Henderson, 1985, p. 757, fn. 9). Lyons (2001, p. 300, fn. 8) explains the change in exchange rate in another way, via the expected depreciation term in equations (2) and (3).

information already known but not fully used by market traders in the determination of exchange rates – to the market, thus influencing exchange rate expectations. This channel assumes that monetary authorities have better information to market participants and that they are willing to reveal it to the public (Sarno – Taylor, 2001), (Dominguez – Frankel, 1993a).

There are two ways for a central bank to change market expectations by intervention: first, the central bank may signal to the market agents that they are using available information and interpreting the current and expected evolution of relevant fundamentals in the wrong way, which leads to a misalignment in exchange rate determination. If, for example, the central bank believes that the exchange rate has appreciated more than economic fundamentals justify, it will buy foreign currency, signaling with it that the exchange rate level should be lower. If market participants believe that the central bank is right, they will correct their expectations and lower the exchange rate by trading with the new information. However, there are two questions about this method. First, why should the central bank have better information about fundamentals to the market participants ((a discussion of this argument can be found for example in (Humpage – Osterberg, 2000)), and second, even if it has, why should the market agents believe that the central bank is right?

The second way in which intervention can influence expectations partly responds to these two questions. First, monetary authorities may not have superior information to the public in all fundamental issues that contribute to the exchange rate determination. However, they have surely superior information in the field of future monetary policy. Thus, foreign exchange intervention may signal changes in future monetary policy. Second, intervention provides very credible information about future monetary policy because the monetary authorities stake their capital in support of that policy, as stated for the first time by Mussa (1981). In this sense, the mere announcement of future monetary policy or other verbal interventions in order to affect exchange rate expectations do not represent credible statements. If, for example, a central bank wants to depreciate the domestic currency, it will buy foreign bonds, signaling with it future monetary ease, i.e. fall in interest rates. Because such an intervention as a signal of future monetary policy is credible – the central bank would otherwise suffer losses if it failed to validate its signals – the market traders will change their expectations of future interest rates. In the portfolio balance framework, for example, the private investors will thus expect depreciation of domestic currency, which lowers the demand for domestic bonds and raises the demand for foreign bonds according to the equations (2) and (3), leading to current depreciation.

The second, more persuasive method is currently discussed in the literature as a possible way of influencing the exchange rate via affecting market expectations (Heikensten – Borg, 2002). However, there are still some relevant questions. First, if the intervention must be accommodated by subsequent changes in monetary policy, it is no more an independent policy instrument. Second, within the inflation targeting regime, central banks gain credibility by sound monetary practices, transparency and inflation forecasts aimed to influence market expectations. Why should such a central

bank use another means to "buy credibility" such as intervention if it wants to announce changes in future monetary policy? Svensson (2001, p. 48) thus argues, "[interventions] may have more substantial effects only when they are interpreted as signals or threats of future interest rate changes. A transparent central bank has better ways of sending such signals, though [...] I see no reason why a transparent inflation-targeter should undertake foreign exchange interventions." Third, discussed in the literature under the term "secrecy puzzle" (Edison, 1993), (Sarno – Taylor, 2001), (Dominguez – Frankel, 1993a), if monetary authorities want to signal future monetary policy by intervention, why do they often maintain secrecy of intervention operations?

3.2.5 The Microstructure (Order Flow) Channel

Even if the signaling channel explains more than the portfolio balance channel, there are some questions, take secrecy puzzle for example, left for further research. In recent literature, the research interest moves to the microstructure approach to foreign exchange market (D'Souza, 2002), (Lyons, 1997, 2001), (Peiers, 1997), (Frankel et al., 1996). The microstructure channel is very similar to the market channel because it focuses on the functioning of foreign exchange markets. Private information, institutions (trading mechanisms) and different motives of players in the market are relevant features that can affect market prices (i.e. exchange rates) but cannot be at the same time explained in the traditional macroeconomic framework of exchange rate determination.

