Exports and Volatility of Exchange Rate Under Alternative Exchange Rate Regimes:The Case of Turkey

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Abstract

This paper aims to establish the links between exchange rate volatility, exports and exchange rate regimes in Turkey. Applying a nonlinear Markow Switching ARCH technique to monthly data spanning the period 1982:01-2006:12 we show that the periods of high exchange rate volatility generally match with the periods during which export performance is low and that the periods of low volatility generally correspond to the periods in which real export growth rates are high.

I.Introduction

In this paper we analyze the relationships between real exports and real exchange rate volatility and attempt to find out whether shifts in exchange rate volatility match with changes in the exchange rate regime in Turkey . This topic deserves investigation for several reasons.

First from a theoretical point of view, there is no clear-cut relationship between exchange rate volatility and trade flows. On the one hand, a number of studies argued that a rise in exchange rate volatility could increase the uncertainty of profits on contracts denominated in a foreign currency because hedging against exchange rate risk is costly or impossible and risk-averse and risk-neutral agents redirect their activity from higher risk foreign markets to lower risk domestic market. A large number of theoretical studies among those Clark (1973), Either (1973), Cushman (1983), Thursby and Thursby (1987) Peree and Steinherr (1989), Demers (1991), Chowdhury (1993), Caporale and Doroodian (1994), Gagnon (1993), Arize (1995) and Wolf (1995) provided empirical evidence. On the other hand, trade can benefit from higher exchange rate volatility and thus higher exchange rate risk. From this point of view trade can be considered as an option held by firms. Like any other option the value of trade can rise with volatility. In the theoretical model developed by Franke (1991), a firm evaluates the exit (entry) costs associated with leaving (entering) a foreign market against losses (profits) created by exports. Under a variety of behavioral assumptions, any given firm would benefit from an increase in exchange rate volatility since their expected cash flows from exports grow at a higher rate than their entry and exit costs. In line with this view, IMF (1984), De Grauwe (1988), Giovannini (1988), Franke (1991), Sercu and Vanhulle (1992) and Viaene and de Vries (1992) showed that exchange rate volatility might benefit trade. Furthermore McKenzie (1999) surveyed a large number of empirical papers on the topic. His survey of the empirical study showed no significant effect, or no systematic effect of exchange rate volatility on trade. The ambiguity of the theoretical predictions reinforces the importance of investigating this issue empirically.

Second, previous empirical works, which had investigated the links between exchange rate volatility and exports obtained different results for developed and developing countries. The studies focused on developed countries generally could not find any statistically significant relationship between export flows and exchange rate volatility. In contrast, recent studies on developing countries carried out by Doroodian (1999), Chou (2000), Achy and Sekkat(2001) provide evidence to support the hypothesis that exchange rate volatility has a negative effect on exports. If this hypothesis holds the volatility of exchange rate can have important implications for forecasting, modeling and evaluating the role of macroeconomic stabilization programs in those countries.

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Third, on the empirical ground, Turkey being a developing country appears a very good object of study. After having liberalized its external trade regime, Turkey pursued a successful export-led growth policies during the 1980s. In consequence, Turkey exports to GDP ratio increased from 5 to 18 percent over the period 1980-1988. During this period, Turkey put in place adjustable peg policy to support exports. The Turkish Lira was daily adjusted in the form of devaluations. According to Aşıkoğlu and Uçtum (1995), Civcir (1996) and Keyder (2002) the real exchange rate depreciated by 6 percent on average during this period. Besides the depreciation of the exchange rate, several tax incentives to exporters were the major forces of the export-led growth policy. After that period, the export performance of Turkey slowed down mainly due to a slow depreciation of Turkish real exchange rates. The part of exports in GDP reduced from 16 percent to 13 percent during the period 1989-1993. In 1994, Turkey experienced a major financial crisis. Turkish government announced a stabilization program and a stand-by arrangement was approved by the International Monetary Fund. At the end of year 1999, Turkish Government put into effect an Exchange Rate Stabilization plan designed by IMF. The aim of the stabilization plan was to reduce inflation from two digits (60 -70 % per annum) to single digits. The Exchange Rate Stabilization plan adopted a crawling peg regime, according to which the percent change in the Turkish Lira value of a basket of foreign exchanges (1 US dollar plus 0.70 Euro) is fixed for a period of a year and half. However the plan failed in November 2000 and February 2001 and Turkey encountered the most important financial crisis since 1945. Aftermath of the financial crisis, Turkey adopted floating exchange rate regime and implemented an implicit inflation targeting policy. Despite the financial crises faced in 1994, 2000 and 2001, exports to GDP ratio increased steadily since 1994, from around 21 percent to 30 percent in 2006.

