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## Foreign exchange interventions in emerging market countries: New lessons from Argentina

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# W. E. P.

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**Würzburg Economic Papers**

No. 79

## Foreign Exchange Interventions in Emerging Market Countries: New Lessons from Argentina

-Extended Working Paper Version-

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# Foreign Exchange Interventions in Emerging Market Countries: New Lessons from Argentina

Alexander Brause\*

-Extended Working Paper Version-

December 19, 2008

## Abstract

Academic literature on foreign exchange market intervention in emerging market countries has grown in recent years. Until now, existing studies have ignored the possible feature of time varying motives and impact effects for/of interventions as well as the relationship to underlying economic and monetary policy fundamentals. Especially, for emerging markets, which are likely to face structural changes, accounting for these aspects is of crucial importance. This paper aims to contribute to this new field of research, by applying rolling estimation frameworks with the purpose to capture changing intervention dynamics. The used methodology allows to disentangle the evolution of intervention objectives and their effectiveness. Furthermore, the development of intervention relationships should be backed by corresponding economic and monetary policy fundamentals. Results for Argentinean experience indicate that (i) intervention motives have varied over time, (ii) impact effects were greatest when interventions were not sterilized and exchange as well as capital restrictions were in place, (iii) motive and impact effects can be explained by economic and monetary policy fundamentals.

*Keywords:* Exchange rates, Intervention, Argentina, Rolling estimation

*JEL Classification:* C22, E52, F31

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# 1 Introduction

Academic literature dealing with the issue of foreign exchange market interventions in emerging markets has grown in recent years. Such countries often claim to preserve the right to intervene in special cases to influence the exchange rate.<sup>1</sup> Thereby, an intervention can be defined as any purchase or sale of foreign currency intended to alter the prevailing exchange rate.

Little has been done to proof if motives and impacts for/of interventions are changing over time. However, this is likely to be the case, since emerging market countries are exposed to high economic dynamics. In the actual environment, such interventions could have changed from simple accumulating reserves towards stabilizing the foreign value of the domestic currency. For example, countries, which are highly indebted in foreign currency, may take special account for exchange rate volatility to minimize potential negative effects of currency mismatches. In this case, a sudden exchange rate depreciation increases countries' foreign debt, and could trigger severe economic consequences. Furthermore short-term excessive appreciation could lead to an over-borrowing in foreign currency, which in turn reflects the seed for a financial crisis. Besides the issue of foreign currency indebtedness, the importance of the exchange rate is further reflected in the exchange rate pass-through effect, making countries prone to growing inflation in cases of a depreciating currency.

The bulk of academic literature dealing with emerging market intervention has focused on countries operating under an inflation targeting framework. Nevertheless, interventions play only a minor role in this framework, since exchange rates are assumed to float freely. Moreover, the inflation targeting framework, like monetary policy in general, is build on the authority's credibility. Since the perpetual question about the effectiveness of interventions has not been answered yet appropriately, no clear intervention strategy has emerged which could have endangered the roots of successful monetary policy, its credibility. Unfortunately, other monetary policy strategies have been neglected so far. The role of interventions in monetary frameworks, different from chasing inflation targets explicitly, has not been discussed in literature, although it is of major interest. Especially in case of monetary targeting, the decision to intervene could stem from either chasing the monetary target or from influencing the exchange rate. In this sense, interventions should be used in a way consistent with other monetary policy instruments. Another drawback of the present academic literature is that the motives for intervention and the effects of intervention are not explained against the background of underlying economic and policy fundamentals. However, depending on the economic structure and other policy measures, motives and impact effects are likely to vary.

From the discussion above this study examines the empirical experience of Argentina with its use of interventions. After the financial crisis in 2001, Argentina abandoned its currency board regime and decided to let the exchange rate float freely. Meanwhile, the strategy of monetary targeting was implemented to pursue the goal of price stability. Although not officially stated, the central bank of Argentina (Banco Central de la República Argentina - BCRA) followed a two way strategy. Besides targeting monetary aggregates, the exchange rate was clearly taken into account by the authorities.<sup>2</sup>

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<sup>1</sup>See Moser-Boehm (2005) for cross-country information on the institutional settings for monetary, exchange rate and intervention policies.

<sup>2</sup>See Frenkel and Rapetti (2007).



The empirical methodology is a two-way approach. Initially, a rolling reaction function is applied to daily intervention data for Argentina in order to disentangle possible time varying motives for interventions. This first step is required to assess the effectiveness of interventions appropriately, which are investigated in a second step by applying a rolling General Autoregressive Conditional Heteroskedasticity (GARCH) framework. Concerning reaction functions, in case of Argentina, daily interventions occur in an almost continuous way, which is why I use a standard Ordinary Least Squares (OLS) methodology. The specification of the reaction function includes exogenous variables for exchange rate volatility, exchange rate trends and monetary policy stances. Furthermore a GARCH model is used to examine the impact of foreign exchange market interventions on the exchange rate and its conditional volatility in Argentina simultaneously. The outcome of both estimation techniques is then assessed against the background of economic and policy fundamentals. Results show that interventions, conducted by the BCRA, were not of static nature but changed in their motives and effects.

The paper is structured as follows. A brief overview about theoretical underpinnings and the academic literature dealing with emerging market interventions is given in section 2. Afterwards, section 3 focuses on economic characteristics of Argentina. Thereby, monetary policy and the role of interventions will be discussed. In the later case, emphasis is given on sterilization and its associated costs. The basic question of research and the applied empirical estimation frameworks are subject of section 4. Empirical results are discussed in section 5. The economic and policy background of motives and impact effects is presented in section 6. Finally, a conclusion is given in section 7.

## 2 Theoretical underpinnings and the literature on interventions in emerging markets

### 2.1 Some theory

#### 2.1.1 Rational for interventions

The question why central banks intervene in the foreign exchange market is not solved theoretically.<sup>3</sup> Of course, it is intuitive that monetary authorities try to influence the exchange rate or accumulate foreign reserves. However, this clearly hinges on the importance of the currency's foreign value for the domestic economy. In practice, the following objectives have come out from several intervention experiences.<sup>4</sup>

(i) *Correcting exchange rate misalignments* is of special importance. Exchange rate misalignments include several outcomes of exchange rate behavior. A stable nominal as well as a real exchange rate equilibrium are essential for economies. Nominal stability signals economic stability, especially when credibility is lacking. Thereby, short-term movements could endanger foreign currency denominated debt and deposit positions in case of an abrupt de- or appreciation. Real stability, and by far more

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<sup>3</sup>One recent exception is Ho (2008), who examined the welfare implications of foreign exchange market interventions in a two-country, two-currency, general equilibrium model.

<sup>4</sup>See e.g. Dominguez and Frankel (1993), Humpage (2003), Sarno and Taylor (2001).

important, a stable real exchange rate equilibrium determines the country's international competitiveness and its inflationary exposure. While an undervalued real rate could create inflationary pressure, an overvalued real rate may undermine the competitiveness of domestic producers on world markets. In both cases nominal and real rate stability reduce welfare losses associated to currency mismatches, which are likely to occur in case of high exchange rate volatility. Furthermore, in the absence of an official nominal anchor, a stable exchange rate anchors inflationary expectations. Misalignments are by far more important in emerging markets compared to industrialized countries.<sup>5</sup> This is due to the fact, that the balance-sheet and exchange rate pass-through effect play a crucial role in emerging markets since such economies are dollarized significantly, and based on foreign trade.

(ii) *Preventing disorderly markets* to guarantee a stable and appropriate functioning foreign exchange market is an essential increment of intervention policy, especially in emerging markets. In general, disorderly markets are characterized by high intraday exchange rate volatility, widening bid-ask spreads, accelerating exchange rate changes, and sharp changes in market turnover. However, it is important to note that these features can be caused from changes in fundamental factors and can therefore not be traced back on disorderly markets.<sup>6</sup> Hence, interventions to prevent male functioning markets should only be used if markets are disordered. In such a case, central banks might step into the market when the market maker principle does not function in order to serve as a financial intermediate, matching supply and demand for foreign currency. In this context, desiccating liquidity can have severe consequences on the real economy. Impeding the appropriate setting of exchange rate quotations could lead to wrong distribution of resources and encumber foreign trade development. However, it is important not to restrict exchange rate market development. In this sense, some kind of disordered market conditions are necessary to stimulate hedging instruments, to enhance the mechanism of self-correction, and thus, to wean the market from its dependence on the central bank.<sup>7</sup>

(iii) *Accumulating foreign reserves* helps to establish confidence of foreign investors in the domestic economy. Thereby, foreign reserves serve as a kind of collateral in case of debt defaults. Moreover, the level of foreign reserves is a key determinant of the government's sovereign creditworthiness. Assuring debt repayments and strengthening external liquidity positions, clearly enhances the confidence of external investors. Additionally, the vulnerability to external shocks can be alleviated through a strong external liquidity position.<sup>8</sup>

The motive of accumulating foreign reserves should not be seen as a motive for intervention per se. The term "intervention" should only be used in cases where the central bank intends to alter prevailing exchange rate developments. The purpose of foreign reserves accumulation is not to alter the actual exchange rate behavior directly. For this reason, foreign currency transaction or exchange rate "neutral" intervention is a more appropriate description of accumulating foreign reserves.

An important aspect worth to discuss concerns the communication policy of foreign exchange market interventions. It is a common feature that central banks do not report their interventions to the market. The so called secrecy puzzle is still a challenge in the ongoing academic literature.<sup>9</sup> This

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<sup>5</sup>See Bergin (2004).

<sup>6</sup>See Canales-Kriljenko et al. (2003).

<sup>7</sup>See Ötker-Robe et al. (2007).

<sup>8</sup>See Mulder and Perrelli (2001).

<sup>9</sup>See Vitale (2007a).

is due to the lack of data availability as well as to missing official statements. Some theoretical and practical considerations are given by Beine and Bernal (2007), Beine et al. (2008), Bhattacharya and Weller (1997), Chiu (2003), Dominguez and Frankel (1993). Three broad reasons can explain why central banks intervene secretly.

*First*, transactions with the aim not to influence the exchange rate, but rather to conduct client transactions, reserve accumulation or portfolio adjustments justifies secrecy. Monetary authorities are inherently reluctant to generate any rumors which could endanger orderly market processes.

*Second*, inconsistency between actual interventions and the underlying monetary policy in general as well as the exchange rate policy in particular are an additional factor. Therefore, interventions are kept secret in order not to lose credibility, which is perhaps the most efficient instrument a central bank can possess. This is especially important, when a central bank is not in charge of foreign exchange interventions.

*Third*, as mentioned, credibility is one of the most powerful instruments of a central bank. In this context, the success of previous interventions is a further determinant for monetary authorities to keep their transactions secret or to make them publicly known. The causality runs in each direction. More precisely, if central bank's previous interventions were ineffective in achieving their goals, authorities will tend to conceal further interventions in order not to lose credibility. Additionally, if monetary authorities lack a sufficient degree of credibility, they also will not publish their transactions for the sake of not disturbing the market which could result in higher exchange rate volatility. But, if previous interventions have been effective, future interventions are likely to be published. The success enhances the credibility, and thus, the power of monetary authorities when using foreign exchange market interventions.

Dominguez and Frankel (1993) favor the publicity of interventions. They argue that interventions can only be effective when investors know that the central bank is in the market. Thereby, interventions reveal secret informations and influence market participants expectations.<sup>10</sup> Generally, the greater the size and the frequency of intervention the more it is difficult to keep them secret. Most theoretic intervention channels, which will be discussed in the next section cannot deal with, or condone secrecy.

### 2.1.2 Intervention channels

Foreign exchange market interventions are assumed to possibly work through five channels.<sup>11</sup>

**monetary channel** The monetary channel grounds on the monetary exchange rate determination model, which consists of two views (flexible price model, and sticky price model). Its basic idea is that the exchange rate reflects the relative price of two monies. A change in the domestic and/or foreign money supply influences the exchange rate directly.<sup>12</sup> However, the discussion depends on many theoretical assumptions and is not straightforward. For simplicity, one can also abstract from

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<sup>10</sup> "...intervention has an important effect on the exchange rate only when it influences expectations, this implies that the intervention must be publicly known in order to be effective." [Dominguez and Frankel (1993), p. 136].

<sup>11</sup>For a comprehensive presentation of theoretical intervention channels see Edison (1993), Sarno and Taylor (2001). For a very readable short overview see Gersl (2004).

<sup>12</sup>See Sarno and Taylor (2002).

the theoretic view of monetary exchange rate determination. In this context any purchase or sale of foreign currency, which is not neutralized (i.e. offset by a contrary directed transaction with domestic assets), influences the monetary base, money supply in the money market, and thus, adjusts the price for money. Then, changing money market interest rates alter the demand for domestic assets, and influence the exchange rate accordingly. Nevertheless, the impact of nonsterilized interventions on money market interest rates also depends on the existence of standing facilities which prevent interest rates from departing too much from a predefined target.<sup>13</sup> Hence, the discussion of the monetary effect must incorporate the implemented monetary framework (interest rate targeting, monetary targeting). It is important to note that this is not fundamentally different from the basic theory of monetary exchange rate determination. However, it allows to abstract from theoretical assumptions.

Suppose that a central bank wants to depreciate the domestic currency. Through buying foreign currency, money supply rises, which pushes the price for domestic money. Accordingly, domestic assets (i.e. money) become less attractive to foreign investors which buy foreign assets for reasons of profitability. The exchange rate depreciates. In the same sense, a central bank can appreciate the exchange rate through selling foreign currency and exerting a monetary contraction.

**portfolio balance channel** Investors optimize their portfolios according to their expectations about domestic ( $i_t$ ) and foreign ( $i_t^* + \Delta s_t^e$ ) assets profitability.<sup>14</sup> Central bank interventions distort investors equilibrium portfolio by changing the relative supply of foreign and domestic assets. In order to reequilibrate financial portfolios the excess supply of foreign or domestic assets must be absorbed by market participants. However, market participants require an additional premium ("reward") to hold the excess supply. This reflects the basic assumption of the portfolio balance channel, which states that domestic and foreign assets are not perfectly substitutable. In this context, the risk premium is a function of the relative supply of foreign and domestic assets. Under the additional assumption of constant interest rates and exchange rate expectations, the risk premium can only be assured through an adjustment of the actual exchange rate. This implies that interventions are sterilized, i.e. the purchase of foreign currency is offset by the sale of an equal amount of domestic assets, which guarantees constant interest rates (at least domestic).<sup>15</sup>

$$f\left(\frac{A}{A^*}\right) = \text{risk premium} = \bar{i}_t - i_t^* - \bar{s}_t^e + s_t \quad (1)$$

In this context, a central bank that wants to appreciate the domestic currency sells foreign assets. This increases the supply of foreign assets ( $A^*$ ).<sup>16</sup> The risk premium of domestic assets must decline (of foreign assets must rise) to balance investors risk-adjusted portfolios. This is fulfilled by an appreciation of the domestic currency ( $s_t \downarrow$ ) which in turn increases the expected return on foreign assets ( $i_t^* + (\bar{s}_t^e - s_t \downarrow)$ ).

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<sup>13</sup>See Geršl (2004).

<sup>14</sup>See Edison (1993).

<sup>15</sup>Domestic central banks can not change foreign money market rates directly.

<sup>16</sup>The assumed sterilization diminishes the supply of domestic assets additionally ( $A \downarrow$ ).

**signalling channel** The signalling channel was brought about by Mussa (1981). Interventions within this channel can be interpreted in two different ways.<sup>17</sup>

*First*, and as widely accepted, foreign exchange intervention can be effective when signalling future monetary policy changes. Through sending a signal to the market, investors receive information about future actions and change their expectations about future fundamental factors. Hence, in case of foreign currency purchases authorities send a signal of future monetary policy loosening since the increase in foreign reserves signals a decline in domestic interest rates, and a depreciation of the domestic currency. It is important to note that the central bank must fulfill its signs in order not to endanger its credibility. The influence on the exchange rate is given by the extent to which the market believes the signs and to which monetary policy is seen as credible. Furthermore, whether interventions are sterilized or not, is irrelevant. Sterilizing interventions and adjusting money market conditions in two steps, or leaving the effects on the money supply unchanged is technical equivalent. However, the question raises why a central bank should take the inconvenient step of signalling monetary policy changes by interventions with all its associated risks (credibility), and not just says what it plans to do?<sup>18</sup>

Therefore, the *second* way of understanding the signalling channel gives another perspective. Instead of signalling future monetary policy changes, the central bank informs the market about its opinion on the actual exchange rate behavior. In this sense, interventions can only be effective if the central bank is seen to be more informed than the market. Thereby, interventions reveal information about fundamental factors or the correct way to interpret public available information. This is important since the market is seen to be inefficient and the central bank helps market participants to process fundamental information appropriately.<sup>19</sup> In this context, a sale of foreign currency should signal the market that the actual level or trend is not consistent with underlying fundamentals. Market participants should learn from this signal and adjust their information process and expectations about future exchange rates.

While the monetary and portfolio balance channel condone the issue of secrecy, the signalling channel can not deal with secret interventions at all. Moreover, to signal future monetary policy or reveal fundamental information, publicity is essential as noted above and argued by Dominguez and Frankel (1993) as well as by Sarno and Taylor (2001).