In this channel, order flow, i.e. transaction volume that is signed according to the initiation of transaction (minus for active selling, plus for active purchasing) plays the central role. If an investor sells EUR 200 million for dollars in the foreign exchange markets at the best bid price, then the transaction volume is EUR 200 million, but order flow is – EUR 200 million. Thus, over time, we can measure order flow as the sum of the signed buyer-initiated and seller-initiated orders. If order flow approaches zero, there is a balance between buyer-initiated and seller-initiated transactions, as opposed to, for example, the financial crisis where the central bank is usually the only buyer of domestic currency (i.e. order flow is significantly negative). Order flow thus carries relevant information about market pressures, fundamentals or market expectations that are often not public. There is asymmetric information; some agents (typically large players) in the market are better informed than others are because they observe more order flow.

The channel works as follows (Peiers, 1997): the central bank intervenes rather secretly and without an official announcement in the foreign exchange market through some commercial bank. Such a bank, by receiving a market order from the central bank, gains information advantage, and a short-term profit opportunity. Thus, it adjusts its order flows and prices. Other banks in the market learn from the order flows that there is an informed agent in the market (i.e. a trader that knows relevant information regarding fundamental determinants of exchange rate) and, in order to minimize losses, will adjust their positions accordingly. However, after all com-

mercial banks gain the information that it was the central bank having given the first impulse, they will return to their pre-intervention trading strategies.

This channel implies that, under the assumption of asymmetric information between informed and uninformed traders and when intervening "secretly" (at least to some extent), the central bank does not have to buy or sell large volumes of currency as in the simple market channel if it aims to influence the spot exchange rate. At the same time, the effect of intervention is not as short lasting as in the market channel. On the other hand, even if the secret intervention strategy, aiming to maintain the traders in some kind of uncertainty about fundamentals, can temporarily weaken the exchange rate misalignment, it is still a kind of "fooling" the market and provides no durable solution to the very problem of market expectations. Thus, again, this channel may serve only to signal the "right" value of exchange rate to the market participants.

3.2.6 The Noise Trading Channel

The question that remains after discussing all the relevant channels is whether intervention could really have longer-lasting effects. Hung (1997) suggested a new transmission channel – again based on the functioning and microstructure of the foreign exchange market – through which the central bank can influence not only the immediate exchange rate, but as well the market expectations about the future exchange rate trend.

The basic logic starts with the assumption that there are "noise traders" in the foreign exchange market, i.e. traders whose behavior is influenced by beliefs or market sentiments not fully consistent with economic fundamentals. Noise traders are chartists who usually follow past trends, relying on some kind of feedback rule, use technical analysis to generate buying or selling signals, and often trade in a correlated fashion. If most of the traders in the foreign exchange market are noise traders, the probability of speculative bubbles and long-term misalignment rises.

If the central bank intervenes secretly in a thin market where chartists operate, the immediate transitory and short-lasting effect may induce the noise traders to perceive that the prevailing trend has broken and to incorporate this new information into their trend analysis. Because chartists usually assign much heavier weight to the most recent exchange rate movement in their forecasts, they may take the effect of intervention as a warning signal of a change in the market direction and even reverse their behavior, for example from buying the currency to selling it.

This kind of intervention, by enhancing the exchange rate volatility and thus promoting a sense of two-way risk in the market, seems to be at the first sight a contradiction of one of the main motive for intervention, i.e. to lower the exchange rate volatility. However, only in this way can the traders be maintained, in the uncertainty about the future exchange rate development. In addition, this channel offers a satisfactory explanation why monetary authorities often intervene in a thin market, why they intervene secretly and why they hope (and sometimes manage) to reach a longer-lasting effect on the exchange rate.

