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Reserve Option Mechanism as a Stabilizing Policy Tool: Evidence from Exchange Rate Expectations

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Reserve Option Mechanism as a Stabilizing Policy Tool: Evidence from Exchange Rate Expectations

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Abstract

During the recent era, many emerging market economies have implemented unconventional policy measures to mitigate the effect of large swings in short-term capital flows on domestic business cycles. This paper focuses on a specific unconventional policy tool introduced by the Central Bank of Turkey, the Reserve Option Mechanism (ROM), that in principle contains excessive fluctuations in foreign exchange rate and helps cushion the economy from large swings in external factors. The results suggest that, after the introduction the ROM (i) market expectations are leaned towards a significantly lower volatility or skewness in the USD/TL relative to other emerging market exchange rates; (ii) controlling for a set of domestic and common external factors, the USD/TL expectations have exhibited lower levels of volatility, skewness and kurtosis; (iii) the higher the intensity of ROM (the fraction of ROM-based reserves in total international reserves) the stronger the effect of ROM on exchange rate expectations. Last, we provide evidence that the mechanism acts as an automatic stabilizer of expectations about excessive movements in the exchange rate: the mechanism decreases the sensitivity of expected USD/TL kurtosis to the common external factor (by an estimated decrease of about 85%).

Keywords: Options-based Exchange Rate Expectations, Reserve Option Mechanism, Unconventional Monetary Policy.

JEL Codes: F31, F40.

1. Introduction

In response to large swings in global capital flows, many emerging market economies have implemented unconventional policy tools to help maintaining domestic financial stability, e.g. active

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use of reserve requirements and macroprudential policies. Turkey stands out as an interesting example in this regard. The Central Bank of the Republic of Turkey (CBRT) has started implementing a novel policy tool, the reserve option mechanism (ROM), to smooth excessive fluctuations in the exchange rate in a market-friendly manner, and to help cushion the economy from short-term volatile capital flows.[1] In this paper, we address how the ROM fares in containing large fluctuations in USD/TL exchange rate expectations. In particular, we empirically study the effect of ROM on the volatility, skewness, and the kurtosis of the USD/TL exchange rate expectations, taking into account a set of external factors common to similar emerging market currencies and domestic variables.

Emerging market economies have a long and only partially successful history of mitigating adverse effects of excessive volatility in short-term capital flows. These flows often times drive large fluctuations in domestic business cycles, creating a boom period associated with domestic credit expansion, higher domestic inflation, and fast economic growth. To the extent the economy builds up external mismatches, the prolonged bonanza period may eventually trigger a sudden reversal of current account (sudden stop).[2] The reserve option mechanism may offer a remedy here: it is a market-friendly tool that in principle acts as an automatic stabilizer of large exchange rate fluctuations and in principle contains distortionary effects of such large fluctuations on emerging economy domestic business cycles.

ROM has been introduced by the CBRT in late 2011. The mechanism allows banks to voluntarily hold a certain fraction of their domestic-currency required reserves in foreign currency (USD). For example, if the ROM allows banks to hold up to 50% of their domestic-currency (TL) required reserves in USD, and a bank find it optimal to fully utilize the facility, then the bank could instead hold 50TL and 50USD rather than 100TL.[3] The optimal level of use of the ROM is market-determined: banks choose the optimal use depending on cost of USD funding relative to TL funding.[4]

ROM in principle acts as an automatic stabilizer on the exchange rate in response to large swings in capital flows. Consider for instance the two following cases: During a surge in capital flows, relative cost of USD funding is lower than the TL funding which encourages banks to utilize

[1]For details on these policy tools as well the on the new policy framework, see Başçı and Kara (2011), Aysan, Fendoğlu, and Kılınç (2013), Oduncu, Akçelik, Ermişoğlu (2013), Alper, Kara, and Yörükoğlu (2012), Kara (2012), and Küçüksaraç and Özel (2012).

[2]For such a feedback cycle that entails an amplification of domestic business cycles which may eventually trigger a sudden reversal of capital flows, see Mendoza (2010), and Bruno and Shin (2013).

[3]In this example, one unit of USD is assumed to cover one unit of TL required reserves. This, however, is not necessarily the case. The policy maker can choose the conversion rate, the reserve option coefficient. For details, see Section 2. For further details, see Alper, Kara, and Yörükoğlu (2012), and Aysan, Fendoğlu, and Kılınç (2013).

[4]For a detailed derivation of threshold level that makes banks indifferent between utilizing and not utilizing the ROM, see Küçüksaraç and Özel (2012).

the facility more. Accordingly, some portion of USD inflow would automatically be retained at the central bank, easing the appreciation pressure. During a capital outflow, on the other hand, banks in general find it harder to borrow in USD, and accordingly would choose to use the ROM facility less. Accordingly, some portion of ROM-based international reserves will be released, reducing the depreciation pressure. In these regards, the ROM can be by-and-large thought as a mechanism that makes banks internalize the social benefit of foreign-currency accumulation during inflow periods.

The main questions that we address in this paper are (i) whether the use of ROM makes the volatility, skewness, or kurtosis of USD/TL expectations lower *relative* to other emerging market currencies; and (ii) whether the USD/TL exchange rate expectations become less sensitive to fluctuations in common external factors due to the ROM.

Methodologically, we first extract the risk-neutral probability distribution function (RN-PDF) of USD/TL exchange rate expectations by using option prices. There is a wide range of techniques to estimate RN-PDF, including parametric, non-parametric, and structural models (see, among others, Bahra, 1997; Bliss and Panigirtzoglou, 2002; Campa, Chang, and Reider, 1998; Malz, 1996; and Malz, 1997). We use Malz (1997) as it enables us to extract the RN-PDF from a relatively low number of cross-sectional options prices. Based on the estimated RN-PDF, we then calculate the standard deviation, skewness and kurtosis of USD/TL expectations. Similarly, we obtain the moments for a large set of emerging market exchange rate expectations, and estimate a common factor for each moment using standard dynamic factor modeling (Stock and Watson, 1989).[5] Finally, we control for common external factors and other policy actions by the CBRT, and use seemingly unrelated regression (SUR) models to address the questions above.

The results are twofold: First, market expects a significantly lower volatility and assigns a significantly lower relative likelihood of depreciation in USD/TL exchange rate compared to other emerging market currencies after the introduction of ROM. Expectations about excessive movements in USD/TL is lower relative to other emerging market currencies during the ROM period, yet the effect is found insignificant. Second, conditional on common external factors, the market expects a lower volatility, a lower relative likelihood of depreciation, and a lower likelihood of excessive movements in the USD/TL exchange rate during the ROM era (all statistically significant). Furthermore, ROM appears to function as an automatic stabilizer of excessive movements in the exchange rate: the implied kurtosis of USD/TL expectations is significantly less sensitive to fluctuations in the common external factor during the ROM era (by about estimated 85% decrease in the sensitivity).

[5]The advantage of this method is that it handles missing observations (through Kalman filtering) and is immune to measurement errors. Moreover, and importantly for the focus of this paper, it does not rely on restrictive assumptions about the choice of variables that potentially reflect common factors.