**noise trading channel** So far, the presented theoretical channels have assumed market participants to be homogeneous agents. However, exchange market agents are heterogeneous concerning their beliefs and process of fundamental information. This feature is recognized by the noise-trading channel proposed by Hung (1997). In this context, the foreign exchange market is assumed to consist of two different market players. The first group, which is labelled "noise-trader", relies on short-run perspectives (inter-day or intraday), and bases its trades on anything it believes to be relevant for future prices (exchange rates), even if it is not consistent with long-run fundamental economic factors. In contrast to noise-traders, the second group of market participants are rational maximizing

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<sup>17</sup>See Sarno and Taylor (2001).

<sup>18</sup>The common argument to justify this step, is that a central bank "buys" credibility in the way that it attaches its own money to support its intentions. See Canales-Kriljenko et al. (2003).

<sup>19</sup>see Eijffinger and Grujters (1992).

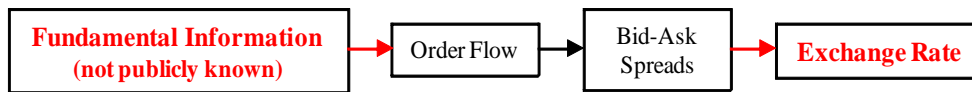


Figure 1: The causality of a pure microstructure model.

"fundamentalists" or "smart money agents", who place their investments largely on their predicted exchange rates, which is based on a fundamental analysis. Through the so called "uncovered arbitrage", smart money agents bring the exchange rate back to its fundamental value. Hence, fundamentalist buy a currency when it is undervalued, and sell a currency when it is overvalued. The possibility that exchange rates deviate from their fundamental values in a persistent way, through irrational behavior of noise-traders, calls central banks to protect the equilibrium value of their currency.<sup>20</sup> In order to reequilibrate those exchange rate developments, monetary authorities have to tackle its roots. Hence, interventions are assumed to influence the noise-trader behavior. As soon as noise-traders become uncertain about future exchange rate movements and question themselves whether they have pushed the exchange rate to far, the central bank should intervene in order to give a "sign", which causes the speculative traders to reverse their positions.<sup>21</sup> The shift in the market flow could cause a breaking of any technical indicators, which in turn serves as a new trading sign. Thus, by increasing exchange rate volatility, the central bank can manage the exchange rate. What leeway do secret interventions have in the noise-trading channel? It can be argued, that highly visible intervention could encourage speculative traders to bet against the central bank, especially if monetary authorities experience a lack of credibility.

**microstructure channel** The microstructure channel incorporates institutional characteristics of foreign exchange markets when explaining the determination of exchange rates and thus the impact of foreign exchange market interventions.<sup>22</sup> The basic idea is that market agents have heterogeneous expectations about economic fundamentals and future exchange rates, which are not publicly known. These expectations are aggregated in the total order flow, i.e. the volume of signed transactions, where signs are given by the initiator ("- sale; "+" purchase). Contrary to the noise-trading channel, heterogeneity is aggregated and not modelled explicitly through different types of market participants. A change in the order flow is recognized by market participants through the "hot potato" effect. Thereby, an open position runs like a "hot potato" through the interdealer market, until one market maker demands this position due to an order from a customer. Through this mechanism, market participants recognize a change in market expectations and adjust their exchange rate quotes (Bid-Ask spreads). This causality is shown in figure 1.

When intervening in the foreign exchange market through a market participant, the central bank serves as a customer and changes the total order flow. This is recognized by market participants through the "hot potato" effect, which in turn causes an informational asymmetry and short-term

<sup>20</sup> This assumes implicitly, that central banks try to target the fair value of their currency, instead of manipulating the exchange rate for intentionally reasons.

<sup>21</sup> This can be called the "noise trading signalling channel" [Almekinders (1995), p.57].

<sup>22</sup> See Lyons (2001), Vitale (2007a, 2007b).

profit opportunities for the informed trader. Accordingly, other market members learn from the order flows that new information on fundamentals have come into the market. In order to minimize losses, they change their expectations and adjust their quotes (signalling idea). Another way to explain how interventions influence the exchange rate is based on the idea of the portfolio balance channel. In this sense, Evans and Lyons (1999, 2000, 2002) argue that orders are manifested by customers portfolio shifts. These shifts are not common knowledge. Dealers, who are the counterpart of customer transactions pass the orders on the interdealer market as described above. Since dealers will not hold open positions at the end of the day, the dealer's inventory imbalances must be absorbed by the public at the end of the day. Because customers are assumed not to be indifferent between two currencies, exchange rates must be adjusted to induce customers to absorb the initial portfolio shifts from the interdealer market.

Various outcomes of the basic model were developed in recent years. Although they differ in assumptions concerning the mechanism of how order flows affect the exchange rate and which role secret interventions play in this context, their basic idea remains the same.<sup>23</sup>

The theoretical channels described above are very unlike to appear by its own. Moreover, a combination of all mechanisms can be assumed. Hence, it is a mix of interest rate changes, portfolio-adjustments, expectation movements, adjustments of market participants' positions, and new information revealed through order flows, which alters the exchange rate if any. This aspect must always be kept in mind when making conclusions on the most appropriate intervention channel.

### 2.1.3 Simultaneity problem

Empirical work faces a lot of problems, which must be taken into account, when investigating the relationship between interventions and exchange rates. The most severe one is the simultaneity bias, which occurs if intervention and exchange rates are exposed to endogeneity. In this sense, simultaneity means that the exchange rate and interventions are "determined" simultaneously in the same period. Hence, the question is what was first, the intervention or the exchange rate behavior. If not addressed, estimated coefficients are biased. A simple example should be used to illustrate the problem.

$$s_t = \alpha I_t + \varepsilon_t \quad (2)$$

$$I_t = \beta s_t + \nu_t \quad (3)$$

The reduced form for equation 2 and 3 yields:

$$I_t = \frac{\beta}{1 - \alpha\beta} \varepsilon_t + \frac{1}{1 - \alpha\beta} \nu_t \quad (4)$$

It can be seen that the necessary condition for unbiased estimation,  $Cov(I_t, \varepsilon_t) = 0$ , is not given. From equation 2 and 4 the OLS estimator for  $\hat{\alpha}$ , which captures the immediate impact of an intervention on the exchange rate, is:

<sup>23</sup>See Bacchetta and van Wincoop (2006), Evans and Lyons (2000), Vitale (2006).

$$\hat{\alpha} = \alpha + \left( \sum_{t=1}^n I_t^2 \right)^{-1} Cov(I_t, \varepsilon_t) \quad (5)$$

$$Cov(I_t, \varepsilon_t) = \frac{\beta}{1 - \alpha\beta} Var(\varepsilon_t) \quad (6)$$

This shows that depending on the intervention strategy, i.e. the sign of  $\beta$ , coefficient  $\hat{\alpha}$ , is downward biased - interventions to *lean against the wind*  $\rightarrow \beta < 0$  - or upward biased - interventions to *lean with the wind*  $\rightarrow \beta > 0$ . In this context, a central bank, which *leans against the wind*, tries to smooth or reverse an existing exchange rate trend, while a central bank, which *leans with the wind*, tries to accelerate the actual exchange rate trend.

Simultaneity can be tackled through two distinctive approaches.<sup>24</sup> The *first* way deals with the estimation strategy. In this context, structural models as proposed by Kearns and Rigobon (2005), and Neely (2006) describe the interrelation between interventions and exchange rates explicitly. Vitale (2007a) mentions, that when identified properly, these models are a good way to overcome the simultaneity bias.<sup>25</sup> Besides, IV-estimation is another possibility to address the matter of endogeneity.<sup>26</sup> Unfortunately, instruments for interventions are usually weak in the sense that they are not orthogonal to the shocks affecting the exchange rate. Finally, event-study analysis, as applied by Fatum and Hutchison (2003, 2006), or Pierdzioch and Stadtmann (2003), have been used to solve the simultaneity issue. Thereby, exchange rate behavior prior (pre-event window) to an event (intervention) is compared with the behavior after the event (post-event window). However, as shown by Neely (2005) these a-theoretic models are not robust towards the simultaneity problem. The *second* method which can be applied to address the simultaneity problem concerns the use of data. Thereby, the investigation of high frequency intraday data on interventions and exchange rates as done by Dominguez (2006) as well as Payne and Vitale (2003), can avoid simultaneity if the timing of intervention is measured precisely and the decision of monetary authorities to intervene is less than the specified time frequency. Under these conditions, no endogeneity between the exchange rate and an intervention occurs. However, central banks are very reluctant to publish intraday intervention data, especially in emerging market countries.<sup>27</sup> Due to the lack of intervention data, some studies use monthly changes in foreign reserves as a proxy for monthly interventions.<sup>28</sup> However, this is very problematic for at least two reasons. At first, changes of foreign reserves are not a good proxy for intervention volumes as shown by Neely (2000).<sup>29</sup> The second reason is that using monthly data condones the inherent feature of high dynamics in case of exchange rate movements. Thereby, when using monthly data, it is very likely that other factors different from central bank interventions have caused the exchange rate to move in one

<sup>24</sup>For an intensive discussion how to tackle simultaneity see Neely (2005).

<sup>25</sup>However, the proper identification reflects the limitation of these models. The lack of sufficient theoretical underpinnings makes it difficult to model the relationship between exchange rates and intervention. Furthermore, as it is the case with other econometric models, coefficients are not robust to structural breaks.

<sup>26</sup>See, e.g. IMF (2007), Kamil (2008).

<sup>27</sup>The Swiss National Bank obtains intraday data on their interventions upon request.

<sup>28</sup>See IMF (2007).

<sup>29</sup>Foreign reserve changes can be caused through various factors different from interventions. Such factors include client transactions, valuation aspects, and interest rate earnings.



direction. Moreover, monthly data are very likely to be exposed to simultaneity since central banks decide to intervene within minutes, hours, or a day. Therefore, if intraday data are not available, daily data are the next best time frequency to use. Nevertheless, if monetary authorities' decision to step into the market is done at lower frequencies, endogeneity must be addressed too. In this context, the most common way to solve endogeneity is to use one period lagged exogenous variables. By doing so, the causality is fixed through time. However, this does not allow to investigate the immediate impact of an intervention on the exchange rate.<sup>30</sup> Another way would be to use end of day exchange rate quotes. In this case simultaneity should be no problem when a central bank intervenes during normal business hours. However, when monetary authorities intervene outside local business hours, problems remain the same.

## 2.2 Academic literature on emerging market interventions

In contrast to the literature dealing with developed market interventions, no broad overview is given for emerging market intervention studies.<sup>31</sup> Until now, the most comprehensive contribution on this field of research is given by the Bank for International Settlements (BIS) (2005). Several aspects like motives for interventions, the role of governments, methods and tactics, and domestic consequences are discussed. However, contributions are of more descriptive nature, and so, do not give a conclusive answer on the question whether interventions are effective or not.

Crucial differences between interventions in industrialized and emerging market countries is discussed by Canales-Kriljenko (2003). Based on a survey conducted by the International Monetary Fund (IMF) with emerging market countries, he emphasizes that interventions, conducted by emerging market authorities, should be more powerful for at least four reasons.<sup>32</sup> *First*, interventions in emerging markets are more powerful since they are not fully sterilized. Thereby, the increase or decrease of the money base changes interest rates, which in turn causes the exchange rate to move in the associated direction. This argument points towards the monetary channel. *Second*, intervention amounts of emerging market central banks account for a substantial fraction of market turnovers, money base, and outstanding stocks of domestic assets. This argument includes the classical portfolio-balance channel as well as its microstructure extension. *Third*, emerging market authorities should possess an information advantage over central banks in major industrialized countries. This advantage stems from reporting requirements and foreign exchange regulations, which give them deeper insights in aggregate order flow. This vantage allows the central bank to place their interventions at the appropriate time and enhance its market share additionally. Moreover, the information advantage is recognized by market members, which supports the credibility of the central bank. This argument materializes the signalling channel. However, since market shares are supported, the microstructure channel must also be mentioned. *Fourth*, some central banks in emerging markets might further use moral suasion

<sup>30</sup>It should be noted that the preceding discussion dealt with the inconsistency of the intervention impact coefficient  $\hat{\alpha}$ . However, the simultaneity concerns the reaction coefficient  $\beta$  as well.

<sup>31</sup>See Almekinders (1995), Edison (1993), Dominguez and Frankel (1993), Humpage (2003), Sarno and Taylor (2001). Most recently, the *International Journal of Finance and Economic* has attended one issue (Vol. 12) to foreign exchange market interventions. Disyatat and Galati (2007) represents one exception for emerging market countries.

<sup>32</sup>These reasons are assigned to the theoretical channels described above.

towards foreign exchange dealers. By threatening them to withdraw their licenses, central banks can force them to open positions supporting the central banks exchange rate purposes.

Another argument for emerging market interventions to be more effective is aligned to the portfolio balance channel of interventions. In this context, domestic and foreign assets of emerging markets are less substitutable compared to industrialized countries. A sterilized purchase of foreign assets increases the supply of domestic assets. To hold this excess supply, foreign investors ask for higher risk premia compared to industrialized assets. This can only be reached by a greater exchange rate adjustment.

In contrast to most intervention studies for industrialized countries, empirical results for emerging markets tend to support the effectiveness of foreign exchange market interventions. Though, these effects tend to be short-lived and only existent in case of consistency between interventions and the actual monetary policy stance. The most recent contributions on this new field of research are given by Disyatat and Galati (2007), Kamil (2008), and Scalia (2008). These studies all offer very interesting but different perspectives about the importance of foreign exchange market interventions in emerging market countries and on what is left for future academic research.<sup>33</sup>

Disyatat and Galati (2007) focused on the relationship between interventions and market expectations in the inflation targeting Czech Republic between 2001 and 2002. The authors estimated the impact of interventions on the spot rate and its expectations. Therefore, data from option markets were used to build measures for exchange rate expectations (implied volatility, risk reversal). Macroeconomic announcements were used as control variables to examine whether deviations from market expectations about macroeconomic fundamentals influence the exchange rate as well. In summary, their empirical results obtained from OLS-Regressions highlight that changes in the spot rate as well as in its expectation measures are hard to detect by interventions or macroeconomic announcements. While cumulative (5-day) interventions did significantly decline an existing exchange rate trend, the impact was very small in economic terms. Furthermore, while the impact on the implied volatility was estimated to be insignificant, interventions influenced the risk reversal significantly. Thereby, a purchase of foreign currency indicated that the market gave more weight on a depreciation of the domestic currency. In this sense, monetary authorities influenced market expectations successfully. Concerning the impact of control variables, results suggested that higher than expected inflation data and retail sales caused the spot rate to appreciate. This is in line with the idea of inflation targeting since higher inflation and growing economic activity is expected to be followed by an increase in interest rates causing an appreciation pressure on the domestic currency. Surprisingly, impacts on exchange rate expectations were estimated to be insignificant.

Kamil (2008) examined the experience of Columbia between 2004 and 2007, which, like the Czech Republic, has implemented an inflation targeting framework in 1999. The case of Colombia is interesting since authorities have implemented a two way intervention strategy. While having explicit intervention rules, the central bank of Colombia claims to preserve the right to intervene in a discretionary way.<sup>34</sup> The author focused on the consistency between discretionary interventions and the

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<sup>33</sup>See Appendix - table 8 for more studies on emerging market interventions.

<sup>34</sup>See [http://www.banrep.gov.co/exchange\\_policy/index.html](http://www.banrep.gov.co/exchange_policy/index.html)

underlying monetary policy stance. During the whole sample, monetary authorities bought foreign currency with the purpose of alleviating an appreciation trend of the peso against the US\$.<sup>35</sup> However, while the first part of the sample was aligned by monetary policy loosening, the second part was characterized by a tightening of monetary conditions to tackle growing inflation and domestic economy overheating. Estimation results of a GARCH model similar to mine presented below, reveal that while interventions during the first sample period were effective in calming the appreciation trend, interventions conducted during monetary policy tightening were almost ineffective. He concluded that an intervention can only be used appropriately when it is consistent with other ("main") monetary instruments.<sup>36</sup>

Scalia (2008) discovered totally new ways in the research of emerging market interventions. Based on theoretical models of microstructure described above, he investigated the effectiveness of Czech Republic foreign exchange market interventions. Moreover, he examined whether news of interventions have an additional impact compared to secret interventions. Data on hourly exchange rate changes and on order flows were obtained from Reuters Spot Matching market covering the second half of 2002, when the Czech National Bank (CNB) leaned against an appreciation trend of the Koruna against the Euro. Intraday intervention data were obtained from informations given by the CNB. His main findings are that the impact of order flow equals 0.076% per 10 mill. €. Only 80% of this impact persists throughout the day, indicating a very short-lasting intervention effect. Furthermore, the publicity of interventions, increased the impact by 0.039% per 10 mill. € additionally. This is in favour with the findings of Dominguez and Frankel (1993) for industrialized countries.

Although offering very interesting perspectives, the presented studies and further contributions have mainly neglected the relationship between intervention motives, impact effects, and underlying economic as well as monetary policy fundamentals. However, the knowledge for what purpose a central bank intervened is crucial for assessing their effectiveness.

### 3 Monetary policy and interventions in Argentina

#### 3.1 Monetary policy

Monetary Policy in Argentina has changed substantially with the financial crisis in 2001. After abandoning the currency board regime in which the BCRA was obliged to convert peso into US\$ with a relation of one to one in December 2001, Argentina chose to let the domestic currency float freely. However, the country faced a lot of problems. Capital outflows, exchange rate overshooting, and a run on the banking system, rocked the country's economy. Foreign reserves declined by 64.6% between January 2001 and July 2002. Although household consumption began to rise slightly at the end of 2001, real GDP growth was still at two digit negative levels (figure 2). Several measures were used to

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<sup>35</sup>Kamil (2008) applied a Tobit - estimation framework to disentangle the motives for discretionary interventions.