3.2.7 The Coordination Channel

Sarno and Taylor (2001) present a new channel, not yet discussed in the literature, based on coordination failure of foreign exchange market. If there is an irrational speculative bubble brought about, for example, by technical trading rules, it may be very hard for individual traders to bring about a reversion of the exchange rate, even if they believe it to be misaligned, due to a coordination failure. If, for example, the Czech koruna was overvalued and all traders knew this, they would still prefer not to sell it because no one wants to be the first to burst the bubble.

This intervention can be seen as fulfilling a coordinating role because it brings other traders into the market and can turn the trend. However, because of its novelty, this channel has not yet been discussed theoretically and there is as well no persuasive empirical evidence of its functioning.

4. Is Foreign Exchange Intervention Efficient? Empirical Evidence

A large amount of literature is devoted to the problem whether (sterilized) foreign exchange intervention, working through any of the described channels, was in reality efficient, i.e. whether monetary authorities actually reached the intended aim through this instrument. The empirical evidence is mixed; in the 1980s, most of the studies largely rejected the effectiveness of intervention. In the 1990s, a number of studies have shown that intervention could be, under some circumstances, efficient. As Sarno and Taylor (2001) argue, however, the studies from the 1980s lack availability of relevant data on intervention (change in foreign exchange reserves was usually used as proxy) and expectations (rational expectations were assumed but not tested). Thus, we should take the new studies more seriously than the older ones.

The first of the empirical studies on intervention, the famous Jurgensen Report (Jurgensen, 1983), prepared by an intergovernmental working group of G-7, did not provide very explicit conclusions about the efficiency of intervention. The main results can be summarized as follows: sterilized intervention affects long-run exchange rates much less than nonsterilized intervention; sterilized intervention can influence exchange rates only in the short run; coordinated intervention (i.e. concerted intervention of more than one central bank) can be much more powerful, relative to official intervention by a single country's authorities. Thus, being unable to affect long-run exchange rates, the intervention was regarded by most authorities as inefficient, the U.S. Treasury in 1981–1985 being the best example.[16] Even if the U.S. dollar significantly appreciated in this period as a result

[16] From the beginning of the floating in 1973 to 1981, the U.S. Treasury, responsible for foreign exchange intervention, intervened together with the Federal Reserve System – through the Federal Reserve Bank of New York – quite heavily against depreciation in late 1970s, however with ambiguous results, providing a strong argument against intervention (Dominguez – Frankel, 1993a).

of the Paul Volcker's disinflation program, the monetary authorities refrained from intervention.

Another famous study, written by Edison (1993), surveys most of the literature between 1982 and 1992. Regarding the portfolio balance channel, the surveyed studies find no or very weak (Gosh, 1992) portfolio balance effect on the exchange rate. The signaling channel is more promising, showing some significant empirical relations between official intervention and future monetary policy. Dominguez and Frankel (1993a, 1993b) show that there are statistically significant effects of both portfolio balance and signaling channels, using official data on intervention and modeling the exchange rate expectations via market forecasts. Especially coordinated intervention has been successful at moving the exchange rate in the desired direction, the best evidence being the coordinated intervention aimed to burst the appreciation bubble of the dollar in 1985 (as embodied in the so-called Plaza Agreement, settled in September 1985 at the G-5 meeting in the New York's Plaza Hotel). On the other hand, Kaminsky and Lewis (1996) find in their empirical study that the U.S. interventions, in some periods of 1980s, signaled future monetary policy in an opposite direction than predicted by the signaling channel.[17]

Thus, as well as the theoretical debate about intervention channels, the empirical evidence on the effectiveness of foreign exchange intervention remains ambiguous. Some concerted, large interventions actually affected exchange rates for more than hours, but if they were not in correspondence with underlying fundamentals and monetary policy, they had only a short-term impact. With some exceptions (Hung, 1997), (Peiers, 1997), the microstructure and the noise trading channel have not been empirically estimated, so that one has to rely on some stylized facts, which however support so far the relevance of both micro-transmission channels when estimating the effectiveness of intervention.