The contribution of this paper is that we study the effect of an unconventional policy tool as compared to conventional measures such as direct foreign exchange market intervention, on the higher moments of the exchange rate expectations, using a large data set on emerging market exchange rates. Related literature are mostly confined to single-country analyses, and in general examines the effect of an important policy event or a possible change in policy regime or economic announcements on the underlying assets (Castren, 2004; Castren, 2005; Gereben, 2002; Aydın, Değerli and Özlü, 2010), or credibility of a target zone or a policy regime (Campa and Chang, 1996; Campa, Chang, and Refalo, 2002). This paper, on the other hand, focuses on a novel unconventional policy tool and evaluates its effectiveness from a comparative perspective. Furthermore, we contribute to the literature on the ROM (Alper, Kara, and Yörükoğlu, 2012; Başçı and Kara, 2011; Değerli and Fendoğlu, 2013; Kara, 2012; and Küçüksaraç and Özel, 2012) by empirically assessing the stabilizing role of the ROM in containing asymmetric/excessive fluctuations in the exchange rate. Closely related to our paper, Oduncu, Akçelik, Ermişoğlu (2013) empirically studies the effect of ROM on the realized exchange rate volatility. Our paper differs from Oduncu, Akçelik, Ermişoğlu (2013) mainly on the following dimensions. First, we study the effect of ROM on the volatility as well as on the higher moments (skewness and kurtosis) of USD/TL exchange rate expectations, and not only in absolute terms but also *relative* to other emerging market exchange rates. Second, we empirically test the stabilizing role of the mechanism, whether the mechanism makes the implied moments of the exchange rate more resilient to common external factors. Also, we study option prices to extract the moments, hence the analysis is forward looking in nature.

The paper proceeds as follows: Section 2 presents the reserve option mechanism more in detail, Section 3 the data and the methodology. Section 4 presents the empirical results, and Section 5 concludes.

2. Reserve Option Mechanism

To manage short-term volatile capital flows, the CBRT has started following a flexible policy framework, using many unconventional policies along with conventional policy tools to ensure financial stability without harming medium-term inflation expectations. Among structural unconventional tools, the reserve option mechanism (ROM) in principle acts as an automatic stabilizer of large fluctuations in the exchange rate.[6] The mechanism in particular allows domestic banks to

[6]The new policy framework includes active use of reserve requirements and asymmetric interest rate corridor as cyclical policy tools, and the reserve option mechanism as a structural policy tool. The asymmetric corridor policy can be thought as an *ex-ante* cyclical measure to encourage/discourage capital flows. A wider corridor (or a lower bound), for instance, imply a higher risk on return or a higher likelihood of a lower interest rate in the money market, discouraging short-term capital flows *ex ante* (for details, see for instance Aysan, Fendoğlu, and Kılınç, 2013). The reserve option mechanism can alternatively be thought as a *structural* measure to smooth large fluctuations in the

hold their domestic-currency required reserves in foreign currency (US dollars or Euros) up to a certain fraction (e.g. 50%). For instance, if a bank is obliged to hold 10 units of domestic currency as reserves at the central bank, the bank can voluntarily retain an equivalent amount of USD at the central bank to meet up to 5 units of domestic-currency required reserves. The central bank can also set the conversion rate, called the reserve option coefficient (ROC), i.e. the amount of USD that should be held to meet one-unit domestic-currency-reserve requirement.

Central bank can set different ROCs for different domestic required reserve trenches. For instance, banks may be obliged to hold 1 domestic-currency worth of USD to meet up to 20% of domestic-currency required reserves, and 2 domestic-currency-worth of USD to meet 20% to 50% of the domestic currency required reserves (hence the ROC is 1 for up to %20, and 2 for 20%-50% to meet domestic currency required reserves, see Figure 1).

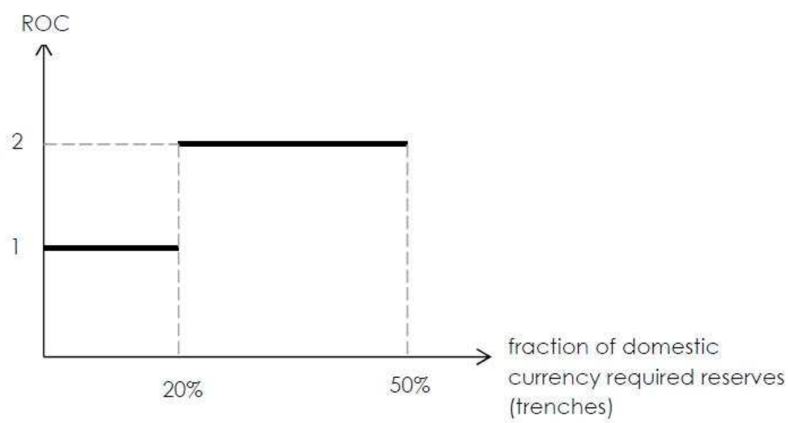


Figure 1: Reserve Option Coefficients: An Example

The main notion of the mechanism is that in principle it acts as an automatic stabilizer of large exchange rate fluctuations. During a surge in capital flows, for instance, banks in general find it easier to borrow in USD (e.g. due to lower USD interest rate) compared to domestic currency. Banks in turn would utilize the mechanism more during such episodes, retaining some portion of the USD inflow at the central bank as reserves. Parallely, during capital outflow periods, banks would find it harder to have USD funding, and in turn would like to utilize the mechanism less. In turn, banks' reserves at the central bank would decrease, again easing the pressure on the exchange rate.

For the mechanism to function as a stabilizer, it is necessary that banks do not fully utilize

exchange rate to mitigate the effect of large fluctuations in capital flows on the domestic business cycle. During a surge in capital flows, the reserve option mechanism in principle encourages banks to retain *ex post* some foreign funding at the central bank as reserves. Hence, an active use of the ROM may reduce the need for cyclically steering the corridor policy to support smoother exchange rate movements; or vice versa.

the mechanism, since otherwise banks can not retain some of the USD inflow at the central bank during inflow periods. Parallely, it is also necessary that the use of the ROM is not very close to zero, since otherwise banks cannot drain some of their USD reserves at the central bank during capital outflow periods. This is why in practice the ROCs are set such that it is easier to utilize the option's first few trenches, and is increasingly harder to utilize the mechanism for higher trenches.

The CBRT has implemented the ROM gradually starting in late 2011, setting the maximum fraction at 10% (i.e. banks can hold up to 10% of their required domestic reserves in USD) with a ROC one. The central bank then has gradually increased the maximum fraction to 60% and set increasing ROCs for the trenches (Figure 2a). So far the utilization rate of the mechanism has reached around 90% (Figure 2b). The total amount of ROM-based international reserves has reached around 30 billion USD by the year 2013 (Figure 3).

(a) (b)

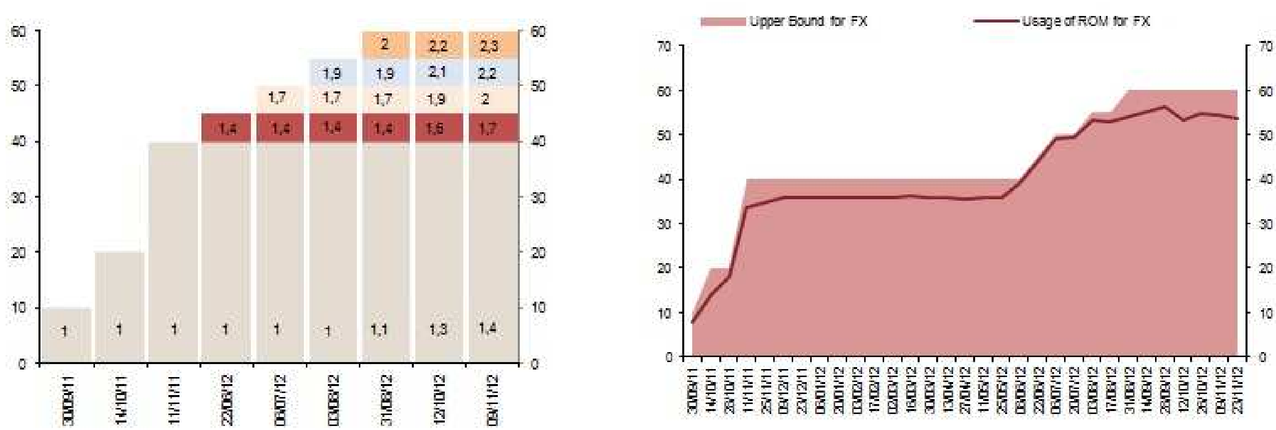


Figure 2: Reserve Option Coefficients and the ROM's Utilization Rate

3. Data and Methodology

The sample includes 11 emerging market countries: Brazil, Chile, Colombia, Czech Republic, Hungary, Indonesia, Mexico, Poland, Romania, South Africa and Turkey. These countries exhibit similar external imbalances (a persistent current account deficit) during recent years. We choose a relatively homogenous sample to have a sound comparative analysis. All the exchange rates are quoted as the value of domestic currency per US dollar.[7] The interest rate used in option pricing is the 1-month interbank money market rate. Correspondingly, we use 1-month over-the-counter