<sup>36</sup>Other emerging market studies dealing with the consistency between foreign exchange intervention and actual monetary policy stance are given by Gersl and Holub (2006), Holub (2004). These studies focus on the experience of the Czech Republic.

attenuate these problems.<sup>37</sup> At first, restrictions on capital outflows and deposit withdrawals (“corralitos”) were imposed to forestall a bankruptcy. These restrictions were also used to hold back the demand for foreign currency to defend the peso and to secure the stock of foreign exchange reserves. Meanwhile, the government implemented a dual exchange rate system, with a fixed parity for certain trade and financial operations (1.4 US\$/ARS) and a free float for the rest of operations. However, due to IMF demands, the exchange rate market was unified soon afterwards.<sup>38</sup> Due to this “inconvenient” step, the peso depreciated up to 4 pesos per US\$ in June 2002, which caused significant wealth destructions. Therefore, the government decided to convert domestic debt denominated in US\$ into peso one to one in order to offset the increase in real debt level and thus to assuage the balance sheet effect. Furthermore, the government decreed to convert US\$ denominated deposits into pesos at a fixed rate lower than the actual market exchange rate. These steps were part of the so called “pesofication”. Capital outflows were restricted by setting limits on monthly exchange transactions per person and by introducing surrender requirements for traditional exporters. Thereby, exporters were forced to cede their earnings at the central bank. All these measures were supported by foreign exchange market interventions with the purpose of calming the illiquid foreign exchange market, due to capital and deposit restrictions. In this environment monetary policy was inexistent, since the central bank faced a not functioning financial system, and did not have a valid monetary policy instrument.<sup>39</sup>

In May 2002, the BCRA started to issue debt letters (“Lebac” – short term bills; “Nobac” – securities, since end of 2003), as an intent to implement a new monetary policy instrument. This was done to push back dollarization and to provide the Argentinean financial market with a peso-denominated substitute for US\$ denominated securities, and to regain control over monetary policy. After 10 years of dependent monetary policy, Argentinean authorities were lacking substantial experience in conducting monetary policy independently. Although many emerging market countries have turned to inflation targeting frameworks, Argentina was not able to implement this dominating monetary policy strategy. The inexistence of a sophisticated and stable domestic financial system made it impossible to focus towards chasing inflation targets explicitly through controlling short-term interest rates.<sup>40</sup> In contrast, Argentinean’s monetary policy can be described as a transition towards this famous monetary policy framework. Since 2003, influenced by the IMF, monetary policy is based on targeting quantitative monetary targets. At the end of each year, target ranges for each quarter of the following year are announced.<sup>41</sup> These targets account for the ultimate goal of price stability as stated in the Central Bank Law.<sup>42</sup> Hence, domestic prices are controlled through a monetary targeting strategy and an expectation anchor given by the quantitative monetary targets.

The most important instrument applied by the BCRA in the most liquid market has been foreign

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<sup>37</sup>See BCRA (2002).

<sup>38</sup>See Frenkel and Rapetti (2007).

<sup>39</sup>Government debt was in default. To make things even more complicated, fifteen different monies (‘quasi-monies’) were in circulation. See McCandless (2005).

<sup>40</sup>It should be noted that the inability was also due to the implementation of the ‘corralito’, which added to the desiccation of the financial system.

<sup>41</sup>Quarterly targets started in 2004. During 2003, BCRA announced bi-monthly targets. See BCRA (2003a).

<sup>42</sup>„The Central Bank of the Argentine Republic shall primarily and essentially preserve the value of currency.”, Article 3:Charter Act No. 24,144 CENTRAL BANK OF THE ARGENTINE REPUBLIC (Updated as at December, 2007).

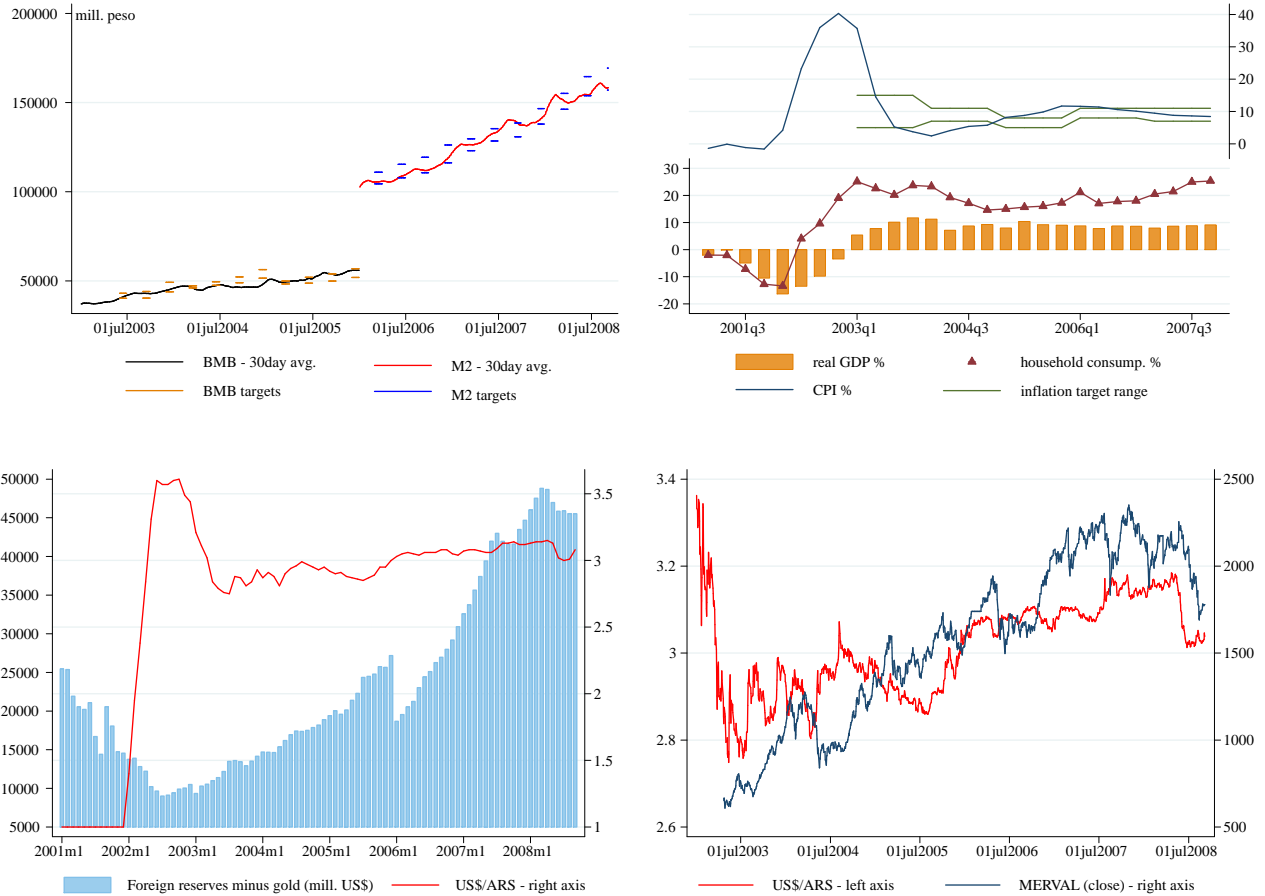


Figure 2: Economic monetary policy features of Argentina between 2001 and 2008 (source: BCRA, IFS, Boston Globe).

exchange intervention to target the broad monetary base (BMB) (currency in circulation held by the nonfinancial sector adjusted for quasi-monies). This in turn reflects the double-targeting regime of Argentina: monetary and exchange rate targeting regime. However, monetary authorities made no statements on the use of foreign exchange market interventions in order to target a specific exchange rate level. Moreover, authorities denied any exchange rate targets: "...even though the BCRA does not pursue an exchange rate target", [BCRA (2003b), p.10]. A change in the monetary target has been announced at the end of 2005. Beginning with 2006, the BCRA chose to control the broader monetary aggregate M2 (cash held by the public, current accounts held by the private and public sector in peso, savings account in peso of the private and public sector).<sup>43</sup> This change was justified by the fact that the money multiplier has increased over years, and that there was a significant expansion in credit lines, which caused M2 to grow.<sup>44</sup> As can be seen in figure 2, the BCRA fulfilled its quantitative monetary

<sup>43</sup>See BCRA (2005a).

<sup>44</sup>It must be noted at this point that the money multiplier defined as the ratio of M2 and broad money base is nevertheless fairly stable and low. Since 2003 the multiplier vary in a range between 1.2 (early 2003) and 1.9 (early 2006).

targets throughout the years and inflation rate came back from high two digit levels.<sup>45</sup> However, with a strong increase in real GDP and household consumption growth, inflation began to exceed its target ranges.<sup>46</sup> This points towards the disability of a monetary targeting framework to ensure stable and predictable domestic prices.

The importance of the exchange rate in Argentinean economy is emphasized by McCandless (2005), who investigated transmission channels of monetary policy in Argentina after the 01/02 crisis. He concluded that while an interest rate channel existed, especially since the introduction of the Lebac, the exchange rate channel is assigned by the most importance. Several reasons justify this fact.

Frenkel and Rapetti (2007), as well as McCandless (2005) argue that, although not officially stated, the BCRA chased a target range between 2.8 and 3.05 peso per US\$ to preserve and maintain a stable and competitive real exchange rate which was given more emphasis in official policy.<sup>47</sup> The emphasis, given on the lower exchange rate level, stemmed from the fact that government's main income was tax revenue from export earnings measured in peso ('retentions'). Therefore, the government was clearly interested in a peso not too strong vis-à-vis the US\$.

	F-stat.	P-value
$\Delta s_t \rightarrow \Delta \ln Merval^a$	1.25481	0.2239
$\Delta \ln Merval_t \rightarrow \Delta s_t^b$	1.78199	0.0323

Sample: 1/02/2003 9/05/2008  
<sup>a</sup> H0: exchange rate does not granger cause stock prices  
<sup>b</sup> H0: stock prices do not granger cause the exchange rate

Table 1: Pairwise Granger causality test for Argentinean stock market prices and exchange rate between 2003 and 2008.

Furthermore, McCandless (2005) showed that a stronger exchange rate signaled a strengthening of the domestic economy. The author found evidence for the exchange rate to influence (Granger causes) the Merval index (stock market). Thereby, an appreciation of the domestic currency was followed by a rise of stock market prices. In this sense an appreciation of the peso signaled more economic stability and confidence in the Argentinean economy, leading to more capital inflow. This indicates that the exchange rate, besides quantitative monetary targets, served as a type of a nominal anchor for economic stability. While this result was obtained for a time period covering 2002 and 2003, Granger-Causality tests for data between 2003 and 2008 reveal some different perspectives. As shown in table 1 daily returns of stock market prices Granger caused exchange rate returns. This points towards the evolution of exchange rate and financial markets. While at early stages, the exchange rate possessed a strong signalling power for economic stability, causality has turned towards other asset market influencing the exchange rate. However, in both cases the importance of the exchange rate remains the same.

<sup>45</sup>The quantitative targets in the third and second quarter of 2004 were also matched. However, due to data limitations figure 2 doesn't capture this fact.

<sup>46</sup>The target range for growth of consumer prices was widened in 2006. Primarily, inflation was aimed to vary between 7% and 4% during 2006. These targets were defined according to the IMF. However, a change in relative prices caused through a higher demand for commodities, exerted additional upward pressure on domestic prices in Argentina.

<sup>47</sup>See IMF (2005).

### 3.2 The role of interventions

Foreign exchange market interventions have been the main source of money growth in Argentina. Figure 3 shows that monetary base effective interventions fully account for variations in the monetary base practically. At the beginning of the “free” float era, the purchase of foreign currency stemmed mainly from surrender requirements imposed on traditional exporters and other capital restrictions. While these restrictions have diminished over time, foreign exchange interventions did not. Other monetary base factors were used to restrict monetary expansions. Beside the above mentioned debt instruments issued since mid-2002, the main factors were operations with the public sector (treasury) and Repurchase/Rediscount operations. After the collapse of the currency board and the resulting decapitalization, the financial system was desiccated. Therefore, foreign currency purchases were used to monetize the financial system. Besides, official statements mentioned the need for interventions in order to calm and stabilize the foreign exchange market.<sup>48</sup> However, with a steadily rising broad monetary base, authorities faced an unpleasant situation as their double targeting instrument caused some tensions in the context of Argentinean monetary policy. Matching announced quantitative monetary targets was endangered by targeting an implicit exchange rate band simultaneously. In this sense, money growth, caused through the purchase of foreign currency to absorb appreciation pressure, was sterilized partially, i.e. the increase in monetary base was offset through the issuance of domestic debt instruments or other monetary base explanatory factors.

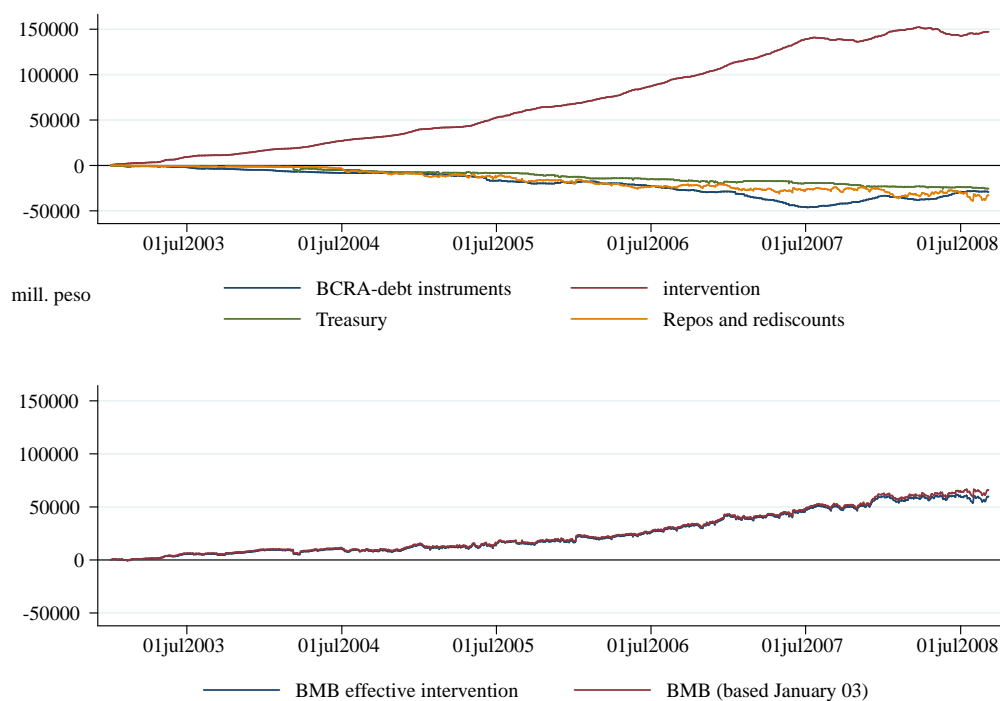


Figure 3: Development of broad monetary base and its main explanatory factors between January 2003 and September 2008 (source: BCRA, own calculation).

<sup>48</sup>See BCRA (2003b).

	$\Delta$	2003			2004			2005		
		BCRA	treasury	Repo	BCRA	treasury	Repo	BCRA	treasury	Repo
Int.		.13**	-.09	.04*	-.08	.16	-.13	-.11	-.26	-.36
t-value		2.13	-1.26	1.69	-.52	.88	-.79	-.88	-1.60	-1.04
$\overline{R^2}$		.015	.01	.01	-.004	-.01	.01	-.004	.005	.01
F-stat.		2.9	2.45	2.03	.43	.36	1.84	.47	1.67	2.26

	$\Delta$	2006			2007			2008		
		BCRA	treasury	Repo	BCRA	treasury	Repo	BCRA	treasury	Repo
Int.		-.17	-.04	.19	-.19**	-.07	-.19	-.21**	.05	-.93**
t-value		-1.32	-.14	.86	-2.70	-1.06	-1.05	-3.17	0.93	-3.02
$\overline{R^2}$		.005	.04	-.004	.01	.11	-.005	.04	.11	.10
F-stat.		1.64	6.63	.49	1.83	16.46	.40	4.29	11.28	8.76

	$\Delta$	2003 - 2008			2003 - 2008		
		BCRA	treasury	Repo	BCRA + treasury + Repo		
Int.		-.18***	-.04	-.40***		-.69***	
t-value		-4.31	-.98	-2.95		-4.66	
$\overline{R^2}$		.01	.02	.02		.02	
F-stat.		12.98	22.12	16.34		21.01	

OLS – Estimation using Newey-West HAC Standard Errors & Covariance

OLS – Regression:  $y_{t,i} = \alpha + \beta y_{t-1,i} + \phi Int_t + \varepsilon_t$  \*10% - \*\*5% - \*\*\*1% significance

$y_i = \Delta BCRA, \Delta treasury, \Delta Repo$  (incl. Rediscounts)

Table 2: Sterilization of daily foreign exchange market interventions between January 2003 and September 2008.