5. Conclusion: The Czech Koruna Episode Reinterpreted

In the light of the theoretical debate and empirical evidence, how are we now to interpret the Czech experience including the use of official intervention? In this respect, there are at least two questions to answer.

Firstly, as already noted, the question is whether a central bank under inflation targeting should use foreign exchange intervention at all. So far, there is no clear answer to this question, given either by theory or by international experience. The theoretical positions reached from the negative one made by Svensson (2001) about redundancy of this instrument as a signal up to the positive one made for example by Wadhwani (2000) about preventing the hysteresis effect. The international experience gives no clear answers as well. The praxis of the inflation targeting central banks reaches from the "no intervention" strategy of the inflation-targeting pioneer New

[17] For further discussion of empirical evidence and for surveys of the relevant literature see (Edison, 1993), (Dominguez – Frankel, 1993a), (Baillie et al., 1999) or (Sarno – Taylor, 2001).

Zealand (has not intervened since 1985) to the more pragmatic approach taken by central banks of Australia or Sweden – see (Heikensten – Borg, 2002) – that occasionally intervene.[18] However, the use of foreign exchange intervention is always somehow justified and regarded as exceptional (for example if the interest rate instrument does not work efficiently). As already noted, specific causes of the excessive koruna appreciation, regarded as misalignment, together with the risks, which such an appreciation may represent for the very open Czech economy, may justify the use of intervention.

Second, the question remains if the interventions conducted by the Czech National Bank have been effective and, if so, through which channels did they work. I have already argued that the role of official intervention – especially those in the second phase, leaving those in the first phase as inefficient at all – in the fight against the appreciation is not clear. Following, I list some arguments supporting the view that the interventions might have contributed to the reversion of the exchange rate path.

First, being performed secretly via foreign banks, the intervention might have affected the overall market expectations about further appreciation and the market sentiment. In this respect, the intervention could have worked through both the order flow channel and the noise trading channel. Through order flow, the traders might have gained the information that some other traders (foreign banks) are reversing their expectations, selling rather than buying the Czech koruna and going out of the "bubble game". Because of rising uncertainty about privatization revenues, or more precisely because of rising certainty that the revenues would not go through the market, the bubble was already at the point of bursting, i.e. the probability of depreciation was considerably high and the share of traders expecting it was significantly increasing. Similarly, through the noise trading channel secret interventions might have increased the volatility and induced the chartists to change their strategies and to incorporate the higher probability of depreciation into their trend analyses, leading to the factual depreciation.

The second argument for the role of intervention considers the lack of other impulses or information that could have caused the sudden reversion. In July 2002, all the information regarding fundamentals, monetary policy or government intentions were already present. No new relevant information about economy arrived, the market expected further declines in interest rates, and government confirmed the will to adhere to the agreed-on Strategy, as had been shown by the sale of euros from the Transgas privatization direct into the foreign exchange reserves of the central bank. Thus, the only "cause" that suddenly changed the market sentiment must have been the secret interventions.

I agree with Holub (2003) that the effectiveness of the interventions conducted in July–September 2002 was supported by other factors: (a) a changing market sentiment, caused by the expected cancellation of some large privatizations and the adherence of the government to the Strategy, (b) ne-

[18] See the web sites of the central banks – New Zealand http://www.rbnz.govt.nz, Sweden http://www.riksbank.se/ and Australia http://www.rba.gov.au/ for their position regarding the use of official intervention.

gative interest rate differential between the koruna-denominated and the euro-denominated assets (since the end of July 2002), making the koruna less attractive for investors, and (c) change in the market's perception of the sterilization costs.