[7]We use the USD as the reference currency since currency options contracts on US Dollar have wider usage than options contracts on Euro and cover a wider time period. Furthermore, some options contracts on Euro do not exist for some of the countries we study.

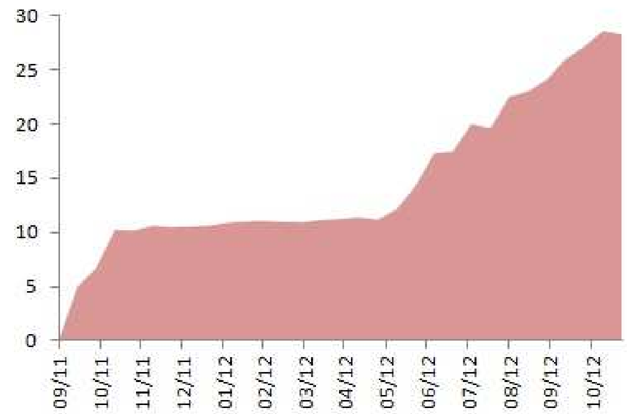


Figure 3: Level of ROM-based international reserves (in billion USD).

(OTC) foreign currency options. The risk-free interest rate is taken as the 1-month constant-maturity US Treasury Bill. The data set starts with October 15, 2010 (the start date of the CBRT's policy of zero remuneration on required reserves) and ends at November 6, 2012.

Foreign exchange options provide invaluable source of information about the expected movement of the exchange rate over some future horizon.[8] In its simplistic sense, if an investor expects a currency depreciation, then she would be better off by buying a put option. Value of the option in turn reflects market-based expectation about a future depreciation. Conversely, if she expects an appreciation, optimal strategy would be to buy a call option, value of which reflects likelihood of an appreciation (as perceived by the market). Accordingly, the value of an option that combines these 'vanilla' currency options could partially reflect the distribution of market expectations about the exchange rate.

In this paper, we consider the following three frequently-traded currency options: (i) a straddle option which combines a call and a put option with the same strike price and maturity (both at-the-money).[9] Accordingly, the higher the spot price deviates from the strike price, the higher the payoff from buying the straddle option. Hence, a higher price for the straddle reflects a higher expected variance. (ii) a risk reversal option which combines selling an out-of-the-money put option and buying an out-of-the-money call option both with the same maturity. If a depreciation is expected more than an appreciation, then the put option would be more valuable than the call option, and the price of the risk reversal would decline (call price - put price). Hence, the price of the currency

[8]An option is a contract that gives the right (not the obligation) to buy or sell an asset at a predetermined date at a certain price (the strike price).

[9]When the strike price of an option is equal to the current spot price of the underlying asset, then the option is labeled as 'at the money'. 'Out of the money' is when the strike price differs from the current spot price.

risk reversal reflects what the market expects about the direction of the exchange rate (expected skewness). (iii) a strangle option which combines buying an out-of-the-money put option and an out-of-the-money call option. Buying a strangle option would be profitable for an investor if the investor expects an extreme movement in the exchange rate. Accordingly, the price of a strangle reflects how strongly large movements in the exchange rate is expected (expected kurtosis).

To this end, we now provide how these options are priced and how probability distribution of exchange rate expectations can be obtained from these prices. We in particular follow the methodology outlined in Malz (1997), as it enables estimating the distribution from a relatively low number of cross-sectional options data (three in our case).

The price of risk reversal can be expressed as

$$RR_t = \sigma_t^{25\delta} - \sigma_t^{75\delta} \tag{1}$$

and the price of strangle as

$$STR_t = 0.5(\sigma_t^{25\delta} + \sigma_t^{75\delta}) - ATM_t \tag{2}$$

where δ is the sensitivity of option price with respect to the spot price, $\sigma_t^{25\delta}$ and $\sigma_t^{75\delta}$ represent the implied volatilities of 25-delta call and 25-delta put options, respectively. RR_t, STR_t, and ATM_t denote the risk reversal price, the strangle price, and the at-the-money volatility ($\sigma_t^{50\delta}$), respectively. These expressions pin down three points on the volatility smile curve (as a function of deltas), i.e. $\sigma_t^{25\delta}$, $\sigma_t^{50\delta}$, and $\sigma_t^{75\delta}$. We then transform the implied volatility-delta space into option price-strike price space by using standard Black-Scholes option pricing formula. Finally, evaluating Breeden and Litzenberger (1978) formula,

$$\frac{\partial^2 C(K, r^*, \tau)}{\partial K^2} = e^{-r\tau} p(K) \tag{3}$$

where K is the strike price, r^* denotes the risk-free rate, r the domestic interest rate, and τ the time-to-maturity, we extract the risk-neutral probability distribution (RN-PDF).[10]

Using the estimated RN-PDF, we then calculate the standard deviation, the skewness and the kurtosis using standard formulas. Namely, the standard deviation of the RN-PDF reflects how uncertain the market is on a given day about the path of the exchange rate over some near future. The skewness can be interpreted as a measure of weight that the market puts on the relative likelihood of depreciation (compared to appreciation) over the near future. Similarly, the kurtosis

[10]Note that the estimated risk-neutral PDFs capture the distribution of market expectations as well as market's preference toward risk. We have not pursued the analysis further to decompose the RN-PDF by following Galati *et al.* (2005). For the estimated RN-PDF of USD/TL exchange rate expectations, see Figure A1. For descriptive statistics of the moments of this distribution, see Section 4.

provides a market-based measure of how likely a very large change in the exchange rate is expected to be over the near future.

To estimate the effect of ROM on the volatility, skewness, and kurtosis of USD/TL exchange rate expectations, we consider variants of the following three-equation seemingly unrelated regression (SUR) model:

$$\begin{aligned}
\mu_t^{(2)} &= \alpha_1 ROM_t + \beta_1 C_t^{(2)} + \gamma_1 ROM_t * C_t^{(2)} + \sum_{k=1}^{T} \rho_1^j \mu_{t-k}^{(2)} + \Gamma_1 x_t + \epsilon_t^{(2)} \\
\mu_t^{(3)} &= \alpha_2 ROM_t + \beta_2 C_t^{(3)} + \gamma_2 ROM_t * C_t^{(3)} + \sum_{k=1}^{T} \rho_2^j \mu_{t-k}^{(3)} + \Gamma_2 x_t + \epsilon_t^{(3)} \\
\mu_t^{(4)} &= \alpha_3 ROM_t + \beta_3 C_t^{(4)} + \gamma_3 ROM_t * C_t^{(4)} + \sum_{k=1}^{T} \rho_3^j \mu_{t-k}^{(4)} + \Gamma_3 x_t + \epsilon_t^{(4)} \qquad (4)
\end{aligned}$$

with $E[\epsilon\epsilon'] \sim N(0, \Omega_{3x3})$ where $\epsilon = [\epsilon_t^{(2)}, \epsilon_t^{(3)}, \epsilon_t^{(4)}]$. Note that Ω is potentially non-diagonal allowing for correlated error terms across the equations. This appealing feature of the SUR is particularly important for our case, since it is natural to think that an exogenous shock to one of the moments might affect other moments as well.[11]

$\mu_t^{(2)}$, $\mu_t^{(3)}$, and $\mu_t^{(4)}$ denote the implied standard deviation, the implied skewness, and the implied kurtosis of USD/TL, respectively. An increase in $\mu_t^{(2)}$, for instance, implies that the market expects larger fluctuations in the USD/TL exchange rate over the near future (1 month in our case).