Results of simple OLS regressions, which are given in table 2, reveal this fact. It can be seen that the matter of sterilization gained in importance since 2005. Estimated coefficients indicating the degree of sterilization of daily interventions (Int.) are mainly negative and since 2007 also significant. Thereby, BCRA instruments (Lebacs and Nobacs) show the most significant results, indicating priority as sterilization instruments.<sup>49</sup> Prior to 2005, and especially in 2003, foreign currency purchases were supported by BCRA debt instruments and repurchase/rediscount operations.<sup>50</sup> Overall, nearly 70% of daily BCRA interventions were sterilized between January 2003 and September 2008.

Interestingly, although interventions were not fully sterilized, money market interest rates did not show the suggested declining behavior caused by an increase in the money base. Instead, they rose since mid-2004 calling for the question whether sustained sterilization was feasible.<sup>51</sup> This question

<sup>49</sup> "The issue of Central Bank bills and notes (LEBAC and NOBAC) has been the monetary authority's natural absorption factor." [BCRA (2005a), p. 2].

<sup>50</sup> Estimation assessing variables are included but will not be discussed. The interpretation is left to the reader. Furthermore, OLS regressions were also conducted using weekly and monthly data. However, results do not differ from those obtained from daily data.

<sup>51</sup> The BCRA increased its rates due to the fast growth of the monetary base. The tightening of monetary policy



reflects the well known dilemma of independently managing external and internal aspects, while having an unrestricted capital market.<sup>52</sup> Sterilized interventions in case of fighting against domestic currency's depreciation are inherently restricted to the level of foreign reserves and are not exerted to cost aspects. The opposite is fact when fighting against exchange rate appreciation. Although monetary authorities are not restricted to purchase foreign currency directly, problems could emerge from its sterilization. This holds if its costs (interest rate payments on domestic debt issued to sterilize interventions) exceeds its earnings (interest rate earnings on foreign reserves added by the rate of domestic currency's devaluation) accounted for the levels of domestic liabilities and foreign assets. Frenkel (2007a, 2007b) has addressed himself to the matter of sustainable sterilization policy. He explained that monetary authorities are able to sterilize their interventions (foreign currency purchases) indefinitely as long as the following condition holds:

$$i \leq (i^* + \Delta s) / \left( \frac{L}{R \cdot S} \right) = i^{\max} \quad (7)$$

Hence, sterilization is sustainable, as long as the domestic interest rate ( $i$ ) does not exceed the quotient of the ratio between the stock of domestic interest rate bearing liabilities ( $L$ ) and domestic value of foreign reserves ( $R \cdot S$ ), and its earnings ( $i^* + \Delta s$ ). If this holds, earnings from foreign assets exceed the costs of domestic liabilities. For Argentina, sterilization is only partially conducted by interest rate bearing liabilities. The BCRA's debt instruments do only account for a fraction of sterilization. Figure 4 shows the evolution of the sustainability condition.<sup>53</sup> It can be seen that with the beginning of monetary policy tightening, sterilization "earnings" have declined. However, the BCRA had enough cushion and could have sterilized their foreign exchange interventions even more, without defacing its balance sheet. Nevertheless, sterilization, which has shored up in recent time, has produced costs indicating potential future problems for foreign exchange market interventions as a double-targeting instrument. It is clear that problems emerge in case of ongoing foreign currency purchases. This might call for an alternative monetary policy framework. However, this is beyond what is discussed in this paper, and should be left for other research.

Some words should be given on institutional aspects of interventions in Argentina. First of all, the BCRA has the right to intervene on its own discretion, and is therefore not aligned to political pressure. Operations are conducted during normal business hours in the spot and future market as well.<sup>54</sup> In contrast to other emerging market economies, Argentina follows a very transparent

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stance was aimed to calm these unpleasant money movements, since broader monetary aggregates (M2) rose more than expected due to an increase in the money multiplier. This was also the reason why the authorities stepped towards a quantitative target for M2. Adding to this, capital controls were renewed to abate speculative inflows. See IMF (2005).

<sup>52</sup>See Bofinger and Wollmershäuser (2001). It would be misleading to describe the Argentinean capital market as completely open. However, restrictions diminished over time. For an actual summary of foreign exchange regulations see <http://www.bcra.gov.ar/pdfs/comytexord/P48761i.pdf>

<sup>53</sup>Used data were:  $L$  - stock of Lebac;  $R$  - stock of foreign reserves;  $i^*$  - yield on 10 year US treasury bonds;  $i$  - average rate of Argentinean interbank rate;  $S$  - US\$/ARS;  $s$  -  $\ln(\text{US}\$/\text{ARS})$ . Due to the use of interbank interest rates, the sustainability condition shown in figure 4 is an approximation of real sustainability condition. These data were used due to data limitations on Lebac interest rates.

<sup>54</sup>Future market operations influence the spot exchange rate via the covered interest rate parity which is assumed to hold generally.

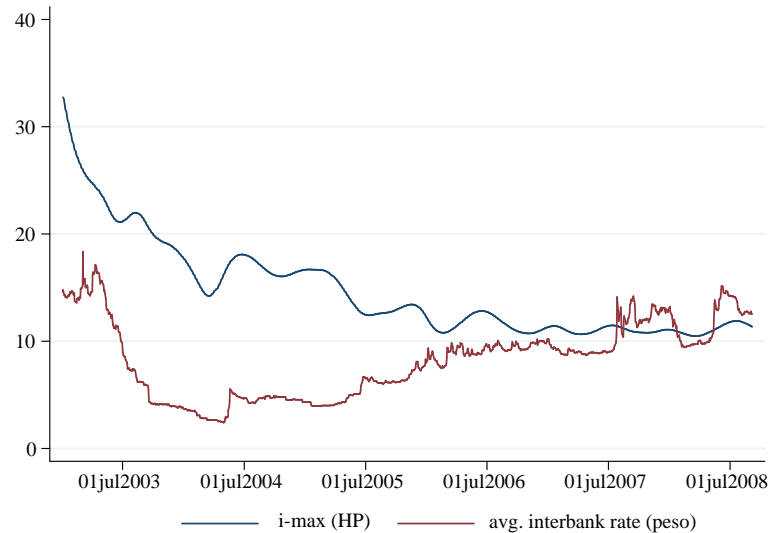


Figure 4: Sustainability condition for sterilizing foreign currency purchases between January 2003 and September 2008 (source: BCRA, Fed; HP: Hodrick-Prescott [ $\lambda = 68000$ ]).

communication policy concerning their foreign exchange market interventions. Although no statement is made immediately, operations are summarized in a weekly report on the exchange rate market, and are further described in monthly monetary reports. Furthermore, statements on foreign exchange transactions can be found in quarterly inflation reports. An important feature of BCRA interventions is its almost daily frequency. In this context, Argentinean interventions can be assumed to be publicly known. The daily frequency will be further discussed when presenting the empirical estimation strategy.

## 4 Question of research and estimation strategy

From the discussion above, it became clear that the BCRA was and still is intended to manage the exchange rate directly via its operations in the foreign exchange market. The foreign value of the peso is too important in the context of fiscal revenues, and signalling economic stability. However, so far, nearly no official statements concerning the motives of interventions were given. For this reason it is of interest for what purposes the BCRA stepped into the market. This can be examined by estimating a reaction function, where interventions are modelled through explanatory factors (motives). Given the financial crisis in 01/02, and the following evolution of Argentina's financial system, it is likely that motives have changed over time. It can be assumed that at the beginning of the "free" float era, emphasis was given on short-term (volatility) exchange rate movements while longer aspects have gained in importance as financial markets become more experienced and sophisticated. Furthermore, the mentioned exchange rate target band (2.8 – 3.05) is likely to have been guarded by monetary authorities over time. Thus, one purpose of this study is to examine the time evolution of Argentina's intervention motives.

Furthermore, it is of interest whether interventions were effective, in the way that the goals of

interventions were reached and whether the impact of interventions has changed over time. Especially against the background of Argentina's monetary targeting and the associated sterilization policy, it can be assumed that interventions were more effective in the early "free" float period. This would be in line with the arguments proposed by Canales-Kriljenko (2003) in the way that interventions in emerging markets are more efficient due to incomplete sterilization of monetary effects. As shown above, this argument fits Argentina's experience at the beginning of the sample, where foreign exchange purchases were the main instrument of domestic economy's monetization, followed by declining interest rates. However, other restrictions imposed by monetary authorities could have also supported the efficiency of foreign exchange market interventions.

To discover these aspects, a two step methodology will be applied. In the first step, a reaction function is estimated to examine the reason for BCRA interventions in the foreign exchange market. As an extension to deal with time varying motives, rolling estimations are used. Given the knowledge of intervention purposes, a GARCH model is estimated in a second step. This allows to discover the intervention impact on the exchange rate and its conditional volatility simultaneously. As it is the case for the reaction function, also GARCH models will be estimated in a rolling way to account for time varying effects. Neglecting possible variation or evolutions in both models could distort estimation results. The usage of rolling estimations is a simple but very fruitful way of tackling structural breaks and getting insights on the time dependent evolution of estimated parameters. Concerning the rolling window, generally, a trade off exists between the window length to enhance the informational content and the possible inclusion of structural changes. Therefore the window length was set to 300 days in order to account for these issues. Estimation results are sometimes highly volatile. Therefore, coefficient series were smoothed using the Hodrick-Prescott Filter. It is important not to rule out too much variation ("cycles") in the generated time series. To account for this  $\lambda$  was set to 68000. To my knowledge the only study which has used rolling estimation is Hillebrand and Schnabl (2006) when examining the effects of interventions in Japan. The authors focused on structural breaks in the intervention impact. Thereby, rolling results served as a primarily indicator. Thus, their intention differed from mine. Nevertheless, it must be noted that despite its advantages this techniques is not free from critique at all. Thereby, the choice of an appropriate window is rather an arbitrary question. Additionally, even estimation windows can be exposed to parameter instability. However, such problems are assumed to have no significant influence on the results.

Figure 5 gives a first overview of BCRA interventions and daily exchange rate movements. It is clear that figure 5 reveals no information about the causality of interventions and exchange rate changes. However, it is useful to display the relationship in order to get a first impression. In the context of this scatter plot, one would expect the relationship to meander around the green line for "best" impact effects. Thereby, large foreign currency purchases (sales) would cause the exchange rate to depreciate (appreciate) substantially. In contrast, the black line displays "best" responses of daily interventions on daily exchange rate returns. In case of short-run (daily) intervention motives, the relationship should vary around the black line indicating foreign currency sales as a response on high exchange rate depreciation. However, both causalities are displayed in figure 5, since contemporaneous and daily returns are displayed.

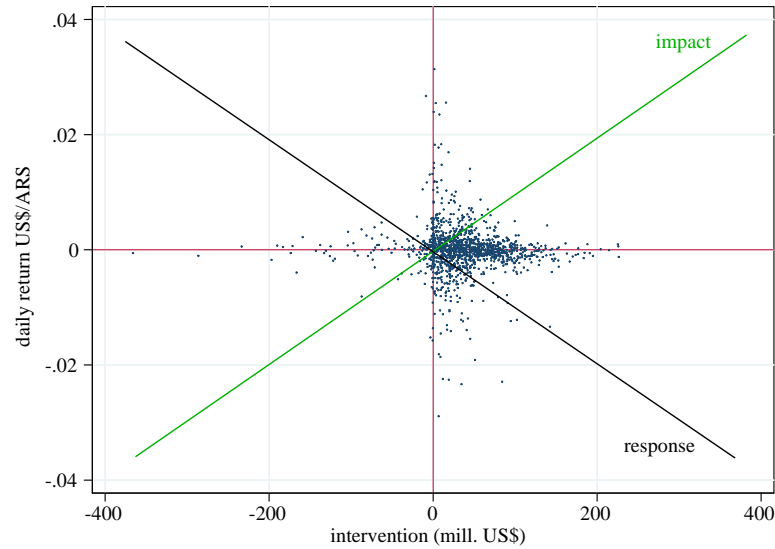


Figure 5: Relationship between daily interventions and daily exchange rate returns in Argentina between January 2003 and September 2008.

Generally, it is important to understand why monetary authorities intervene, and why interventions influence the exchange rate in either way. More insights in this questions will enhance the understanding of how to use the still disputed instrument of foreign exchange market interventions. I am convinced, that interventions, when used carefully, possess enough power to support monetary policy settings. Thereby, the focus lies on the supporting nature of foreign exchange market interventions.

#### 4.1 Reaction function

When estimating intervention reaction functions, the distributional characteristic of interventions must be seriously taken into account before applying an appropriate estimation procedure.<sup>55</sup> As it is the case with most foreign exchange market interventions, they occur in a discontinuous way. This may be due to the decision making process, where authorities deliberate about costs and benefits of interventions imposing an implicit band around explanatory variables in the reaction function.<sup>56</sup> Thereby, authorities take special account not to endanger their credibility. This discontinuity imposes severe consequences for econometric estimation. Errors of a simple linear regression of non-continuous interventions on continuous right hand variables are likely to be not normally distributed, making inferences problematic.<sup>57</sup> One way to overcome the problems associated to discontinuous dependent variables is to apply probit, logit, or ordered probit estimation.<sup>58</sup> Thereby, the dependent variable (intervention)

<sup>55</sup>Worth noting is that commonly, intervention reaction functions lack a theoretical framework. This is due to the fact that only little has been done on explaining central bank interventions from a theoretic perspective. This feature was mentioned in section 2.

<sup>56</sup>See Alemkinders and Eijffinger (1996), Ito and Yabu (2007).

<sup>57</sup>Nevertheless, as long as the explanatory variables are uncorrelated with the errors, estimation is at least consistent.

<sup>58</sup>See e.g. Ito and Yabu (2007) for ordered probit, Frenkel and Stadtmann (2001) for Logit, Hillebrand and Schnabl (2006) for probit. However, these discrete choice models are associated to other econometric problems, especially in case

is defined in a 1-0(-1) (purchase/sale – zero – sale) way, where the regressors determine the probability of an intervention. However, applying this econometric technique in case of continuous interventions, will seriously lead to worthless estimations. The reason is that the dependent variable takes 1 at almost every observation in time.<sup>59</sup> Therefore, since interventions occur on nearly every day showing no clustering around specific times in Argentina, applying a discrete dependent variable model is not an appropriate estimation technique for an Argentinean reaction function.

#### 4.1.1 OLS model - specification

In case of Argentinean interventions, I chose to use a simple OLS regression. The continuous character of BCRA's interventions in the foreign exchange market makes this estimation strategy a suitable choice.<sup>60</sup> The specified reaction function takes the following form:

$$\begin{aligned} Int_t = & \alpha_0 + \alpha_1 Int_{t-1} + \alpha_2 \left( s_{t-1} - s_{t-1}^{10d} \right) + \alpha_3 \left( s_{t-1} - s_{t-1}^{180d} \right) + \alpha_4 \left( s_{t-1} - s_{t-1}^T \right) \\ & + \alpha_5 h_{t-1} + \alpha_6 idiff_{t-1}^{ovn} + \varepsilon_t \end{aligned} \quad (8)$$

In order to examine whether the BCRA targets the exchange rate implicitly, several variables were chosen to explain daily interventions expressed in mill. of US\$.

At *first*, deviations from a short-term ( $s_t - s_t^{10d}$ ) and long-term ( $s_t - s_t^{180d}$ ) exchange rate trend, expressed as the aberration of the logarithm exchange rate from its 10 day moving average and 180 day moving average respectively, are included (see explanatory factors 1 in figure 6). Data on exchange rates are obtained from the BCRA.<sup>61</sup> By doing so, the BCRA's emphasis on short-term and long-term exchange rate trends is examined. The idea behind this is, that central banks intervene in response on excessive short-term movements in order to alleviate potential severe spillovers on the financial portfolios of private and public sector. In this context, a short-term depreciation could blight domestic portfolios, which are invested in foreign currency, and at the same time distend foreign debt positions. While this might be per se unproblematic, it signals financial distresses and could trigger further capital flights. For a short-term appreciation, things do not seem as bad. However, overborrowing, especially at the short-end, is the seed of financial turmoils and should be kept in mind clearly. Furthermore, short-term appreciation can cause foreign currency denominated deposits to decrease in domestic currency's

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of lagged dependent variables. While the inclusion of lagged dependent variables is unproblematic in case of liner OLS regressions, it does impose drawbacks in case of non-linear models. For more information see de Jong and Herrera (2004), de Jong and Woutersen (2003).

<sup>59</sup> Another way would be to model the reaction function as a friction, which is basically an extension of ordered probit/logit models in the way that besides the occurrence of interventions its magnitude is modeled. See e.g. Almekinders (1995), Almekinders and Eijffinger (1996), Kim and Sheen (2002), Neely (2006).

<sup>60</sup> Ito (2002) also applied an OLS regression as reaction function for Japanese interventions. However, interventions conducted by the BoJ do not show the same continuity as in case of Argentina.

<sup>61</sup> The used "Reference Exchange Rate" Communication "A" 3500 (Wholesale) is a daily average nominal exchange rate, Buenos Aires market place. The Central Bank conducts a survey to local entities three times per day (from 10 a.m. to 11 a.m., from 12 a.m. to 1 p.m. and from 2 p.m. to 3 p.m.). The "Reference Exchange Rate" is estimated as the average of that collected information.

value. Hence, there is always the other side of the coin. In case of long-run perspectives, the rationale for responding to exchange rate swings stems from the importance of a stable and predictable foreign trade position. In this sense a relative "weak" domestic currency helps to support exports of goods and services, and thus, boosts domestic economy. On the other side, the import of inflation must be considered, when incorporating long-run exchange rate perspectives into intervention strategies. For this reason the estimated coefficients should take negative significant values, indicating a purchase of foreign currency in case of excessive "short ( $\alpha_2$ )"- and "long ( $\alpha_3$ )"-term exchange rate appreciation, vice versa.