The negative interest rate differential not only made the foreign exchange intervention – if preventing the koruna from further appreciation – even profitable, but also contributed to the change of behavior of the main market makers – commercial banks. In the first phase of interventions in October 2001–April 2002, the commercial banks had to absorb most of the foreign currency in the market, facing a risk of losing money with lower interest rates on the euro than on the koruna. As a result, together with the expectations of continuing koruna appreciation, they offered less and less for the euro, making the koruna factually strong. In this situation, the banks used the interventions only as a welcome opportunity to get rid of the foreign currency, without any stronger effects on the offered exchange rate. However, with falling domestic interest rates and changing market sentiment in July–September 2002 from appreciation to possible depreciation, foreign assets became more profitable, contributing to the reversion of the trend. In this case, the banks reacted to the interventions more sensitively than in the first phase.[19]

From the point of view just described, one has to ask whether these "complement" factors would not have sufficed for the reversion of the exchange rate trend and whether the interventions had been necessary. This issue must be seen in a larger perspective of the traditional empirical debate on exchange rate determination. We are rarely possible to identify ex post the definitive fundamental cause of the exchange rate development. However, if fundamental variables create space for the reversion of the exchange rate trend, then interventions may play a decisive role.[20] I argue that interventions at the right time and under favorable fundamental conditions, as mentioned above, can have a multiple effect through the described microstructure channels on the market expectations and hence on the exchange rate. This thesis is in accordance with the conclusion of Dominguez and Frankel (1993a, p. 140) as well: "It may be that sterilized intervention can only have effects in the short term. But if "short-term effects" include the bursting of a nine-month bubble earlier than it would otherwise have burst, then such an effect may be all that is needed."

One may ask if the intervention worked also through the signaling channel, as the channel that has some empirical relevance and sound logic. Well, I argue that even if one can interpret the intervention as a signal of further decline in interest rates, the signal was redundant. Within the inflation-targeting framework, as mentioned above, the Czech National Bank has already sent a clear message of its intentions regarding interest rates through the published Bank Board minutes, everyday communication with media, and Inflation Reports. In this regard, the Czech experience also challenges the traditional theoretical approach to the effectiveness of interven-

[19] I owe this comment to one anonymous referee.

[20] I owe this comment to Oliver Landmann.

tions, diminishing the relevance of the macroeconomic portfolio-balance and signaling channels, and providing more support for the microstructure channels.

We may conclude that intervention is and remains an important instrument of central banks, as a renewed interest in recent literature shows (Canales-Kriljenko et al., 2003). However, its use should be limited only to those rare situations where standard instruments (i.e. interest rates) do not work any more. When considering foreign exchange intervention, the central bank should moreover wait for the right moment in order to maximize the effect on the expectations and the exchange rate, and take into consideration specific circumstances, market sentiment and external factors, contributing to the exchange rate determination. From this point of view, those of the Czech National Bank's interventions that were conducted in July–September 2002 can be assessed as quite efficient and relatively successful.

REFERENCES

BAILLIE, R. T. – OSTERBERG, W. P. (1997): Central bank intervention and risk in the forward market. *Journal of International Economics*, vol. 43, 1997, pp. 483–497.

BAILLIE, R. T – HUMPAGE, O. F. – OSTERBERG, W. P. (1999): Intervention as Information: A Survey. *Federal Reserve Bank of Cleveland Working Paper*, no. 9918.

BERNANKE, B. S. – LAUBACH, T. – MISHKIN, F. S. – POSEN, A. S. (1999): *Inflation Targeting: Lessons from the International Experience*. Princeton (New Jersey), Princeton University Press, 1999.

BILSON, J. F. O. – MARSTON, R. C. (eds.) (1984): *Exchange Rate Theory and Practice*. The University of Chicago Press, Chicago and London, 1984.

BOPP, L. (1982): *Wechselkursmanagement der Zentralbanken*. Freiburg im Bresigau, Rudolf Haufe Verlag, 1982.

BORIO, C. (1997): The implementation of monetary policy in industrial countries: a survey. *BIS Economic Papers*, 1997, no. 47.