We consider two specifications for the ROM_t. First, we consider a binary variable, D_ROM, to capture the period after the implementation of ROM. It takes a value 1 for September 30, 2011 onwards, and 0 else. Second, we consider how intensely the ROM is utilized, $\widetilde{ROM}_t$, international reserves held by banks at the central bank due to the ROM facility as a ratio of total international reserves of the central bank.[12]

We control for external global conditions and other policy actions by the CBRT: a common external factor for each moment (estimated from a dynamic factor model using the implied exchange rate moments of the set of 10 similar emerging markets), two variables to capture CBRT's other policy actions, and lastly, past values of the implied moments.[13]

[11] For reference purposes, we report the ordinary least squares estimation results as well.

[12] It is important to note that the CBRT does not cyclically adjust the ROCs, the conversion rate, as a response to changes in exchange rate moments. In particular, the CBRT has revised the ROCs over the course of ROM's construction to ensure that the mechanism functions as an automatic stabilizer, i.e. the use of the mechanism being not at 100% or 0%. Also, as we have discussed in Section 2, banks' use of ROM depends on the relative cost of USD funding (see Küçüksaraç and Özel (2012) for details). In these regards, endogeneity should not be a major issue here.

[13] Other control variables that have the potential to explain the exchange rate moments, e.g. current account

$C_t^{(2)}$ is the common factor for the implied standard deviation, $C_t^{(3)}$ the common factor for the implied skewness, and $C_t^{(4)}$ the common factor for the implied kurtosis. To calculate these factors, we consider a simple dynamic factor model (DFM) for each moment. We assume that *for each moment*, $\mu_t^{(i)}$ where $i = 2, 3$ or 4, there exists the following factor structure:

$$\mu_{jt}^{(i)} = \mu + \Lambda_i^C C_t^{(i)} + \varepsilon_{jt}^{(i)}; \qquad j = 1, ..., N = 10 \tag{5}$$

$$C_t^{(i)} = \rho_i C_{t-1}^{(i)} + u_{it}^C; \qquad u_{it}^C \sim i.i.d.N(0, 1) \tag{6}$$

$$\varepsilon_{jt}^{(i)} = \phi_1 \varepsilon_{jt-1}^{(i)} + \upsilon_{jt}; \qquad \upsilon_{jt} \sim i.i.d.N(0, \sigma_j^2) \tag{7}$$

where $\mu_{jt}^{(i)}$ denotes the ith moment of country j's exchange rate expectations at time t. $E[\upsilon_{it}\upsilon_{js}] = 0$ for $i \neq j$, and where C_0 and R_0 are uncorrelated with v_t and u_t for all t. The variance of innovations to the global factor is normalized to one to separately identify the factor loading and the factor itself (Stock and Watson, 1993).[14] The model above is a backbone DFM for a variety of models used in the DFM literature (Stock and Watson, 2011). It is a simple version of those studied in, for instance, Kose *et al.* (2003) (on international business cycles), Del Negro and Otrok (2008) (on the European business cycles), and Stock and Watson (2008) (on the US housing market). The moments are first standardized to have a mean zero and standard deviation one to ensure that an individual economy does not have an disproportionate effect on the evolution of common factor. The model is then estimated by Gaussian maximum likelihood, where the likelihood function is evaluated using the Kalman filter.

The estimated common factors are presented in Figure 4(a) to 4(c). The figures show that the common factors exhibit a sharp increase in late 2008 (coinciding with the Lehman Brother's collapse at the time), and a resurrecting increase in mid- to late-2011, coinciding with the Eurozone economies' debt problems and further concerns about the health of the global economy).[15]

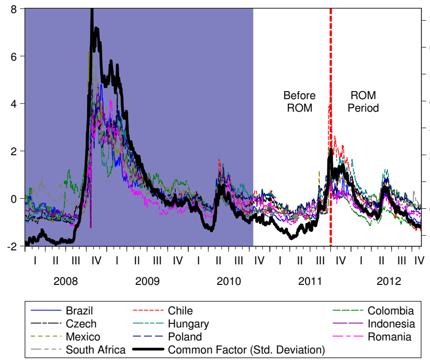
x_t controls for discretionary policy actions by the CBRT during the sample period: additional monetary tightening (AMT) and foreign exchange market interventions (FXS). Additional monetary tightening is captured by the dummy variable AMT which takes a value 1 for days of additional

deficit, fiscal balance, among others, might also be used. Nonetheless, these domestic fundamentals are at a much lower frequency, hence cannot be used. Alternatively, one might think of higher frequency, weekly or daily, domestic financial variables as additional control variables. We think that use of lagged moments is an efficient way to capture such potential domestic financial variables. Another reason why we have included the lagged moments is to make the level or squared level of error terms non-autocorrelated.

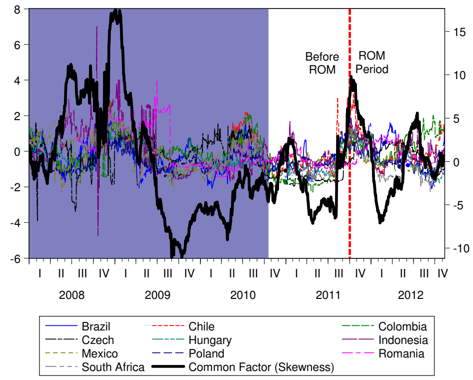
[14] Note that the normalization does not affect economic inferences such as the estimated evolution of factors or variance decomposition.

[15] For comparison purposes, we present the estimated common factor for standard deviation against a volatility index compiled for emerging markets, JP Morgans' JPMVXYEM index (see Figure A2). As evident, the two series closely follow each other. We leave aside further results regarding the dynamic factor model, as our main purpose is to estimate the path of the common factors. Further results for the dynamic factor model are available upon request.

(a)



(b)



(c)

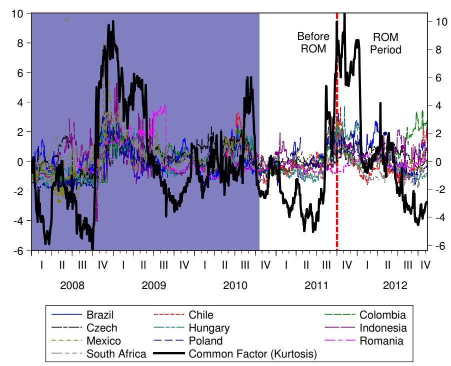


Figure 4: The (standardized) moments for each emerging market exchange rate expectations and the common factors –$C_t^{(2)}$, $C_t^{(3)}$, $C_t^{(4)}$–.

monetary tightening and 0 else.[16] FXS is defined as the ratio of daily amount of foreign exchange sold by the CBRT (through auctions or interventions) to gross foreign exchange reserves of the CBRT.