*Second*, as mentioned above the BCRA accounted for an exchange rate band in its monetary policy orientation, although not officially stated (see explanatory factors 2 in figure 6). To capture this, the deviation of the actual logarithm exchange rate from the logarithm of the mid rate (2.925) of the suggested band (upper level – 3.05, lower level – 2.8) is included ( $s_t - s_t^T$ ). The rationale for targeting an exchange rate band target is similar to long-run aspects described above. As it is the case for trend deviations  $\alpha_4$  should be negative and significant at the common levels.

*Third*, similar to the idea of short-term exchange rate movements, the conditional volatility ( $h_t$ ) is assumed to explain foreign exchange interventions conducted by the BCRA (see explanatory factors 3 in figure 6).<sup>62</sup> A properly functioning exchange rate market is an essential increment of a sound financial system. In this context, the academic literature often speaks about disorderly markets. However, no specific definition is given. Generally, widening bid-ask spreads, desiccating foreign exchange turnovers, and high intraday volatility, can be summarized as characteristic features of disorderly markets as explained above. Especially for Argentina, it is likely that the BCRA had these aspects in mind when intervening at early stages of the free float period. Hence, daily conditional volatility serves as an approximation of disorderly markets. Another approach would be to include realized instead of estimated conditional or implied volatility derived from option market data.<sup>63</sup> While using realized volatility has the advantage to be a less noisy measure, even though no universal argument in favor of using realized or implied volatility exists.<sup>64</sup> In contrast to the exchange rate trend and level measure, coefficient  $\alpha_5$  should show significant values. Negative or positive values indicate whether the BCRA purchased or sold foreign currency as a response to increasing market volatility. However, it can be assumed that central banks sell foreign currency in case of high volatility, since they provide the market with more liquidity.

*Fourth*, the difference between Argentinean daily interbank overnight rates and effective Fed Fund rates is included ( $idiff_{t-1}^{ovn}$ ) as a control variable (see explanatory factors 4 in figure 6). This leads to the assumption that the BCRA intervened in response to changing interest rates in order to alleviate resulting exchange rate pressure. Therefore,  $\alpha_6$  is supposed to show positive significant values. Thereby, it is assumed that Argentinean authorities tend to purchase foreign currency when confronted with positive interest rate differentials trying to absorb any appreciation pressure on the domestic currency.

<sup>62</sup> Conditional volatility is estimated by a GARCH(3,3) model, which is further used as an impact analysis.

<sup>63</sup> See, e.g. Andersen et al. (2002), Beine et al. (2008).

<sup>64</sup> See Dominguez (1998), Rogers and Siklos (2003). Moreover, Murray et al. (1997) speak clearly in favor for using implied rather than realized volatility.

Furthermore, any changes in the monetary stances of both countries and/or sterilization policies should be captured this way.

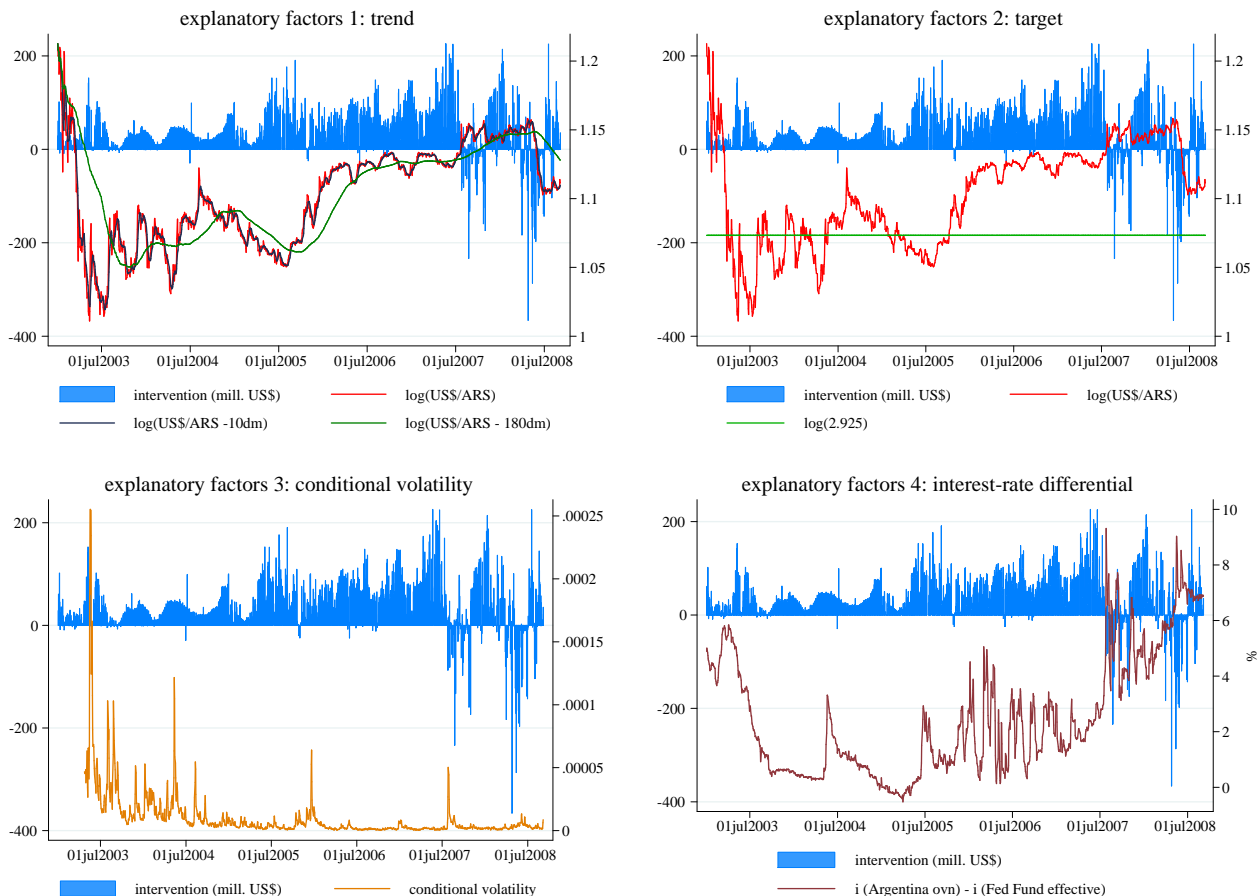


Figure 6: Explanatory factors for daily BCRA foreign exchange market interventions between January 2003 and September 2008 (source: BCRA, Fed, own calculation).

While the presented specification captures short-term, long-term, target and interest rate aspects, it does not account directly for the motive of simple accumulating foreign reserves. The inclusion of an exogenous variable addressing for this purpose is problematic. Data on foreign reserves are mostly available on a monthly basis. Hence, it would be necessary to interpolate monthly foreign reserves on a daily basis. It is clear that this procedure would generate noisy estimation results.<sup>65</sup> Furthermore, it can be assumed that monetary authorities in Argentina always kept the level of foreign reserves in mind when buying foreign currency. As mentioned above "fx buying" interventions occurred on almost every day. Hence, the explicit motive to accumulate foreign reserve should be seen as a by-product in case of Argentinean interventions, particularly with regard to foreign reserve targets imposed by the

<sup>65</sup> Kim and Sheen (2002) included such inventory aspects through daily interpolation from monthly data into a reaction function for Australian interventions. However, estimation results were inconclusive.

IMF.<sup>66</sup>

Estimation is conducted by using Newey-West heteroskedastic robust estimators. Furthermore, in order to overcome simultaneity problems as described above, all right hand variables are included with a lag of one period (one day), since the used exchange rate is an average of intraday quotes. As can be seen in figure 6 and mentioned above, interventions occur on almost every day in the sample. In order to capture this persistency, one period lagged interventions are also included.

## 4.2 Impact analysis

In order to examine the effect of foreign exchange market interventions on exchange rates, GARCH models have turned out to be a very fruitful methodology.<sup>67</sup> Its popularity stems from its big advantage, which is twofold.<sup>68</sup> At first, applying a GARCH model allows to investigate the impact on the mean and the conditional volatility of an exchange rate simultaneously. Second, GARCH models capture a nearly inherent feature of time varying volatility in high frequent exchange rate time series (heteroskedasticity).<sup>69</sup> In this context, times of tranquil volatility are followed by periods of high volatility. The key point of ARCH effects in time-series does not stem from the serial correlation of the error term (linear relationship), but from the dependency caused through their second moments. Hence, the squared errors show significant autocorrelation and the volatility can therefore be modelled as an autoregressive conditional process (Autoregressive Conditional Heteroskedasticity). The basic idea of GARCH models (General-ARCH) as an extension of ARCH models is a parsimonious specification of high order ARCH models. This is similar to the ARMA presentation of time-series proposed by Box et al. (1994). However, it is important to note that modelling the conditional volatility is not equal, but similar to an ARMA formulation, since it is not stochastic. In contrast to OLS regressions for reaction functions, an assumption concerning the error distribution is required, because GARCH models are estimated through the Maximum-Likelihood method.

Applying a GARCH model for exchange rates and associated intervention effects also calls for using appropriate additional explanatory variables for daily exchange-rate returns. From a theoretic perspective, in this case, the exchange rate is seen according to the asset view of exchange rate determination.<sup>70</sup> Hence, the asset returns must be explained by appropriate additional explanatory factors. This is a science by its own. No stable relationship between exchange rate returns and determining factors has been found yet.<sup>71</sup> However, some factors contain explanatory power for exchange-rate returns.

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<sup>66</sup>See BCRA (2003a).

<sup>67</sup>See Engle (1982) for ARCH models and Bollerslev (1986) for GARCH models.

<sup>68</sup>See e.g. Almekinders (1995), Domaç and Mendoza (2004), Dominguez and Frankel (1993), Edison et al. (2006), Hillebrand and Schnabl (2006), Ito (2002).

<sup>69</sup>See Enders (2004), Krätzig and Lütkepohl (2004).

<sup>70</sup>See Levich (2001).

<sup>71</sup>This reflects the well known Random Walk hypothesis as proposed by Fama (1965). Thereby, the best forecast of future exchange rate is today's exchange rate.



### 4.2.1 GARCH model - specification

The following GARCH(p,q) model is used to examine the impact of daily interventions on the mean and the conditional volatility of daily exchange rate returns.

$$\begin{aligned} \Delta s_t = & \alpha_o + \alpha_1 \Delta s_{t-1} + \alpha_2 \Delta s_{t-2} + \beta_i \sum_{i=1}^2 Int_{t-i} + \gamma_i \sum_{i=1}^{Thurd} D_i \\ & + \lambda_1 idiff_t^{ovn} + \phi_1 \Delta Merval_t + \varepsilon_t \end{aligned} \quad (9)$$

$$\varepsilon_t | \Omega_{t-1} \sim N(0, h_t)$$

$$\begin{aligned} h_t = & b + \gamma_i \sum_{i=1}^q \varepsilon_{t-i}^2 + \partial_i \sum_{i=1}^p h_{t-i} + \theta_i \sum_{i=1}^2 |Int_{t-i}| + \mu_i \sum_{i=1}^{Thurd} D_i \\ & + \lambda_2 |idiff_t^{ovn}| + \phi_2 |\Delta Merval_t| \end{aligned} \quad (10)$$

For reasons of stationarity daily exchange rate returns, expressed as the difference of daily logarithm spot rates, were used as the dependent variable. In order to capture exchange rate dynamics best, and thus, estimate the correct impact of interventions on the exchange rate, the following explanatory variables are included.

At *first*, to account for autocorrelation in daily exchange rate returns, one and two day lagged daily returns are included. Standardized errors did not show any remaining autocorrelation. The inclusion of two lags reveals the high persistency or long memory of daily exchange rate returns.

*Second*, intervention volumes (expressed in mill. US\$) are included as their one day and two day lags. This was done to capture intervention dynamics. Contemporaneous interventions were excluded for reasons of simultaneity.<sup>72</sup> It is of crucial interest whether the effects of interventions increase or diminish on successive days, revealing some more insights in the effectiveness of foreign exchange market interventions. While total volumes (purchases/sales) enter the mean equation, absolute intervention volumes are included in the conditional volatility equation. This is necessary to avoid possible negative volatilities. For interventions to influence daily exchange rate returns effectively, positive significant coefficients  $\beta_{1,2}$  are expected. This indicates that a purchase of foreign currency depreciates the Argentinean peso, while a sale of foreign currency appreciates the domestic currency. In case of influencing the conditional volatility, results should yield negative and significant values for  $\theta_{1,2}$ .

*Third*, day dummies are supposed to capture possible effects of different days of the week on the exchange rate return and its conditional volatility. This is also known as capturing daily seasonality in foreign exchange rates. Coefficients  $\gamma_i$  and  $\mu_i$  should yield significant results in case of daily seasonality for daily returns and conditional volatility respectively. Dummy variables to account for any exchange rate effects due to holidays were included in preliminary estimations. The idea is that prior to a holiday exchange rates should experience additional pressure in either direction. This could be explained by

<sup>72</sup>Preliminary GARCH estimation results showed that contemporaneous intervention effects were opposite signed as it is the case in the presence of simultaneity bias.

foreign exchange dealers' expectations about future quotations. In this context, investors who assume the domestic currency to get stronger after the holiday will buy prior to the holiday additional currency, or vice versa. However, these factors had no explanatory content and were therefore excluded from the GARCH model.

*Fourth*, daily overnight interest rate differential enter the mean and the volatility equation. This is common when modelling daily exchange rate returns. Especially, in the context of interventions, including interest rate differential accounts for possible effects of interventions on the money market (sterilization), or captures changing money market conditions influencing the exchange rate by itself. Therefore, estimation results for the mean equation should reveal a negative and significant influence of positive interest rate differentials on daily US\$/ARS returns ( $\lambda_1$ ). Concerning the impact on the conditional volatility, preliminary assumptions are inconclusive. It can not be stated whether overnight interest rates should stabilize the exchange rate or vice versa.<sup>73</sup>

*Fifth*, the importance of the exchange rate was shown by McCandless (2005) in the relationship between stock market prices and exchange rate movements as mentioned above. In early stages of the free float period, exchange rate returns influenced stock market prices. In the same sense, and as shown in Granger-Causality tests, capital inflows into stock markets caused the exchange rate. Hence, daily changes in the close price of the Merval stock market are included to account for the contemporaneous impact of disturbances in other asset markets.<sup>74</sup> Negative signs are expected for  $\phi_1$  since an increase in stock market prices should cause the exchange rate to appreciate.<sup>75</sup> Similar, a rise in stock market prices should signal economic stability and exert a negative influence on the conditional volatility ( $\phi_2 < 0$ ).

Two big issues are the choice of the appropriate lag-length for p and q, in order to rule out any remaining ARCH/GARCH effects of daily exchange rate returns and the assumption on the underlying error distribution. It is common that exchange rate returns are not normally distributed. They usually display fat tails (lepturkotic feature), calling for more appropriate distributions like t-distribution or generalized error distribution (GED). However, it has been empirically tested that using these alternative distributions does not make a big difference in terms of estimation results for the coefficients. Furthermore, tests for errors to come from fat tail distributions often fail to support their usage.<sup>76</sup> For this reason, the normal (Gaussian) distribution was applied for reasons of simplicity leading to a quasi maximum likelihood estimation in the sense of White (1982). Under the assumption that daily exchange rate returns are modelled correctly, estimation results are still consistent although errors are nonnormal distributed.<sup>77</sup>

The appropriate lag length turned out to be three for ARCH ( $\varepsilon_{t-i}^2$ ) as well as GARCH ( $h_{t-i}$ ) variables, as indicated by ARCH-LM tests. Thus, by including three "AR" and three "MA" terms

<sup>73</sup> Empirical experience for Mexico and Turkey show different impacts of overnight rates on the conditional volatility. See Domaç and Mendoza (2004).

<sup>74</sup> The inclusion of other asset markets was originally suggested by Bonser-Neal and Tanner (1996).

<sup>75</sup> Data on Merval close prices were taken from the Boston Globe homepage.

<http://finance.boston.com/boston?Page=World>

<sup>76</sup> See Hentschel (1995).

<sup>77</sup> See Bollerslev (1986), Straumann (2005).

no correlation in the second moments remain. At this point some notes should be given on the interpretation of the ARCH/GARCH coefficients, since it is often neglected in other studies using this approach. While coefficient  $\gamma_i$  captures the impact of errors on the conditional volatility,  $\partial_i$  displays its persistency. Hence, large values for  $\gamma_i$  indicate a high impact of errors on the conditional volatility, i.e. the response of  $h_t$  to new information ( $\varepsilon_{t-i}^2$ ) is large. Large values for  $\partial_i$  show a high degree of autoregressive persistency, or a long memory of the conditional volatility series. The sum of both coefficients give information about the overall persistency of the conditional volatility.<sup>78</sup>

## 5 Estimation results

### 5.1 Motive development

#### 5.1.1 Global results

Table 3 shows global results for reaction function 8. Adjusted R2 as well as F-stat. indicate high explanatory power of the right hand variables, and a high significant influence on daily interventions. Most coefficient are significant at the 5% level. Results for persistency effects, show that daily interventions are indeed highly correlated. The value of 0.56 indicates that the BCRA tended to purchase (sale) at day t 56% of the amount bought (sold) the previous day.