BRANSON, W. H. (1983): Macroeconomic Determinants of Real Exchange Risk. In: Herring, R. J. (ed.): *Managing Foreign Exchange Risk*. Cambridge, Cambridge University Press, 1983.

BRANSON, W. H. – HENDERSON, D. W. (1985): The Specification and Influence of Asset Markets. In: Jones, R. W. – Kenen, P. B. (eds): *The Handbook of International Economics.* Vol. II. Amsterdam, North-Holland, 1985, pp. 749–805.

CANALES-KRILJENKO, J. I. – GUIMARAES, R. – KARACADAG, C. (2003): Official Intervention in the Foreign Exchange Market: Elements of Best Practice. *IMF Working Paper*, no. 03/152.

Czech National Bank (2002): *Strategy for Dealing with the Exchange Rate Effects of Capital Inflows from Privatisation of State Property and from Other Foreign Exchange Revenues of the State.* http://www.cnb.cz/en/pdf/vlada_cnb_kurz_en.pdf

D'SOUZA, CH. (2002): A Market Microstructure Analysis of Foreign Exchange Intervention in Canada. *Bank of Canada Working Paper*, no. 2002-16.

DOMINGUEZ, K. M. – FRANKEL, J. A. (1993a): *Does Foreign Exchange Intervention Work?* Washington, Institute for International Economics, 1993.

DOMINGUEZ, K. M. – FRANKEL, J. A. (1993b): Does Foreign-Exchange Intervention Matter? The Portfolio Effect. *American Economic Review*, vol. 83, 1993, no. 5.

EDISON, H. J. (1993): The Effectiveness of Central Bank Intervention: A Survey of the Literature after 1982. Special papers in *International Economics*, no. 18. (Princeton, Princeton University), 1993.

EMMINGER, O. (1986): *D-Mark, Dollar, Währungskrisen: Erinnerungen eines ehemaligen Bundesbankpräsidenten.* Stuttgart, Deutsche Verlags-Anstalt, 1986.

FRAIT, J. (1997): Intervence na devizovych trzích v teorii a empirii. *Finance a úvěr*, roč. 47, 1997, č. 10, pp. 627–639.

FRANKEL, J. A. – GALLI, G. – GIOVANNINI, A. (eds) (1996): *The Microstructure of Foreign Exchange Markets.* The University of Chicago Press, Chicago and London, 1996.

GALATI, G. – MELICK, W. (2002): Central bank intervention and market expectations. *BIS Papers*, 2002, no. 10.

GOSH, A. R. (1992): Is It Signaling? Exchange Intervention and the Dollar-Deutschemark Rate. *Journal of International Economics*, vol. 32, 1992, pp. 201–220.

HEIKENSTEN, L. – BORG, A. (2002): The Riksbank's Foreign Exchange Interventions – Preparations, Decision and Communication. *Sveriges Riksbank Economic Review*, 2002, no. 1.

HENDERSON, D. W. (1984): Exchange Market Intervention Operations: Their Role in Financial Policy and Their Effects. In: Bilson, J. F. O. – Marston, R. C. (eds): *Exchange Rate Theory and Practice.* The University of Chicago Press, Chicago and London, 1984, pp. 359–406.

HOLUB, T. (2003): *Foreign Exchange Interventions under Inflation Targeting: The Czech Experience.* Paper presented at a CEPR/Deutsche Bank Research Workshop, Kronberg, 30–31 January 2003.

HUMPAGE, O. F. – OSTERBERG, W. P. (2000): Why Intervention Rarely Works. *Federal Reserve Bank of Cleveland Economic Commentary*, February 2000, pp. 1–4.

HUNG, J. H. (1997): Intervention Strategies and Exchange Rate Volatility: A Noise Trading Perspective. *Journal of International Money and Finance*, vol. 16, 1997, no. 5, pp. 779–793.

HUSTED, S. – MELVIN, M. (2001): *International Economics*. New York, Addison Wesley Longman, 2001.