4. Empirical Results

4.1. Does the Reserve Option Mechanism reduce the volatility, skewness and kurtosis of USD/TL exchange rate expectations relative to other emerging market currencies?

We first study where the USD/TL moments lie in the cross-sectional distribution of other emerging market currencies during the sample period (consider for instance the cross-sectional distribution of implied standard deviation for $t = 5/2/2011$ (for the sake of example) in Figure

[16]CBRT has done additional monetary tightening on 12/29/2011-01/09/2012, 3/23/2012-3/29/2012, 4/12/2012-4/17/2012, 5/4/2012-5/11/2012, 5/18/2012-5/25/2012, and 5/31/2012-6/4/2012. See Ermişoğlu *et al.* (2012) for details.

5, where the implied standard deviation of USD/TL is 80.9). We calculate for each t at which percentile the implied USD/TL standard deviation lies in the cross-sectional distribution. Hence, a decrease over time in the percentile of the USD/TL standard deviation, a lower $\%\mu_t^{(2)}$, implies that the USD/TL standard deviation is lower *compared* to other emerging market exchange rates (moving towards the left of the cross-sectional distribution).

Table 1 shows that the percentiles for each moment ($\%\mu_t^{(2)}$,$\%\mu_t^{(3)}$,$\%\mu_t^{(4)}$) are all lower during the ROM period. That is, the volatility, skewness and kurtosis of USD/TL exchange rate expectations are lower compared to other emerging market exchange rates. Numerically, $\%\mu_t^{(2)}$ decreases by about 50%, $\%\mu_t^{(3)}$ by about 30%, and $\%\mu_t^{(4)}$ by about 15%.

Table 1: Descriptive Statistics (Percentiles)

	Before ROM (Oct. 15, 2010 - Sept. 29, 2011)				*ROM Period (Sept. 30, 2011 - Nov. 6, 2012)*			
Variable	Mean	St.Dev.	Min	Max	Mean	St.Dev.	Min	Max
$\%\mu_t^{(2)}$	.782	.248	0	1	.391	.199	0	.8
$\%\mu_t^{(3)}$	.464	.216	0	.888	.333	.205	0	.8
$\%\mu_t^{(4)}$	.336	.172	0	.8	.287	.230	0	.888
AMT	-	-	-	-	.111	.315	0	1
FXS	.014	.046	0	.401	.057	.260	0	3.338
D_ROM	-	-	-	-	1	0	1	1
$\widetilde{ROM}_t$	-	-	-	-	.167	.059	0	.287

Notes. $\%\mu_t^{(2)}$, $\%\mu_t^{(3)}$, and $\%\mu_t^{(4)}$ denotes the percentiles of the implied standard deviation, the implied skewness and the implied kurtosis of USD/TL exchange rate expectations, respectively. The percentile at t reflects where the USD/TL moment lies in the cross-sectional distribution of moments of other emerging market exchange rate expectations. AMT is a dummy variable that takes a value 1 for days of additional monetary tightening (of the CBRT), and 0 otherwise. FXS denotes the foreign exchange selling operations of the CBRT, and is the ratio of daily amount of foreign exchange sold by the CBRT (through auctions or interventions) to gross foreign exchange reserves of the CBRT. D_ROM takes a value 1 for the ROM period, and 0 else. $\widetilde{ROM}_t$ is the international reserves held at the central bank due to the ROM facility as a ratio of total international reserves of the central bank.

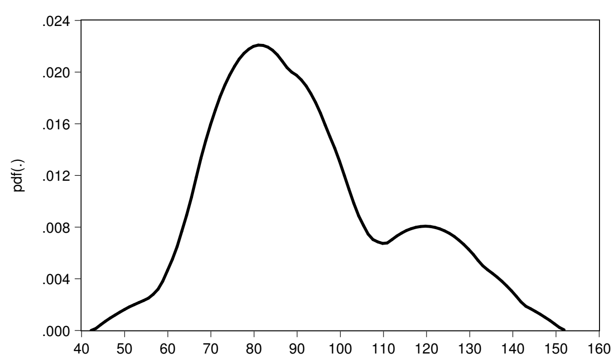


Figure 5: Cross-Sectional Distribution of Implied Standard Deviations (on 5/2/2012). We normalize implied standard deviation for each country at 100 for 1/4/2011.

To this end, we estimate the following SUR model to shed further light on how the ROM affects the implied moments of USD/TL *relative* to other emerging markets.

$$
\begin{aligned}
\%\mu_t^{(2)} &= \alpha_1 ROM_t + \sum_{k=1}^{T} \rho_1^j \%\mu_{t-k}^{(2)} + \Gamma_1 x_t + \epsilon_t^{(2)} \\
\%\mu_t^{(3)} &= \alpha_2 ROM_t + \sum_{k=1}^{T} \rho_2^j \%\mu_{t-k}^{(3)} + \Gamma_2 x_t + \epsilon_t^{(3)} \\
\%\mu_t^{(4)} &= \alpha_3 ROM_t + \sum_{k=1}^{T} \rho_3^j \%\mu_{t-k}^{(4)} + \Gamma_3 x_t + \epsilon_t^{(4)} \qquad (8)
\end{aligned}
$$

where $\%\mu_t^{(2)}$ captures the implied standard deviation of USD/TL exchange rate *relative* to other emerging markets (the percentile of USD/TL implied standard deviation in the cross-sectional distribution of implied standard deviations), and similarly for other implied moments; with $E[\epsilon\epsilon'] \sim N(0, \Omega_{3x3})$ where $\epsilon = [\epsilon_t^{(2)}, \epsilon_t^{(3)}, \epsilon_t^{(4)}]$. We use the same set of x_t control variables, the CBRT's additional monetary tightening and foreign exchange market operations.[17]

The results are presented in Tables 2 and 3. After the implementation of the ROM, market expectations are leaned towards a significantly lower volatility or skewness in the USD/TL relative to other emerging market exchange rates. The expected likelihood of excessive movements in the USD/TL is again lower, though, is not significantly different compared to other emerging market exchange rates. A similar result holds if we consider the ratio of ROM-based reserves to total international reserves (ROM intensity) as presented in Table 3.

[Tables 2 and 3 around here]

4.2. Does the Reserve Option Mechanism reduce the sensitivity of standard deviation, skewness, and kurtosis of USD/TL exchange rate expectations to common external factors?

We first provide *a priori* evidence on the effect of ROM on the implied USD/TL exchange rate moments. Table 4 shows that the implied moments ($\mu_t^{(2)}$,$\mu_t^{(3)}$,$\mu_t^{(4)}$) have increased slightly during the ROM period. Common factors have shown a noticeable increase as well, possibly due to intensified Eurozone debt crisis in late 2011 onwards.

Next, we focus on the effect of ROM on the USD/TL moments *conditional* on common external factors. For convenience, we re-express the estimated SUR model below:

[17] We have not included the common external factor here, since it is reflected inherently by the cross-sectional distribution of exchange rate expectations. For example, a higher $C^{(2)}$, *ceteris paribus*, would imply a lower $\%\mu_t^{(2)}$.