According to trend results, the BCRA seemed to focus on long-term rather than short-term exchange rate movements. 10 day deviations carry the wrong sign and are insignificant. In case of 180 day trend deviations, estimation results reveal that the BCRA tended to sell(buy) 2.12 million US\$ when the peso was 1% above(below) its 180 day exchange rate trend against the US\$. The fact that the BCRA used different measures to dedollarize the domestic financial system might explain the poor result of short-term movements. However, this will be explained more in detail in section 6.

Concerning the implicit target level, it is interesting that, though significant at the 5% level, deviations show a perverse result. Estimation outcome for coefficient  $\alpha_4$  indicates that the BCRA tended to purchase foreign currency when the exchange rate depreciated above its target level, and sell foreign currency in case of appreciation. Hence, instead of defending the target, monetary authorities seemed to step off this target, generating additional pressure on the actual exchange rate development. This result seems to be at odds with the arguments discussed above.

Conditional volatility influenced daily interventions significantly. The BCRA tended to sell 0.45 million US\$ at the median of the conditional volatility ( $3.58 \times 10^{-6}$ ). While this is no huge amount, the result shows that the BCRA indeed took care of orderly markets by intervening to provide additional liquidity to the foreign exchange market. Thereby, the BCRA served as a financial intermediate, matching supply and demand of foreign currency.

As it is the case for the target level, results for overnight interest rate differentials carry the wrong sign. The BCRA purchased domestic currency as a response on positive differentials. More precisely, for every percentage point monetary authorities in Argentina sold 3.5 million US\$. Instead of absorbing potential exchange rate pressure, the BCRA tended to add more.

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<sup>78</sup>See Enders (2004).

explanatory factors	coefficient	std. error	t-stat.	prob.
$\alpha_0$	21.36***	2.45	8.70	.000
$Int_{t-1}$	0.56***	0.04	13.86	.000
$(s_{t-1} - s_{t-1}^{10d})$	21.77	177.05	0.12	.902
$(s_{t-1} - s_{t-1}^{180d})$	-212.81***	64.05	-3.32	.001
$(s_{t-1} - s_{t-1}^T)$	133.46**	58.23	2.29	.022
$h_{t-1}$	-1.26x10 <sup>5</sup> **	5.05x10 <sup>4</sup>	-2.50	.012
$idif f_{t-1}^{own}$	-3.47***	0.94	-3.72	.000
<i>adjusted R2</i>	0.362	<i>F - stat.</i>	126.4	
<i>Log likelihood</i>	-6840.8	<i>p - value</i>	.000	

\*10% - \*\*5% - \*\*\*1% significance

Table 3: Global estimation results for Argentinean reaction function (sample: 02 January 2003 - 05 September 2008).

### 5.1.2 Time-varying (local) results

As stated above, it is necessary to proof, if intervention motives have changed over time and/or if results from global estimation are exposed to structural breaks inducing biased results. Figure 7 shows the time dependent variation of different BCRA intervention purposes. Each coefficient result and its associated t-value are displayed. Furthermore, the 10% significance-band is included as a visual support.<sup>79</sup> It can be seen that nearly all included reason for Argentinean authorities to intervene in the exchange rate market have experienced an evolution in the time span under investigation. Furthermore, the explanatory content of the rolling window estimation did not decrease substantially. Adjusted R2 - values vary in a range between 0.5 and 0.2.<sup>80</sup>

Starting with purposes of intervening in response to trend deviations, figure 7 ("long-run trend" "short-run trend") shows clearly, that the BCRA responded mainly to long-run variations, and gave no emphasis on short-run perspectives. This supports global results basically. Estimated t-values for short-run trends do not cross the 10% level in neither direction and are winding around zero, showing no explicit tendency. In contrast, results for long-run trends are more clear. While the beginning of the free float period is characterized by positive significant coefficients, this changed especially between mid 2006 and early 2008. During that time coefficients are estimated to be highly significant and steadily decreasing in its value revealing the rising importance of the long-run trend over time.

Interestingly, local results for the implicit target level are challenging the global result. Contrary to the positive signed coefficient in table 3, figure 7 ("target level") displays two periods of intervening in response to target level deviations. In the early free float period and during mid-2007 results are significant negative as expected when monetary authorities intervene towards a target level. As it is the case for long-run trend, coefficients differ significantly in absolute values from global results. This supports the assumption discussed above. The estimated reaction function assumed the target band

<sup>79</sup>The 10% level are based on the assumption of normal distributed errors. However, this assumption is often violated in empirical estimations. For this reason, the level should only serve as a lead and is not binding.

<sup>80</sup>Ito (2002) obtained R2 values of 0.35.

to be constant. However, it must also be mentioned that the implicit target band may varied over time. This might explain the varying significance of the estimated coefficient.

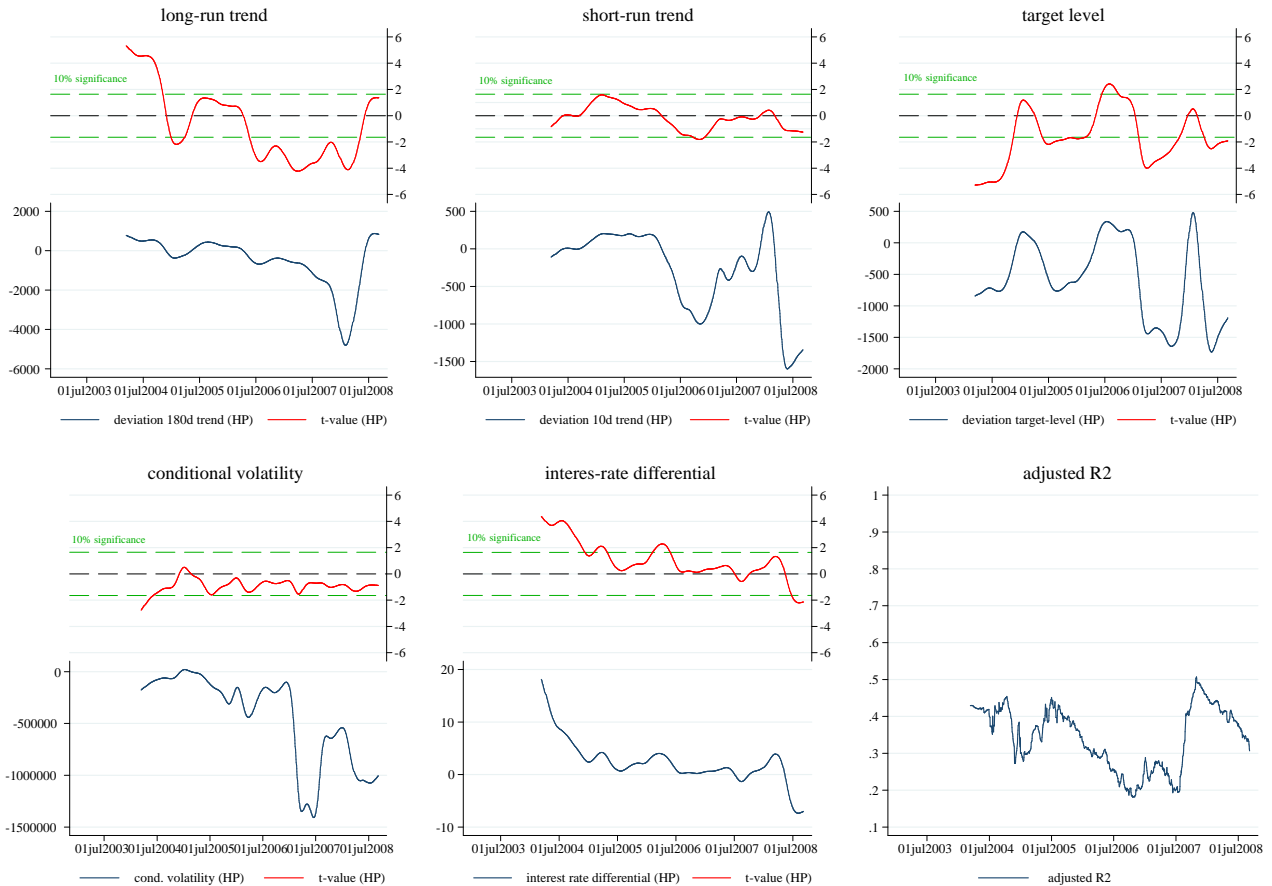


Figure 7: Local estimation results for Argentinean reaction function (window = 300 days; results are Hodrick-Prescott filtered [ $\lambda = 68000$ ]).

Results for the conditional volatility are somehow inconclusive. During the sample under investigation, almost all estimated coefficients are negative, and t-values move in the lower (negative) significance band. However, from this, one cannot conclude that the conditional volatility triggered interventions (sale of foreign currency) explicitly. The only significant results are reached at the first 300 day windows. This is consistent with the assumption that the BCRA was striving to guarantee stable and orderly foreign exchange market conditions when the peso started to float.

Similar to the results obtained from target level deviations, estimated coefficients for overnight interest-rate differential are contrary to the global result. Estimated coefficients are only partially significant. In early stages of the sample, positive significant results indicate that the BCRA intervened against the interest-rate differentials (4%), which caused the peso to appreciate from its overshooting after starting to float freely. In contrast to this, at the end of the sample, monetary authorities interventions "leaned with" the interest-rate differential.

The comparison of global and local results shows the importance of accounting for time-variations in intervention motives. Not doing so had led to wrong conclusions about the BCRA's intentions to intervene in the foreign exchange market. Overall, one can conclude that long-run and exchange-rate target perspectives were given more importance than short-run and volatility issues.

## 5.2 Impact development

### 5.2.1 Global results

Table 4 presents global results for the estimated GARCH(3,3) model. First of all, the applied GARCH(3,3) framework models the heteroskedastic feature of daily exchange rate returns appropriately. Results obtained from ARCH LM tests and Ljung-Box Q-statistics (*ARCH - test* :  $Prob - F(3, 1336)$ ;  $Q^2(20)$ ) reveal no remaining ARCH/GARCH effects.

Most interestingly, and in contrast to many other studies dealing with the effectiveness of foreign exchange market interventions, results reveal that interventions conducted by the BCRA were effective in influencing daily exchange rate returns during the whole period from January 2003 to September 2008. Coefficient results for  $Int_{t-1}$  and  $Int_{t-2}$  are both positive and significant, at least at the 10% level, indicating that the purchase of foreign currency caused the exchange rate to depreciate and vice versa. However, its economic impact is rather weak. A purchase of 100 million US\$ tended to depreciate the domestic currency by 0.05% within two days. Thus, the average and maximum amount of foreign currency purchased by the BCRA tended to depreciate the peso by 0.022% and 0.11% respectively. In case of sale interventions, the average and maximum amount sold in the market tended to appreciate the peso by 0.019% and 0.18% respectively. Nevertheless, these impact effects account for a sizable amount compared to the average daily return of the US\$/ARS exchange rate (-0.0071%). In contrast, the impact on the conditional volatility is not clear cut. While one day lagged interventions declined volatility, two day lagged interventions increased it. Furthermore, both coefficients are clearly insignificant reflecting the poor explanatory content for the conditional volatility. From these impact effects, the question arises whether interventions have been successful? Against the background of its emphasis on long-term rather than short-term and volatility targets, the BCRA indeed succeeded in managing daily exchange rate returns. The fact that the conditional volatility was not influenced at all, cannot be used to assess interventions as ineffective.

Turning to control variables, results for day of the week dummies reveal some seasonality. While only the Thursday exerted a significant influence on daily exchange rate returns, all included days were significant in the conditional volatility equation. Surprisingly, overnight money market rates did not affect the US\$/ARS exchange rate. Interest rate differential did play neither in the mean equation nor in the conditional volatility equation a significant role. However, this is wondering since high interest rate differentials should have caused capital inflows resulting in an appreciation of the peso. On the other hand, it can be stated that a risk premium absorbed any appreciation pressure from positive interest rate differentials. In this sense, interest rate differentials did not influenced the conditional volatility. Although negative, coefficient  $\lambda_2$  shows no significance at the common levels. As stated above, stock

explanatory factors	coefficient	std. error	z-stat.	prob.
Mean equation				
$\alpha_0$	-.000126**	.000126	-1.005	.032
$\Delta s_{t-1}$	.240***	.0326	7.375	.000
$\Delta s_{t-2}$	-.113***	.0278	-4.052	.000
$Int_{t-1}$	$3.35 \times 10^{-6}$ ***	$1.00 \times 10^{-6}$	3.347	.000
$Int_{t-2}$	$1.61 \times 10^{-6}$ *	$9.03 \times 10^{-7}$	1.779	.075
<i>Monday</i>	$-6.12 \times 10^{-5}$	.000137	-.447	.655
<i>Tuesday</i>	-.000206	.000135	-1.524	.128
<i>Wednesday</i>	$-3.79 \times 10^{-5}$	.000137	-.276	.783
<i>Thursday</i>	-.000230*	.000128	-1.803	.071
$idif_t^{ovn}$	$7.18 \times 10^{-6}$	$2.12 \times 10^{-5}$	.338	.735
$\Delta Merval_t$	$-8.01 \times 10^{-6}$ ***	$1.15 \times 10^{-6}$	-5.304	.000
Variance Equation				
$b$	$-3.09 \times 10^{-7}$ ***	$1.55 \times 10^{-8}$	-19.991	.000
$\varepsilon_{t-1}^2$	.275***	.0489	5.622	.000
$\varepsilon_{t-2}^2$	.0738**	.0290	2.539	.011
$\varepsilon_{t-3}^2$	-.202***	.0496	-4.073	.000
$h_{t-1}$	.299*	.1557	1.923	.054
$h_{t-2}$	.930***	.0298	31.130	.000
$h_{t-3}$	-.379***	.1273	-2.983	.003
$ Int_{t-1} $	$-3.61 \times 10^{-10}$	$1.71 \times 10^{-9}$	-.211	.833
$ Int_{t-2} $	$8.66 \times 10^{-10}$	$1.71 \times 10^{-9}$	.507	.612
<i>Monday</i>	$3.45 \times 10^{-7}$ ***	$1.29 \times 10^{-8}$	26.703	.000
<i>Tuesday</i>	$6.45 \times 10^{-7}$ ***	$1.46 \times 10^{-8}$	44.321	.000
<i>Wednesday</i>	$7.41 \times 10^{-7}$ ***	$1.95 \times 10^{-8}$	38.019	.000
<i>Thursday</i>	$-9.84 \times 10^{-8}$ ***	$2.06 \times 10^{-8}$	-4.786	.000
$ idif_t^{ovn} $	$-3.19 \times 10^{-9}$	$1.57 \times 10^{-8}$	-.203	.838
$ \Delta Merval_t $	$1.73 \times 10^{-9}$	$3.00 \times 10^{-9}$	.576	.564
<i>Log likelihood</i>	6387.203		$Q(20)^\dagger$	.262
<i>ARCH - test : Prob - F(3, 1336)</i>	.1344		$Q^2(20)^\dagger$	.490

<sup>†</sup>  $p$ - values for standardized residuals

\*10% - \*\*5% - \*\*\*1% significance

Table 4: Global estimation results for Argentinean impact analysis (sample: 02 January 2003 - 05 September 2008).

market changes influenced the exchange rate in the suggested way. The negative, highly significant coefficient indicates that a rise of stock market prices caused the exchange rate to appreciate, though, the economic size is rather small. Concerning the impact on the conditional volatility, absolute changes in the Merval index did not cause any volatility movements. The estimated coefficient is neither of economic importance nor significant at the common levels.<sup>81</sup> Concerning ARCH/GARCH effects, the sum of the specific significant coefficients is near unity  $\left(1 - \sum_{i=1}^3 \gamma_i - \sum_{i=1}^3 \partial_i = 0.9968\right)$  indicating a high persistency of the conditional volatility lead mainly by the autoregressive influence of  $h_{t-i}$ .

### 5.2.2 Time-varying (local) results

Since I focus on the time varying impact of BCRA's foreign exchange transactions, only coefficients for interventions are regarded. Figure 8 presents results of rolling GARCH(3,3) estimations.

Left panels of Figure 8 display interesting results. It is shown that the impact of interventions on daily returns had the correct sign indicating a depreciation of the peso when the BCRA purchased foreign currency. Moreover, estimated z-stat. show high significance, especially during the first estimation windows. However, as it was the case in the global estimation, absolute effects are rather small in the overall view. Beside the positive effects, it can be seen that intervention impacts at the beginning of sample period were greater in amount, declining over time but gaining back slightly at the end of the period. In this context, the highest overall impact within two days, was reached in June 2004, indicating that a purchase of the average amount of US\$ depreciated the peso by 0.1%. Compared to the global result, this effect is an increase by 355%. However, in the following windows, impact effects declined to the level of global results, which are, though small in absolute size, of economic importance.

Also remarkable is the fact that intervention dynamics within two days were contrary at the beginning and equal directed in the proceeding estimation windows. As stated above, the contrary effect can not be explained with simultaneity issues since no simultaneous interventions were included. However, similar to the way contemporaneous intervention effects are explained when showing the wrong sign, negative intervention effects of one day lagged transactions indicate a strong leaning against the wind strategy. As the exchange rate appreciated strongly in the early sample phase, the BCRA purchased currency, thereby, leaning against the appreciation trend causing the negative sign. The impact effect, then, is displayed by the second day lag, which is strongly significant and positive signed.