In a recent study Özbay (1999) investigated the effects of exchange rate uncertainty on Turkish exports over the period 1988Q2-1997Q2. Özbay measured the volatility by applying the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) technique to quarterly data for a relatively short period. However the GARCH technique requires using of high frequency data. Furthermore, as pointed out by Hamilton and Susmel(1994) GARCH models may impute a lot of persistence to volatility and provide relatively poor forecasts.
In this study we attempt to overcome these problems by applying Markow-Switching ARCH technique (MS-ARCH) to monthly data spanning the period 1982:1 2006:12.

To the best of our knowledge this study is the first utilizing the bivariate Markov Switching Autoregressive Conditional Heteroscedasticity econometric technique in this context. We suggest that exports process is governed by two unobserved regimes or states: In the first state, export performance may be high and in the second regime it may be poor. We can also view the exchange rate as being characterized by the episodes of high and low volatility. The episodes of high and low volatility can also be associated with two unobserved states: high volatility and low volatility states. To connect export flows to exchange rate volatility we further assume that the phases of export flows and those of exchange rate are governed by the same fundamentals and the shifts in exchange rate volatility states take place before the shifts in export states. Thus the effect of an unanticipated change in exchange rate on trade flows is delayed.

Our objective in this study is twofolds. First we analyze the effects of exchange rate volatility on Turkish exports. Second we investigate whether the volatility changes in exchange rate correspond to changes in the exchange rate regime in Turkey.

We expect that, exchange rate may have adverse effects on exports flows during the episodes of high volatility, while it may have no (or insignificant) effect on export flows during the periods of low volatility. Our expectation is based on the fact that trade is not option for Turkish firms.

The rest of the paper is organized as follows: Section II introduces the econometric methodology of this study. Data and stationarity analysis are given in Section III. Section IV illustrates empirical results obtained from MS-ARCH models. Section V provides empirical findings concerning the relations between exchange rate regimes and exchange rate volatility. Finally Section VI concludes

II.Methodology

This study examines the links between real exchange rate volatility and real exports using a non-linear bivariate Markow Switching Autoregressive Conditional Heteroscedasticity model. MS-ARCH model was originally developed by Hamilton and Lee (1996). The model allows us to estimate simultaneously the conditional variance of exchange rate (a measure of volatility) for each observation in the sample and the effects of exchange rate volatility on real exports. In this paper we model the conditional mean of real exports employing the following 2-regime Markow switching model

$$y_t=z_t+\mu_{s_t^{exp}} \tag{1}$$

where we assume that z_t is generated by an autoregressive process of order p:

$$z_t=\alpha_1 z_{t-1}+......\alpha_p z_{t-p}+u_t \quad \text{and} \quad u_t \sim \text{i.i.d } N(0,\sigma^2) \tag{2}$$

The variable y_t in equation (1) denotes real exports. s_t^{exp} is an unobserved random variable and it represents "the state" of export performance. We assume that the random variable s_t^{exp} takes only the values 1 or 2: (s_t^{exp}) takes the value 1 when export performance is high and takes the value 2 when export performance is low. Thus $\mu_{s_t^{exp}}$ denotes the parameter μ_1 when the process is in the state 1 represented by $s_t^{exp}=1$ and it denotes μ_2 when $s_t^{exp}=2$. As indicated in equation (2), the deviations from mean (z_t) are modeled as a first order autoregressive process and its innovation u_t is assumed to have a zero average and a constant variance. We assume that the unobserved random variable s_t^{exp} can be described by a following Markov chain

$$\text{Prob}(s_t^{exp}=j \mid s_{t-1}^{exp}=i)=p_{ij}^{exp}, \ i,j=1,2. \tag{3}$$

where p_{ij}^{exp} indicates the probability of moving from state i to state j. We further assume that the transition probabilities are fixed.