Table 4: Descriptive Statistics

	Before ROM (Oct. 15, 2010 - Sept. 29, 2011)				*ROM Period (Sept. 30, 2011 - Nov. 6, 2012)*			
Variable	Mean	St.Dev.	Min	Max	Mean	St.Dev.	Min	Max
$\mu_t^{(2)}$	1.124	.2527	.767	2.015	1.140	.317	.611	1.825
$\mu_t^{(3)}$	.829	.174	.447	1.400	.862	.147	.512	1.459
$\mu_t^{(4)}$	4.488	.321	4.014	5.816	4.558	.321	3.855	5.889
$C^{(2)}$	-4.934	5.436	-11.227	19.130	2.860	6.770	-6.845	20.291
$C^{(3)}$	-2.203	3.092	-7.122	6.291	.449	4.106	-7.089	9.785
$C^{(4)}$	-1.758	2.498	-5.047	7.438	1.071	4.113	-4.518	10.574
AMT	-	-	-	-	.111	.315	0	1
FXS	.014	.046	0	.401	.057	.260	0	3.338
D_ROM	-	-	-	-	1	0	1	1
$\widetilde{ROM}_t$	-	-	-	-	.167	.059	0	.287

Notes. $\mu_t^{(2)}$, $\mu_t^{(3)}$, and $\mu_t^{(4)}$ denote the implied standard deviation, the implied skewness, and the implied kurtosis of USD/TL exchange rate, respectively. $C^{(2)}$, $C^{(3)}$, and $C^{(4)}$ denote the common factor for each moment.

$$\begin{aligned}
\mu_t^{(2)} &= \alpha_1 ROM_t + \beta_1 C_t^{(2)} + \gamma_1 ROM_t * C_t^{(2)} + \sum_{k=1}^{T} \rho_1^j \mu_{t-k}^{(2)} + \Gamma_1 x_t + \epsilon_t^{(2)} \\
\mu_t^{(3)} &= \alpha_2 ROM_t + \beta_2 C_t^{(3)} + \gamma_2 ROM_t * C_t^{(3)} + \sum_{k=1}^{T} \rho_2^j \mu_{t-k}^{(3)} + \Gamma_2 x_t + \epsilon_t^{(3)} \\
\mu_t^{(4)} &= \alpha_3 ROM_t + \beta_3 C_t^{(4)} + \gamma_3 ROM_t * C_t^{(4)} + \sum_{k=1}^{T} \rho_3^j \mu_{t-k}^{(4)} + \Gamma_3 x_t + \epsilon_t^{(4)} \qquad (9)
\end{aligned}$$

with $E[\epsilon\epsilon'] \sim N(0, \Omega_{3x3})$ where $\epsilon = [\epsilon_t^{(2)}, \epsilon_t^{(3)}, \epsilon_t^{(4)}]$.[18] We include two lags of the dependent variables ($T = 2$) to eliminate any remaining correlation in the level or squared level of error terms. In particular, we start with $T = 0$ and successively increase T till error terms exhibit no autocorrelation.

Tables 5 and 6 present the main results. In Table 5, we capture the ROM by a dummy variable, D_ROM, which takes a value 1 for September 30, 2011 onwards, and 0 else, and in Table 6, we use the ratio of ROM-based reserves to total international reserves (ROM Intensity).[19]

[Tables 5 and 6 around here]

(i) Controlling for common external factors and other alternative policy actions by the CBRT, introduction of ROM appears to be reducing the implied standard deviation, skewness and the

[18] Breusch-Pagan test of independent error terms strongly favors the SUR specification ($p(\chi^2)$ in the Tables).

[19] In both Tables, we use two specifications, the ROM with and without the interaction term with the common external factor. The results are by and large robust.

kurtosis of the USD/TL expectations. In other words, given other controlled factors, the market expects (over the following month) a lower volatility, a lower likelihood of depreciation (relative to appreciation), and expects a lower likelihood of large movements in the USD/TL exchange rate during the ROM era. Moreover, the effect is statistically significant at a high degree (p-value less than .05). Previous results are by-and-large follows for the intensity of the ROM as well (Table 6), except that the effect, now, is economically larger. A 1%-increase in ROM-based reserves in total reserves decreases the expected moments more.

(ii) For each moment, an increase in the common external factor leads to an estimated (and significant) increase in the expected USD/TL moment.

(iii) ROM appears to be an *automatic stabilizer* of expectations about excessive movements of the USD/TL exchange rate. In particular, the effect of common kurtosis factor on the USD/TL implied kurtosis is closer to zero with the introduction of ROM (Table 3). The stabilizing effect is economically large (the estimated coefficient reduces to .002 from .012, by about 85%) and statistically significant (with a p-value less than .01). Similarly, the higher the ROM intensity, the lower the effect of common kurtosis factor on the USD/TL implied kurtosis.[20] The effect is again statistically significant.

5. Conclusion

Many emerging economies have resorted to various policy tools to mitigate potential effect of large swings in short-term capital flows on domestic business cycles. This paper focuses on a novel unconventional policy tool, the Reserve Option Mechanism (ROM), that in principle contains excessive fluctuations in foreign exchange rate in a market friendly manner (hence can be regarded as less distortionary on banks' intertemporal decision making compared to direct market interventions), and in turn helps cushion the economy from large swings in external factors. In this paper, we study the effect of ROM on USD/TL exchange rate expectations, taking into account potential effect of a set of domestic and external common factors.

The results show that market expects a significantly lower volatility and asymmetric movement in the USD/TL during the ROM period *compared* to other emerging market exchange rates. Moreover, conditional on common external factors, the USD/TL expectations have exhibited (significantly) lower levels of volatility, skewness and kurtosis after the implementation of ROM. Also,

[20] Note that ROM intensity takes values between 0 and 1 (as opposed to D_ROM which takes 0 or 1). Hence, the coefficient estimates for the interaction term (ROM Intensity * Common Factor$^{(4)}$) is not readily comparable between Table 3 and 4 (using lower values for the ROM_t maps into a larger coefficient estimate (.049) in Table 4). To give a sense of comparable coefficient estimate for the interaction term, think of multiplying the coefficient by the average ROM Intensity (-.049*.091=-.005).

the higher the fraction of ROM-based reserves in total international reserves, the stronger the effect of ROM on exchange rate expectations. Last but not the least, we provide evidence that the mechanism helps decreasing the sensitivity of expected USD/TL kurtosis to the common external factor, acting like an automatic stabilizer in this regard.

In sum, from a small-open economy perspective, the ROM appears to help containing large fluctuations in the exchange rate, and importantly in a market-friendly manner, increasing the resilience of domestic economy to common external factors.

Note that the sample period we study is mostly characterized with abundant global liquidity, during which the use of ROM has exhibited an (almost) monotonic increase (Figures 2b and 3). Theoretically, and as also discussed in Aysan, Fendoğlu, and Kılınç (2013), Değerli and Fendoğlu (2013), Oduncu, Akçelik, Ermişoğlu (2013), and Alper, Kara, and Yörükoğlu (2012), the mechanism would in principle be used less during capital outflow periods, again help smoothing large movements in the exchange rate. As more data chimes in, we will be able to empirically evaluate and compare the effectiveness of the mechanism during both inflow and outflow periods. It would also be a timely contribution to study the effect of ROM on domestic business cycles (both in empirical and theoretical frameworks). These points are left to future work.

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Tables used in the main text

Table 2: Does the Reserve Option Mechanism reduce the volatility, skewness and kurtosis of USD/TL exchange rate expectations relative to other emerging market currencies?