In case of conditional volatility, right panels of figure 8 reveal no explicit effects. Basically, global estimation outcome is supported. While at the beginning of the period high significant contrary effects neutralized themselves, interventions were estimated to have no impact at all on the conditional volatility in recent time. In this sense, estimated z-stat. meander around the zero line. The small coefficients of around  $(\pm) 2.00 \times 10^{-10}$  can be interpreted in the way that a purchase of the average amount tended to increase/decline the conditional volatility by  $9 \times 10^{-9}$ . However, z.-stat. are far from indicating a significant influence. These results show that interventions did not have an impact on the

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<sup>81</sup> Estimation with separated Merval changes (positive, negative) showed that an increase and a decline in stock market prices had a negative impact on the consitional volatility. However, since coefficients were insignificant, results are not reported.



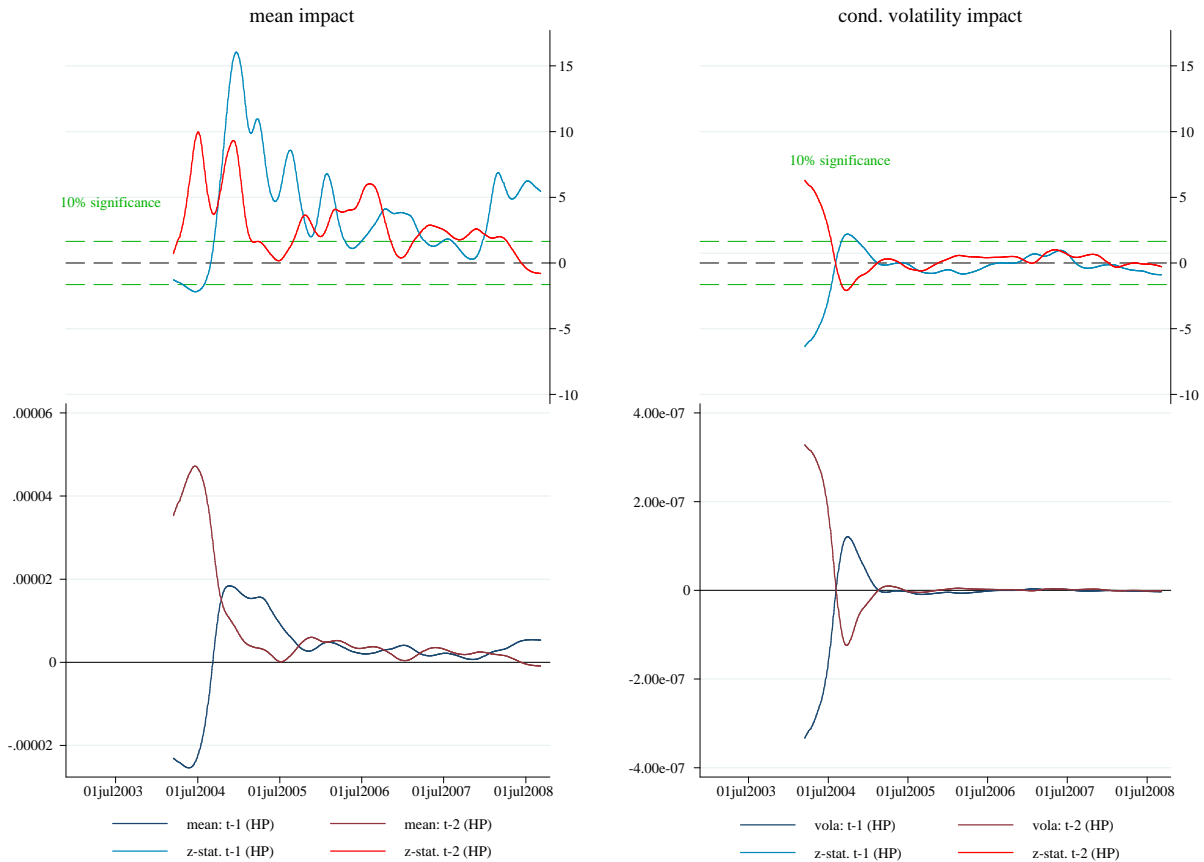


Figure 8: Local estimation results for Argentinean impact analysis (window = 300 days; results are Hodrick-Prescott filtered [ $\lambda = 68000$ ]).

conditional volatility of daily US\$/ARS exchange rate returns.<sup>82</sup>

## 6 Economic backgrounds

From estimation results presented above it can be summarized that:

1. BCRA's motives to intervene in the exchange market have changed over time.
2. While in early phases of the free float era, target perspectives were emphasized, and long-run motives have gained in importance in recent time.
3. Interventions were effective in influencing daily exchange-rate returns, especially at the beginning of the sample.
4. Interventions had no effect on the conditional volatility.

<sup>82</sup>It must be noted that this interpretation is based on the assumption of normal distribution. Therefore, it is only an approximative interpretation.

Now, it is of interest whether these results can be explained by surrounding economic fundamentals as well as monetary policy measures, in case of motive developments, and by the arguments placed by Canales-Kriljenko (2003) in case of impact effects.

## 6.1 Explanation of intervention motives

Starting with the development of intervention motives, it is of interest whether the main motives discerned in the preceding sections can be explained by economic and monetary policy fundamentals. So, the questions are: *First*, why did the BCRA not intervene in response on short-term exchange rate movements (except at the beginning of the sample when the conditional volatility was estimated to influence interventions significantly)? *Second*, why did the BCRA focused on an implicit target level? *Third*, why did the BCRA intervene in response to long-run trend deviations, especially at the end of the sample?

*First*, as touched above, short-term exchange rate movements exhibit a potential threat through boosting debt levels and distressing financial stability in case of exchange rate depreciation. However, during the sample under investigation, the Argentinean economy was not confronted with an excessive short-term depreciation which occurred after abandoning the currency board, when the exchange rate depreciated by 300% up to 4 US\$/ARS. Besides depreciation, an excessive appreciation can also cause severe consequences. In the first half of 2003 the exchange rate appreciated strongly by 18%. Furthermore, the spillovers of excessive exchange-rate movements hinge clearly on the relative size of foreign debt and deposits compared to domestic currency debt and deposits. In this context, several measures have been imposed by authorities to tackle potential severe spillovers of short-term exchange rate movements on private and public sectors portfolios. A conversion of foreign currency denominated debt and deposit was decreed. In February 2002, decree 214/02 established the conversion of foreign currency obligations into peso.<sup>83</sup> However, this was done asymmetrically. While debts were converted one to one, deposits were converted at 1.4 pesos per US\$. This measure, although not directly intended to support interventions, exonerated monetary authorities from intervening in the foreign exchange market in order to forestall additional financial distress. Figure 9 displays the impact of decree 214/02 on debt and deposit levels. It can be seen that in January 2002 deposits and debt positions declined significantly from nearly 50 bill. peso to less than 10 bill. peso, and were not gaining back during the full sample. This kind of pesofication attenuated potential severe short-term exchange rate movements. Hence, interventions in order to smooth out excessive movements of the exchange rate in the short-run were not necessary.

*Second*, the reason why the BCRA targeted an implicit exchange rate or an exchange rate window is not clear at first sight. No official statement give conclusive insights. Nevertheless, it was an open secret that the BCRA targeted the exchange rate:

*"Staff noted that, while there was a need for the central bank to continue to augment reserves, intervention should be carried out in a manner that did not effectively peg the exchange rate. Staff noted that while Argentina had, de jure, a floating exchange rate regime, the exchange rate had, in*

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<sup>83</sup>see BCRA (2002b).

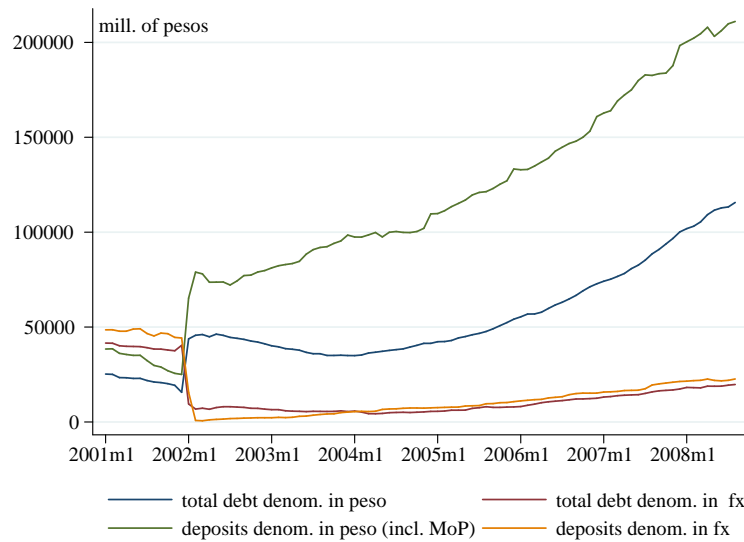


Figure 9: Development of domestic and foreign currency obligations and deposits between January 2001 and August 2008 (source: BCRA).

*fact, been confined within a very narrow range, and could be classified under an empirical rule as a currency peg.*" [IMF (2005), p. 21]

The intention of a target zone is to limit the pitfalls of both fixed and completely free exchange rates. A theoretical model is presented by Krugman (1991). The question of an appropriate exchange rate target band goes beyond this paper. Nevertheless, I will give some arguments. In general, when defining a target band, a trade-off exists between enough flexibility for the exchange rate to serve as an economic shock absorber and sufficient stability for the exchange rate to fix expectations and signal economic stability. In the absence of a reliable nominal anchor, as it is the case in Argentina, the exchange rate may fulfill this role.<sup>84</sup> Therefore, the economic and financial stability is assessed in terms of a stable exchange rate within an implicit range. However, this does not explain an exchange rate band sufficiently. Moreover, it is necessary to discuss the target range more appropriately.

Fiscal policy was closely connected to exchange rate developments, explaining the floor of the target band. The reason is that tax incomes on exports are directly influenced by the exchange rate. Thereby, exporters have to pay about 20% of their earnings to the government, which makes up a substantial share of total government revenues (see figure 10).<sup>85</sup> Hence, a domestic currency getting too strong diminishes tax revenues and is therefore unfavorable for fiscal policy reasons.

In contrast, the ceiling of the band stems from signalling financial stability, serving as a nominal anchor, and assuaging the price impact of exchange rate depreciation. The relationship between

<sup>84</sup>One might argue, that the quantitative monetary targets could serve as a nominal anchor. However, the endemic feature of a nominal anchor is to provide stable long-run perspectives and expectations in order to plan economic decisions. However, quantitative targets are published at the end of every year for each quarter of the following year. By doing so, the natural purpose of a nominal anchor is not fulfilled clearly, since changing quantitative targets do not support long-run perspectives.

<sup>85</sup>This export tax and tax established on financial operations were the main factors driving fiscal adjustments. Both together pulled in about 2.7% of GDP in 2004. See Frenkel and Rapetti (2007).

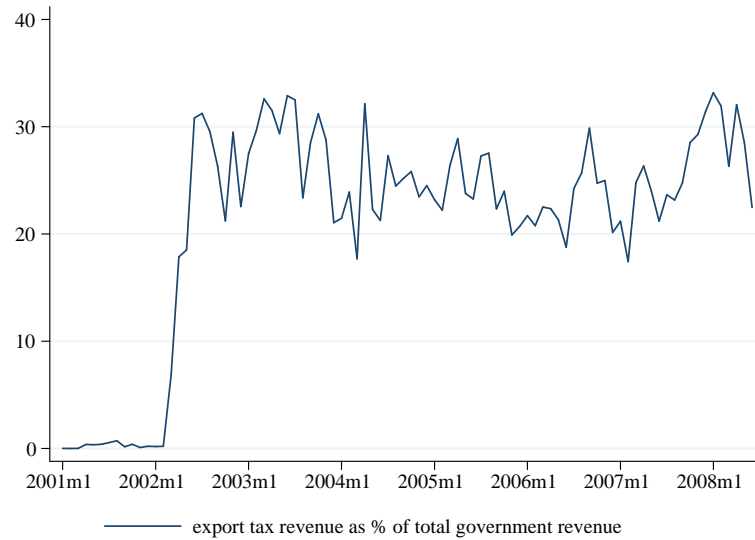


Figure 10: The importance of export taxes in the context of total government revenues (source: Bloomberg, own calculations).

domestic prices and the exchange rate pass through effect on domestic inflation was examined by It and Sato (2007). They applied a structural vector autoregression technique (sVAR) for the post crisis period 2002 to 2006. Empirical results indicate that a one percent depreciation of the nominal effective exchange rate significantly increased import prices by 0.7%, producer prices by 0.4%, and consumer prices by 0.2%. These estimation results reveal the importance of an implicit upper exchange rate target. However, in this case the question must be aligned to the effects of a domestic currency depreciation vis-à-vis the US\$ (bilateral exchange rate) on domestic prices. Table 5 shows the results of exchange rate-pass-through effects on domestic prices obtained from OLS regressions. It can be seen that a monthly 1% depreciation caused the producer prices (ppi) to rise by 0.3% in one month. In contrast, the effect on consumer prices (cpi) was very small and insignificant. Furthermore, a rise in producer prices had no significant influence on consumer prices. At first sight, a bilateral exchange rate pass-through effect on consumer prices seems to be inexistent. This can be explained by a pricing to market strategy of domestic producers. Thereby, domestic producers absorb the rise in producer prices when fixing prices for domestic goods, which in turn attenuated exchange rate impact effects. However, this absorbs their earnings and is therefore no sustainable strategy. For this reason, the BCRA was vigilant against a weak exchange rate, in order to support domestic producers and to enhance the real economy.

*Third*, though not making any statements on a nominal target, authorities began to emphasize the importance of a stable and competitive (real) exchange rate. The importance of the exchange rate for Argentinean economy was addressed above, however, the stability of the peso can further be discussed from a different perspective. Since a substantial fraction of the domestic economy grounds on foreign trade, a stable long-run foreign value of the peso is essential. As can be seen in the left panel of figure 11 exports and imports have increased since 2002 by about 250%. Since that time,

influence	coefficient	t-value	$\overline{R^2}$	F-stat.
$\Delta s_t \rightarrow \Delta ppi_t$	0.330***	3.614	0.24	22.5
$\Delta s_t \rightarrow \Delta cpi_t$	0.018	0.598	0.36	19.6
$\Delta ppi_t \rightarrow \Delta cpi_t$	0.035	0.901	0.37	19.9

OLS – Estimation using Newey-West HAC Standard Errors & Covariance

$$y_{t,i} = \alpha + \beta y_{t-1,i} + \phi x_{t,i} + \varepsilon_t$$

$$y_i = \Delta ppi, \Delta cpi; x_{t,i} = \Delta s_t, \Delta ppi_t$$

\*10% - \*\*5% - \*\*\*1% significance

Table 5: Results of OLS-estimation: exchange rate-pass through effects on domestic prices between January 2003 and September 2008.

Argentina has a continuous current account surplus. Simultaneously, the relative size of foreign trade  $\left(\frac{\text{Export} + \text{Imports}}{2 \text{GDP}}\right)$  accounts for almost 25% of Argentinean economy.<sup>86</sup> In general, a stable foreign price of the domestic currency helps to enhance the predictability of import and export prices and therefore supports investment decisions.

Furthermore, a stable and competitive "real" exchange rate is essential for domestic producers of tradeable goods and services to compete on world markets. Against the background of the large foreign size of Argentina's economy, these issues are of special interest. Right panel of figure 11 displays the evolution of the real exchange rate between Argentina's two biggest trading partners and the multilateral real exchange rate index (ITCRM), which measures Argentina's external competitiveness against its main trading partners.<sup>87</sup> It can be seen that while the real US\$/ARS rate appreciated, real BRL/ARS rate depreciated strongly since the beginning of 2003. Both, real US\$ and BRL rate make up about 50% of the ITCRM. Accordingly, the ITCRM experienced a slight depreciation since 2003, bolstering Argentina's international competitiveness. Argentinean authorities intervened in the US\$ market to influence the real exchange rate index. Although the nominal exchange rate was fairly stable, inflation differential caused the real US\$/ARS rate to gain up. Furthermore, the growing depreciation of the real exchange rates in recent time might have triggered USD sale interventions to absorb this effect on the multilateral index. The importance of stable nominal as well as competitive real exchange rate caused the BCRA to intervene during the investigated sample. This is supported by the results obtained for deviations from a 180 day trend.<sup>88</sup>

<sup>86</sup> Although accounting for a substantial part of domestic economy, foreign trade did not add much to economic growth in recent years. As shown by Weisbrot and Sandoval (2007), exports only accounted for about 13% of total GDP growth. Nevertheless, the substantial absolute volume of foreign trade to GDP calls for monitoring exchange rate movements vigilantly.

<sup>87</sup> For more information on the ITCRM see BCRA (2005b).

<sup>88</sup> For a detailed discussion of targeting real exchange rates see: Frenkel (2006), Frenkel and Rapetti (2007).