JURGENSEN, P. et al. (1983): *Report of the Working Group on Exchange Market Intervention.* Washington D. C., U. S. Department of the Treasury, 1983.

KAMINSKY, G. L. – LEWIS, K. K. (1996): Does foreign exchange intervention signal future monetary policy? *Journal of Monetary Economics*, vol. 37, 1996, pp. 285–312.

KLEIN, D. (2001): *The Exchange Rate Band – an Illusion?* The Manufacturers' Association Conference, Jerusalem, June 25, 2001.

KRUGMAN, P. R. – OBSTFELD, M. (2000): *International Economics*. New York, Addison Wesley Longman, 2000.

LAWLER, K. – SEDDIGHI, H. (2001): *International Economics*. London, Pearson Education, 2001.

LEHMENT, H. (1980): Devisenmarktinterventionen bei flexiblen Wechselkursen. Tübingen, J.C.B. Mohr, *Kieler Studien*, vol. 162.

LYONS, R. K. (1997): A simultaneous trade model of the foreign exchange hot potato. *Journal of International Economics*, vol. 42, 1997, pp. 275–298.

LYONS, R. K. (2001): *The Microstructure Approach to Exchange Rates*. The MIT Press, Cambridge and London, 2001.

McCALLUM, B. T. (1997): Issues in the Design of Monetary Policy Rules. *NBER Working Paper,* no. 6016.

MISHKIN, F. S. – SCHMIDT-HEBBEL, K. (2001): One decade of inflation targeting in the world: What do we know and what do we need to know? *Banco Central de Chile Working Paper*, no. 101/2001.

MUSSA, M. (1981): The Role of Official Intervention. New York, *Group of Thirty, Occasional Paper,* no. 6.

NEELY, CH. J. (2001): The Practice of Central Bank Intervention: Looking Under the Hood. *Federal Reserve Bank of St. Louis Review*, vol. 83, May/June 2001, no. 3, pp. 1–10.

PEIERS, B. (1997): Informed Traders, Intervention, and Price Leadership: A Deeper View of the Microstructure of the Foreign Exchange Market. *The Journal of Finance*, vol. 52, 1997, no. 4, pp. 1589–1614.

SARNO, L. – TAYLOR, M. P. (2001): Official Intervention in the Foreign Exchange Market: Is It Effective and, If So, How Does It Work? *Journal of Economic Literature*, vol. XXXIX (September 2001), pp. 839–868.

SVENSSON, L. E. O. (1999): How Should Monetary Policy Be Conducted in an Era of Price Stability? In: Federal Reserve Bank of Kansas City: *New Challenges for Monetary Policy*, 1999, pp. 195–259.

SVENSSON, L. E. O. (2001): *Independent Review of the Operation of Monetary Policy in New Zealand: Report to the Minister of Finance*. Reserve Bank of New Zealand, 2001.

TAYLOR, M. P. (1995): The Economics of Exchange Rates. *Journal of Economic Literature*, vol. XXXIII (March 1995), pp. 13–47.

WADHWANI, S. (2000): *The exchange rate and the MPC: What can we do?* Speech to the Senior Business Forum at the Centre for Economic Performance on 31 May 2000, Bank of England.

SUMMARY

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Foreign Exchange Intervention: The Theoretical Debate and the Czech Koruna Episode

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The strong appreciation of the Czech koruna over 2001–2002 and the foreign exchange interventions conducted by the Czech central bank under its inflation-targeting regime provide a good opportunity to consider the pros and cons of FX intervention, an often-controversial monetary-policy instrument. This article considers the koruna's said appreciation, possible causation, and the policy measures taken by the central bank then to counter the appreciation. The theoretical channels through which foreign exchange intervention may influence the exchange rate, and empirical evidence of their effectiveness are presented. Finally, the FX interventions of the Czech National Bank are discussed and those conducted in a rather secret manner over July–September 2002 assessed as relatively effective.