	SUR			OLS		
	$\%\mu_t^{(2)}$	$\%\mu_t^{(3)}$	$\%\mu_t^{(4)}$	$\%\mu_t^{(2)}$	$\%\mu_t^{(3)}$	$\%\mu_t^{(4)}$
D_ROM	-0.045***	-0.033**	-0.021	-0.046*	-0.027	-.019
	(0.017)	(0.017)	(0.014)	(0.025)	(0.017)	(0.014)
AMT	-0.008	0.045	0.018	-0.007	0.039	0.017
	(0.027)	(0.033)	(0.029)	(0.022)	(0.029)	(0.026)
FXS	0.018	-0.002	-0.036	.018	-0.007	-0.036
	(0.027)	(0.034)	(0.030)	(.013)	(0.012)	(0.016)
$\%\mu_{t-1}^{(2)}$	0.449***			0.450***		
	(0.059)			(0.124)		
$\%\mu_{t-2}^{(2)}$	0.458***			0.453***		
	(0.057)			(0.101)		
$\%\mu_{t-1}^{(3)}$		0.585***			0.688***	
		(0.053)			(0.072)	
$\%\mu_{t-2}^{(3)}$		0.275***			0.201***	
		(0.054)			(0.070)	
$\%\mu_{t-1}^{(4)}$			0.501***			0.569***
			(0.048)			(0.058)
$\%\mu_{t-2}^{(4)}$			0.357***			0.320***
			(0.050)			(0.064)
Constant	0.084***	0.064***	0.050***	0.086***	0.048***	
	(0.024)	(0.021)	(0.015)	(0.039)	(0.018)	
Observations	235	235	235	235	235	
R-squared	0.886	0.711	0.731	0.885	0.715	0.733
$p(\chi^2)$	0.000	0.000	0.000	-	-	-
$Q(5)$	0.979	0.999	0.999	0.981	1.000	0.973
$Q^2(5)$	0.010	0.999	1.000	0.011	1.000	1.000

Notes. ***,**,* denote significance level at .01, .05 and .1, respectively, based on robust OLS or SUR standard errors (in parantheses). $p(\chi^2)$ denotes the p-value for testing the null of independent error terms across the equations (Breusch-Pagan). $Q(5)$ and $Q^2(5)$ denote the p-value for the Ljung-Box Q statistic for testing no autocorrelation in the error or squared error terms up to 5 lags, respectively.

Table 3: Does the Reserve Option Mechanism reduce the volatility, skewness and kurtosis of USD/TL exchange rate expectations relative to other emerging market currencies?

	SUR			OLS		
	$\%\mu_t^{(2)}$	$\%\mu_t^{(3)}$	$\%\mu_t^{(4)}$	$\%\mu_t^{(2)}$	$\%\mu_t^{(3)}$	$\%\mu_t^{(4)}$
ROM Intensity	-0.307***	-0.148*	-0.093	-0.314**	-0.128	-0.097
	(0.099)	(0.085)	(0.075)	(0.158)	(0.087)	(0.089)
AMT	-0.013	0.039	0.014	-0.013	0.035	0.014
	(0.026)	(0.032)	(0.029)	(0.022)	(0.028)	(0.026)
FXS	0.011	-0.008	-0.039	0.011	-0.012	-0.039***
	(0.027)	(0.034)	(0.030)	(0.010)	(0.011)	(0.015)
$\%\mu_{t-1}^{(2)}$	0.437***			0.438***		
	(0.059)			(0.126)		
$\%\mu_{t-2}^{(2)}$	0.446***			0.441***		
	(0.057)			(0.099)		
$\%\mu_{t-1}^{(3)}$		0.276***			0.204***	
		(0.054)			(0.071)	
$\%\mu_{t-2}^{(3)}$		0.276***			0.204***	
		(0.054)			(0.071)	
$\%\mu_{t-1}^{(4)}$			0.503***			0.573***
			(0.048)			(0.059)
$\%\mu_{t-2}^{(4)}$			0.358***			0.323***
			(0.050)			(0.064)
Constant	0.102***	0.057***	0.046***	0.104**	0.043**	0.035***
	(0.026)	(0.019)	(0.014)	(0.046)	(0.018)	(0.013)
Observations	235	235	235	235	235	235
R-squared	0.887	0.710	0.731	0.887	0.714	0.733
$p(\chi^2)$	0.000	0.000	0.000	-	-	-
$Q(5)$	0.868	0.711	0.264	0.872	0.978	0.566
$Q^2(5)$	0.000	0.535	0.025	0.000	0.748	0.0294

Notes. ***,**,* denote significance level at .01, .05 and .1, respectively, based on robust OLS or SUR standard errors (in parantheses). $p(\chi^2)$ denotes the p-value for testing the null of independent error terms across the equations (Breusch-Pagan). $Q(5)$ and $Q^2(5)$ denote the p-value for the Ljung-Box Q statistic for testing no autocorrelation in the error or squared error terms up to 5 lags, respectively.

Table 5: Does the Reserve Option Mechanism reduce the sensitivity of standard deviation, skewness, and kurtosis of USD/TL exchange rate expectations to common external factors?

	SUR						OLS					
	$\mu_t^{(2)}$		$\mu_t^{(3)}$		$\mu_t^{(4)}$		$\mu_t^{(2)}$		$\mu_t^{(3)}$		$\mu_t^{(4)}$	
D_ROM	-0.039***	-0.039***	-0.011**	-0.013**	-0.026**	-0.037**	-0.052**	-0.052**	-0.013*	-0.016*	-0.033*	-0.045*
	(0.009)	(0.009)	(0.006)	(0.006)	(0.016)	(0.017)	(0.022)	(0.022)	(0.008)	(0.009)	(0.023)	(0.027)
$C^{(2)}$	0.004***	0.004***					0.006*	0.006*				
	(0.001)	(0.001)					(0.003)	(0.003)				
D_ROM * $C^{(2)}$		0.001						0.000				
		(0.000)						(0.002)				
$C^{(3)}$			0.001	0.002*					0.001	0.003		
			(0.001)	(0.001)					(0.001)	(0.002)		
D_ROM * $C^{(3)}$				-0.002						-0.002		
				(0.001)						(0.002)		
$C^{(4)}$					0.003	0.012***					0.005	0.014
					(0.002)	(0.004)					(0.003)	(0.009)
D_ROM * $C^{(4)}$						-0.010***						-0.011
						(0.004)						(0.009)
AMT	0.003	0.003	0.018	0.018	0.031	0.034	0.004	0.004	0.019*	0.018*	0.028	0.031
	(0.012)	(0.012)	(0.012)	(0.012)	(0.032)	(0.033)	(0.014)	(0.001)	(0.011)	(0.011)	(0.024)	(0.024)
FXS	0.014	0.014	-0.015	-0.015	-0.033	-0.033	0.010	0.010	-0.021***	-0.019***	-0.050***	-0.044***
	(0.013)	(0.013)	(0.012)	(0.012)	(0.035)	(0.035)	(0.008)	(0.008)	(0.005)	(0.005)	(0.012)	(0.012)
$\mu_{t-1}^{(2)}$	0.863***	0.863***					0.902***	0.902***				
	(0.056)	(0.056)					(0.096)	(0.096)				
$\mu_{t-2}^{(2)}$	0.026	0.031					-0.036	-0.036				
	(0.056)	(.055)					(0.107)	(0.105)				
$\mu_{t-1}^{(3)}$			0.913***	0.909***					0.986***	0.981***		
			(0.047)	(0.047)					(0.050)	(0.052)		
$\mu_{t-2}^{(3)}$			0.068	0.066					0.011	0.013		
			(0.048)	(0.047)					(0.049)	(0.051)		
$\mu_{t-1}^{(4)}$					0.781***	0.762***					0.836***	0.814***
					(0.049)	(0.049)					(0.041)	(0.044)
$\mu_{t-2}^{(4)}$					0.170***	0.166***					0.121**	0.121**
					(0.051)	(0.051)					(0.049)	(0.049)
Observations	235	235	235	235	235	235	235	235	235	235	235	235
R-squared	0.977	0.977	0.935	0.935	0.870	0.873	0.977	0.977	0.935	0.936	0.871	0.874
$p(\chi^2)$	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-
$Q(5)$	0.968	0.975	0.923	0.904	0.929	0.887	0.879	0.883	0.985	0.984	0.989	0.986
$Q^2(5)$	0.161	0.955	0.984	0.994	0.933	0.927	0.161	0.187	0.955	0.981	0.933	0.875

Notes. ***,**,* denote significance level at .01, .05 and .1, respectively, based on robust OLS or SUR standard errors (in parantheses). $p(\chi^2)$ denotes the p-value for testing the null of independent error terms across the equations (Breusch-Pagan). A value below .05 favors the SUR specification (at .05). $Q(5)$ and $Q^2(5)$ denote the p-value for the Ljung-Box Q statistic for testing no autocorrelation in the error or squared error terms up to 5 lags, respectively.