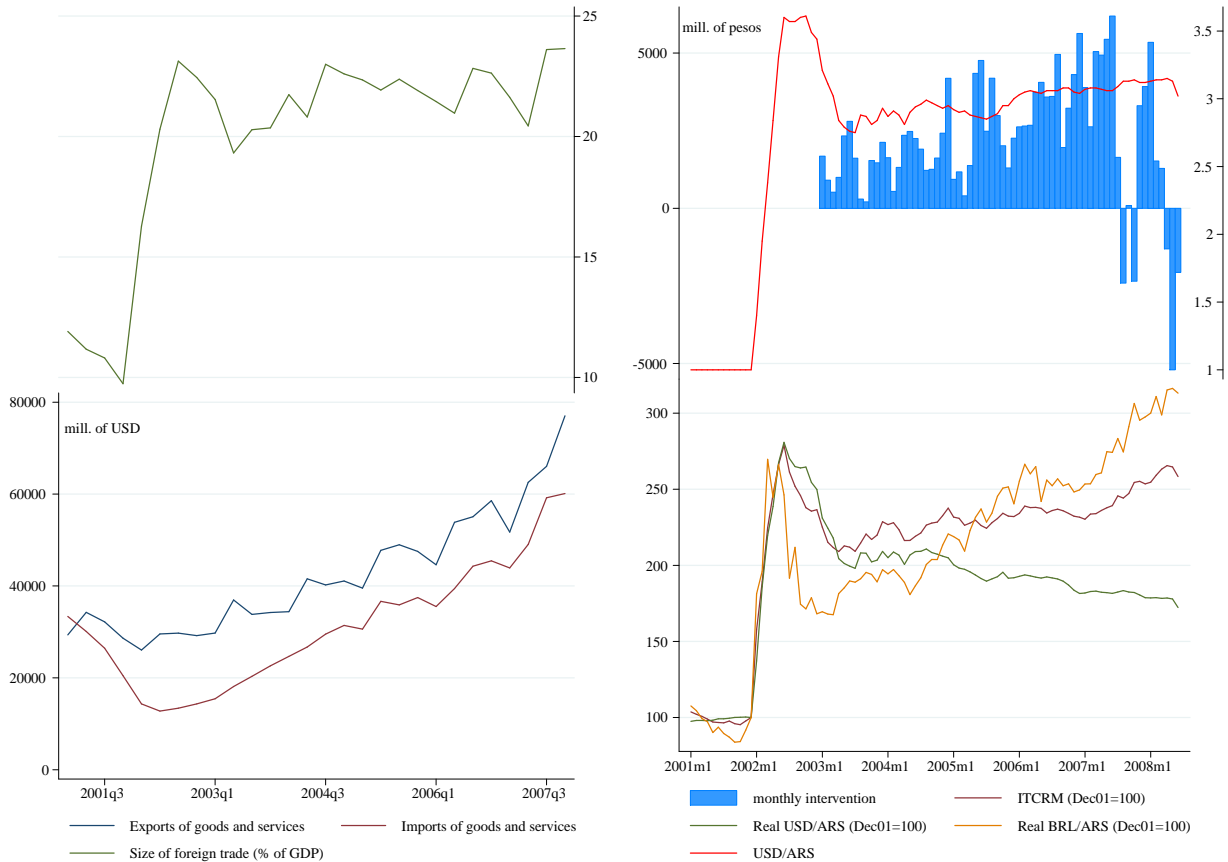


Figure 11: Development of foreign size and real exchange rates in Argentina between 2001 and 2008 (source: BCRA, Bloomberg, IFS, own calculation).

## 6.2 Explanation of impact effects

Turning to the effectiveness of interventions, arguments of Canales-Kriljenko (2003) fit interventions conducted by the BCRA. These arguments are: *first*, interventions are not fully sterilized; *second*, intervention volumes account for a substantial fraction of market turnovers, monetary base (and outstanding stocks of assets); *third*, central banks possess additional information through reporting requirements; *fourth*, central banks use moral suasion. Focusing on the first three arguments, it can be said that in the case of Argentina:

*First*, foreign exchange transactions were not fully sterilized, as shown in table 3. Moreover, sterilization has changed over time. While in early years of the "free" float system interventions were not sterilized, neutralizing monetary expansion shored up in recent years. This was due to the increasing growth of monetary aggregates, which further caused the BCRA to change its quantitative target aggregate from the BMB towards the broader monetary aggregate M2. Accordingly, interventions were most effective in early estimation windows. Why were these interventions more effective? Clearly, the monetary channel of exchange rate determination pushed the exchange rate in the desired direc-

tion. Growing monetary aggregates, caused through the purchase of foreign currency, declined money market rates as can be seen in figure 4. This is in line with the monetary idea of how interventions are influencing the exchange rate as discussed in section 2. However, with the change in quantitative monetary targets, interventions became partially sterilized and interest rates began to rise. Accordingly, the impact effect of interventions on the exchange rate diminished, although it was still signed correctly. This points toward another mechanism to be responsible for intervention effects.

*Second*, as mentioned above interventions have been the main instrument for monetary growth in Argentina. Other instruments are widely used to absorb monetary expansion. In this context, interventions make up a substantial part of the monetary base. More precisely, since 2003 daily interventions made up a fraction of 0.18% between 2003 and 2004, and 0.24% between 2005 and 2008 of BMB daily stocks. While this might not be a substantial fraction per se, it is when compared to industrialized markets. For example, Japan (the Bank of Japan - BoJ) was the only industrialized country intervening regularly until 2004. Daily intervention amounts compared to the average stock of monetary aggregate M1 made up an average share of 0.07% between 1990 and 2004. This is astonishing since Japan authorities intervened with huge amounts to stop the appreciation trend of the yen in the late 1990s. Compared to daily foreign exchange turnover, interventions conducted by the BCRA accounted for approximately 7% of market share between January 2003 and December 2004.<sup>89</sup> However, since 2005 the average daily intervention amount of 55 mill. US\$ made up a fraction of about 13% of daily overall turnover. Again, compared to industrialized market shares, this is a substantial amount. Japanese average daily intervention volume (1.8 bill US\$) accounted for approximately 1.6% between 1991 and 2004. The relevance of intervention volumes to monetary stock and market turnovers supports the argument of Canales-Kriljenko (2003). Especially, the increase in market share since 2005 could be a reason why interventions have still been "successful" at times when the importance of the monetary channel declined. In this sense, the effectiveness could be aligned to some kind of microstructure channel. Through steadily intervening in the foreign exchange market, authorities influenced the order flow significantly. Thereby, the relative high amounts compared to total turnover, could have induced international investors to call for an additional fee in order to hold the additional amounts of foreign currency (microstructure portfolio-balance idea). Moreover, the effectiveness could and should also be explained by the simplest way of thinking about intervention mechanism. Steady and high intervention amounts (almost every day) could have altered the supply of foreign currency and thus its actual price.

*Third*, several exchange controls were established in the aftermath of the financial crisis. As it was the case when explaining intervention motives (negligence of short-run exchange rate developments) exchange controls might also be responsible for the effectiveness of interventions in Argentina. With the unification of the exchange market on January 11 2002, regulations for six main categories were imposed:<sup>90</sup> 1) collections of proceeds from export of goods, 2) payments for the import of goods, 3) other current account payments (services, interest, profits, dividends), 4) servicing of debt principle, 5) setting up of foreign assets abroad by the private sector, and 6) repatriation of investments by

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<sup>89</sup>See Irigoyen (2005).

<sup>90</sup>See BCRA (2002b) Chapter III.

	BCRA		BoJ
	2003 – 2004	2005 – 2008	1991 – 2004
market share of intervention (daily)	7%	13%	1.6%
share of monetary base	0.18% <sup>1</sup>	0.24% <sup>1</sup>	0.07% <sup>2</sup>

<sup>1</sup> avg. of daily interventions as a share of daily stocks of broad monetary base

<sup>2</sup> avg. of daily interventions compared to avg. M1 since 1990

Table 6: Relative size of daily BCRA’s foreign exchange market interventions compared to BoJ interventions (Source: IFS, BCRA, BoJ, own calculation).

non-residents. These controls gave the authorities a comprehensive insight into the foreign exchange market. Moreover, they also served to guide a stable development of the exchange market. Starting in June 2002, bills of lading more than 200 thousand US\$ and income for any amount for export advances and pre-finance were to be ceded to the central bank. This crucially enhanced the fraction of central bank trades in the foreign exchange market. However, these restrictions were assuaged over time. Again, this fits the evolution of impact effects. Being substantial at the beginning of the free float period, impact effects declined with lowering restrictions on foreign exchange trade. The informational advantage, is often associated to the signalling channel of interventions to be responsible for effectively influencing exchange rates. Thereby, interventions signal the market the central bank’s view of the appropriate exchange rate, which in turn clearly hinges on the central bank’s credibility.

## 7 Conclusion

This paper aimed to give further contribution on a new field of research dealing with the effectiveness of foreign exchange market interventions in emerging markets. It has discussed whether intervention motives and impact effects have varied over time and to what extent these issues can be explained by economic and monetary fundamentals. The experience of Argentina with interventions served as a good example. The monetary policy framework of Argentina is directed towards quantitative monetary targeting while accounting for a stable and competitive exchange rate, reflecting a double targeting monetary policy regime.

As was discussed in the preceding sections, intervention motives and its time dependent development can be explained by economic and policy backgrounds. Different policy measures and real economic fundamentals rationalized the purposes of central bank interventions. This fact has been widely neglected so far in other studies dealing with emerging market interventions. Thereby, other policy instruments implemented by Argentinean authorities explained why the BCRA did not focus on short-term movements of the exchange rate. In this context, different policy measures were used in a complementary way. Furthermore, the reason for the BCRA to focus on an implicit exchange rate target (band) might be explained by several reasons. The lack of a sufficient nominal anchor,



the importance to signal economic stability, and the exchange rate pass through effect opens some rationality for an exchange rate ceiling. Besides, the relationship between fiscal policy and exchange rate targeting explains why the BCRA was concerned about a strong domestic currency. Finally, targeting a stable real exchange rate is especially important in cases where foreign trade makes up a large fraction of total domestic economy. Thereby, the BCRA's emphasis on a stable 180 day exchange rate trend became more important in recent time.

The explanation of impact effects supports the arguments of Canales-Kriljenko (2003). These arguments must be seen in a complementary context. Overall, the most interesting point, supporting the monetary channel, is that interventions at the beginning of the sample period had the greatest impact on daily exchange rate returns. These interventions were not sterilized. In the same sense, restrictive exchange controls might have enhanced the informational advantage of monetary authorities during that time. As monetary authorities began to sterilize their transactions, and restrictions were relaxed, impact effects declined. However, other factors which shored up at this time might have been responsible for the effectiveness of interventions. Especially, the increase in market shares could have induced correct signed and significant impact effects of BCRA's interventions. Interestingly, conditional volatility were not influenced by monetary authorities transactions at all. Concerning the effectiveness of Argentinean interventions, one can conclude that they have been effective against the background of their motives.

Some final words should be given on the monetary policy and the use of interventions in Argentina. As explained above the ultimate goal of Argentina's monetary policy has been price stability. Thereby, Argentinean authorities try to fulfill its ultimate goal through a double targeting policy regime. Monetary policy used foreign exchange market interventions to ensure its monetary targets and to manage the exchange rate simultaneously. Until recent times, this procedure was feasible, since interventions were not sterilized, and resulting low domestic interest rates were welcome to stimulate domestic economy. However, with fighting against exchange rate appreciation and sterilizing foreign currency purchases to ensure the quantitative monetary targets, the BCRA faces some severe problems. The increase in interest rates to tackle high inflation rates caused by several years of strong real GDP growth and relative price adjustments, increases sterilization costs of foreign exchange market interventions (foreign currency purchases). Abandoning sterilization would explode monetary growth and deteriorate monetary policy credibility. It seems that the double targeting framework experiences its limits.

Future research should focus on the aspects brought forward in this paper. Especially, it is of interest how other emerging markets, operating under different monetary policy frameworks, have performed with foreign exchange market interventions. Moreover, a comparison between emerging market interventions and industrialized market interventions against the background of the arguments mentioned by Canales-Kriljenko (2003) would enhance the understanding of interventions clearly. In the same tenor, a comparison of the underlying economic and policy factors could support the understanding for intervention motives.

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## A Appendix

	mean	median	maximum	minimum	std. dev.	Unit-root*	obs
<i>Intervention</i>	35.88	31.24	226.25	-366.03	49.04	.000	1368
<i>purchases</i>	45.65	35.77	226.25	.0054	37.78		1211
<i>sales</i>	-39.40	-11.28	-.1998	-366.03	59.66		157
$\Delta s_t$	$-7.1 \times 10^{-5}$	0	.0313	-.0288	.0042	.000	1419
$(s_t - s_t^{10d})$	$-3.0 \times 10^{-4}$	$-1.7 \times 10^{-4}$	.0482	-.0563	.0072	.000	1420
$(s_t - s_t^{180d})$	-.0017	.0041	.0500	-.1100	.0259	.052	1420
$(s_t - s_t^T)$	.0290	.0334	.1393	-.0622	.0361	.041	1420
$h_t$	$9.8 \times 10^{-6}$	$3.5 \times 10^{-6}$	$2.6 \times 10^{-4}$	$3.7 \times 10^{-6}$	$1.9 \times 10^{-5}$	.000	1343
$idiff_{f_t}^{ovn}$	2.4589	1.8025	9.3125	-.5225	2.1409	.088	1420
$\Delta Merval_t$	.8289	1.2550	118.33	-166.23	24.86	.000	1343

\* Augmented Dickey-Fuller test with intercept: p-values H0: series has a unit root

Table 7: Data Statistics



Study	Method		FX-Data	Intervention	Authorities	Period
	I.A.	R.F.				
Akinci et al. (2005a)	GARCH	Probit	daily to USD	official data	Turkey	05/2001 - 12/2003
Akinci et al. (2005b)	Event-study State Space		daily to USD	official data	Turkey	01/2002 - 12/2003
Domaç and Mendoza (2004)	EGARCH		daily to USD	official data	Mexico Turkey	08/1996 - 06/2001 02/2001 - 05/2002
Égert and Komárek (2005)	Event-study GARCH		daily to EUR/DM	official data	Czech Republic	01/1997 - 12/2002
Guimarães and Karacadag (2004)	ACT-GARCH	Probit	daily to USD	official data	Mexico Turkey	08/1996 - 06/2003 03/2001 - 10/2003
Herrera and Özbay (2005)	GARCHM	dynamic Tobit	daily to USD	official data	Turkey	03/1995 - 12/1999 02/2001 - 12/2003
Julio and Toro (2008)	GARCH		intraday 10-min to USD	official data	Colombia	09/2004 - 03/2006
Tapia and Tokman (2004)	I-V, OLS	OLS	daily, intraday to USD	official data	Chile	01/1998 - 02/2003

Table 8: Literature about the efficiency of intervention in developing countries

## Würzburg Economic Papers (Recent Papers)

05-57	Olaf Posch and Klaus Wälde	Natural Volatility, Welfare and Taxation
05-58	Ken Sennewald and Klaus Wälde	"Ito's Lemma" and the Bellman equation for Poisson processes: An applied view
05-59	Marc Oeffner	Die Duale Einkommensteuer des Sachverständigenrates in der Diskussion
05-60	Thorsten Hock and Patrick Zimmermann	Forecasting Monetary Policy in Switzerland: Some Empirical Assistance
05-61	Christian Kleiber Martin Sexauer and Klaus Wälde	Bequests, taxation and the distribution of wealth in a general equilibrium model
05-62	Norbert Schulz	Resale Price Maintenance and the Service Argument: Efficiency Effects
05-63	Jörg Iingens, Klaus Wälde	Pareto - Improving Unemployment Policies
05-64	Christain Holzner Andrey Launov	Search Equilibrium, Production Parameters and Social Returns to Education: Theory and Estimation
05-65	Andrey Launov Joachim Wolf	Parametric vs. Nonparametric Estimation of an Equilibrium Search Model with Employer Heterogeneity
06-66	Peter Bofinger, Eric Mayer and Timo Wollmershäuser	Teaching New Keynesian Open Economy Macroeconomics at the Intermediate Level
06-67	Peter Bofinger Eric Mayer	The Svensson versus McCallum and Nelson Controversy Revisited in the BMW Framework
06-68	Michael Geiger	Monetary Policy in China (1994-2004); Targets, Instruments and their Effectiveness
06-69	Jens Eisenschmidt Klaus Wälde	International Trade, Hedging and the Demand for Forward Contracts
06-70	Norbert Schulz	Does the Service Argument Justify Resale Price Maintenance?
06-71	Oliver Hülsewig, Eric Mayer , and Timo Wollmershäuser	Bank Behavior and the Cost Channel of Monetary Transmission
06-72	Isabel Günter and Andrey	Competitive and Segmented Informal Labor Markets

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| 06-73 | Robin Kleer   | The Effect of Merges on the Incentive to Invest in Cost Reducing Innovations                         |
| 07-74 | Steffen Henzel,<br>Oliver Hülsewig,<br>Eric Mayer and<br>Timo<br>Wollmershäuser | The Prize Puzzle Revisited: Can the Cost Channel explain a Rise in Inflation after a Monetary Shock? |
| 07-75 | Michael Graber,<br>Andrey Launov<br>and Klaus Wälde                             | How To Get Tenured   |
| 07-76 | Norbert Schulz  | Review of the literature on the impact of mergers on innovation                                      |
| 07-77 | Thorsten Hock   | Tactical Rotation in Switzerland   |
| 07-78 | Eric Mayer and<br>Oliver Grimm  | Countercyclical Taxation and Price Dispersion  |

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