Table 6: Does the Reserve Option Mechanism reduce the sensitivity of standard deviation, skewness, and kurtosis of USD/TL exchange rate expectations to common external factors?

	SUR						OLS					
	$\mu_t^{(2)}$		$\mu_t^{(3)}$		$\mu_t^{(4)}$		$\mu_t^{(2)}$		$\mu_t^{(3)}$		$\mu_t^{(4)}$	
ROM Intensity	-0.193***	-0.209***	-0.069**	-0.078**	-0.138	-0.242**	-0.236**	-0.259**	-0.075	-0.078**	-0.139	-0.231
	(0.048)	(0.052)	(0.031)	(0.031)	(0.085)	(0.101)	(0.085)	(0.115)	(0.034)	(0.038)	(0.109)	(0.170)
$C^{(2)}$	0.003	0.004***					0.005**	0.006**				
	(0.000)	(0.001)					(0.002)	(0.003)				
ROM Intensity * $C^{(2)}$		-0.004						-0.007				
		(0.006)						(0.013)				
$C^{(3)}$			0.001	0.002*					0.001	0.002		
			(0.001)	(0.001)					(0.001)	(0.002)		
ROM Intensity * $C^{(3)}$				-0.008						-0.004		
				(0.007)						(0.013)		
$C^{(4)}$					0.002	0.008**					0.003	0.008
					(0.001)	(0.003)					(0.003)	(0.007)
ROM Intensity * $C^{(4)}$						-0.049*						-0.044
						(0.026)						(0.056)
AMT	-0.003	-0.003	0.018	0.018	0.027	0.037	-0.005	-0.004	0.017*	0.017*	0.023	0.032
	(0.012)	(0.012)	(0.011)	(0.011)	(0.033)	(0.033)	(0.014)	(0.014)	(0.010)	(0.010)	(0.024))	(0.025)
FXS	0.014	0.014	-0.017	-0.017	-0.040	-0.040	0.010	0.011	-0.022***	-0.022***	-0.048	-0.046***
	(0.013)	(0.013)	(0.012)	(0.012)	(0.035)	(0.035)	(0.008)	(0.008)	(0.005)	(0.005)	(0.011)	(0.011)
$\mu_{t-1}^{(2)}$	0.869***	0.867***					0.918***	0.916***				
	(0.055)	(0.056)					(0.088)	(0.092)				
$\mu_{t-2}^{(2)}$	0.017	0.017					-0.056	-0.054				
	(0.056)	(0.056)					(0.105)	(0.107)				
$\mu_{t-1}^{(3)}$			0.906***	0.905***					0.985***	0.985***		
			(0.046)	(0.047)					(0.049)	(0.049)		
$\mu_{t-2}^{(3)}$			0.065	0.059					0.002	0.002		
			(0.047)	(0.047)					(0.050)	(0.050)		
$\mu_{t-1}^{(4)}$					0.775***	0.767***					0.839***	0.832***
					(0.048)	(0.049)					(0.043)	(0.043)
$\mu_{t-2}^{(4)}$					0.167***	0.154***					0.121	0.112**
					(0.051)	(0.052)					(0.051)	(0.050)
Observations	235	235	235	235	235	235	235	235	235	235	235	235
R-squared	0.977	0.977	0.934	0.935	0.870	0.871	0.977	0.977	0.936	0.936	0.871	0.872
$p(\chi^2)$	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-
$Q(5)$	0.980	0.972	0.914	0.915	0.913	0.922	0.932	0.911	0.988	0.989	0.990	0.988
$Q^2(5)$	0.752	0.922	0.985	0.993	0.940	0.914	0.752	0.481	0.985	0.985	0.940	0.911

Notes. ***,**,* denote significance level at .01, .05 and .1, respectively, based on robust OLS or SUR standard errors (in parantheses). $p(\chi^2)$ denotes the p-value for testing the null of independent error terms across the equations (Breusch-Pagan). A value below .05 favors the SUR specification (at .05). $Q(5)$ and $Q^2(5)$ denote the p-value for the Ljung-Box Q statistic for testing no autocorrelation in the error or squared error terms up to 5 lags, respectively.

Appendix A. Additional Figures

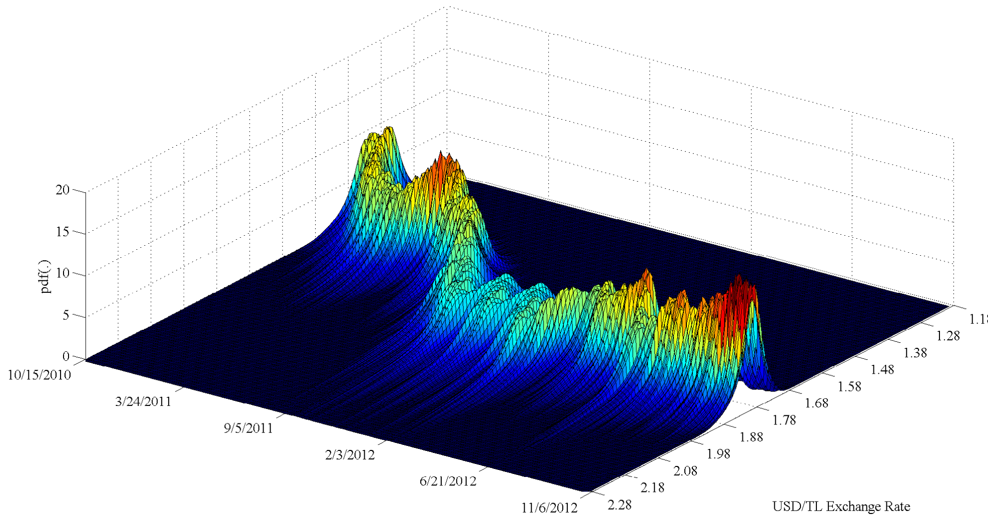

Figure A.1: The estimated risk-neutral probability distribution function of USD/TL exchange rate expectations.

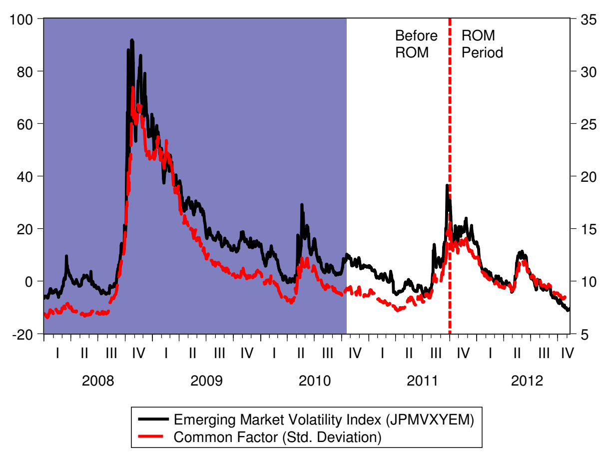

Figure A.2: The common factor for standard deviation ($C_t^{(2)}$) and emerging market volatility index.

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