After having modeled real exports we turn to exchange rate volatility specification. For this purpose we adopt Hamilton and Susmel's (1994) Markov switching ARCH (MS-ARCH) specification. Representing the conditional mean of real exchange rate by an AR(p) process and the conditional variance of real exchange rate by an ARCH(q) process, a 2-state MS-ARCH specification can be written as follows[1]:

$$EXR_t=\beta_0+\beta_1 EXR_{t-1}+......\beta_p EXR_{t-p}+\varepsilon_t \tag{4}$$

$$\varepsilon_t=\sqrt{\lambda_{s_t^{exr}}}\,\tilde{v}_t \tag{5}$$

$$\tilde{v}_t=\sqrt{h_t}\,\eta_t \tag{6}$$

$$h_t=\phi_0+\phi_1\tilde{v}_{t-1}^2+........\phi_q\tilde{v}_{t-q}^2 \tag{7}$$

where η_t in equation (6) is assumed to be i.i.d N(0,1). The term s_t^{exr} is an unobserved random variable that stands for the volatility phase of exchange rate. The random variable s_t^{exr} takes the value 1 when exchange rate volatility is high and takes the value 2 when the volatility of exchange rate is low. The variable $\tilde{v}_t$ is multiplied by the scale factor $\sqrt{\lambda_{s_1^{exr}}}$ when $s_t^{exr}=1$ and by $\sqrt{\lambda_{s_2^{exr}}}$ when $s_t^{exr}=2$.

Note that the scale factor for the first state $\sqrt{\lambda_{s_1^{exr}}}$ is normalized at unity so that $\sqrt{\lambda_{s_2^{exr}}}$ can be interpreted as the ratio of the average variance of exchange rate in high volatility state compared to that observed in low volatility state. The intuition behind this is to model changes in regime as changes in the scale of the process.

As argued above, in order to link export flows to exchange rate volatility we further assume that the phases of export flows and those of exchange rate are governed by the same fundamentals and the shifts in exchange rate volatility states take place before the shifts in exports states($s_t^{exp}=s_{t-1}^{exr}$). This can be explained by the fact that most international transactions are realized after a time lag and contracts are generally denominated in one of the major currencies.

The phases of the stock market and that of monetary policy can be connected by an unobserved random variable (s_t), which follows a Markov Chain. This unobserved random variable (s_t) (the "state" of the economy) is supposed to determine both the mean of real exports and the scale of exchange rate volatility. Using the assumption that ($s_t^{exp}=s_{t-1}^{exr}$) we can describe the unobserved random variable random variable s_t as follows:

$$\begin{aligned} s_t&=1 \text{ if } s_t^{exr}=1 \text{ and } s_{t-1}^{exr}=1\\ s_t&=2 \text{ if } s_t^{exr}=2 \text{ and } s_{t-1}^{exr}=1\\ s_t&=3 \text{ if } s_t^{exr}=1 \text{ and } s_{t-1}^{exr}=2 \end{aligned} \tag{8}$$

[1] This a restricted version. More general form of MS-ARCH is considered in Klaassen(1999).

$s_t=4$ if $s_t^{exr}=2$ and $s_{t-1}^{exr}=2$

Using the above assumptions, the unobserved random variable s_t follows a four-state Markov chain with the following transition probabilities:

$$P=\begin{bmatrix} p^{exr}_{11} & 0 & p^{exr}_{11} & 0 \\ p^{exr}_{12} & 0 & p^{exr}_{12} & 0 \\ 0 & p^{exr}_{21} & 0 & p^{exr}_{21} \\ 0 & p^{exr}_{22} & 0 & p^{exr}_{22} \end{bmatrix} \qquad (9)$$

where p_{ij} =Prob (s_t=j| s_{t-1}=i)=Prob(s_t^{exr} =j| s_{t-1}^{exr} =i)= p^{exr}_{ij}, j=1,2.

To take the interactions between exchange rate volatility and exports into account, we combine the Markov Switching model of exports equations (1) – (3) with the Markov Switching Autoregressive Conditional Heteroscedasticty model of exchange rate volatility equations (4)-(7). The resulting model is estimated by the Maximum Likelihood method using BFGS numerical optimization algorithm as described in Hamilton and Lin (1996),

III.Data and Stationarity Analysis

To study the relationships between exports and exchange rate volatility we use monthly data spanning the period 1982:1-2006:12. Real exports are obtained using Turkish consumer price index as a deflator[2]. To measure the real exchange rate we use trade weighted consumer price indexes of five major trading partners of Turkey. All variables are expressed in logarithm. The data are obtained from IMF's International Financial statistics and Turkish Central Bank database. Figure 1 illustrates real exchange rate and real exports in logarithmic form. Real exchange rate and real exports series seem to be non-stationary. To make the series stationary we take their first difference. The augmented Dickey-Fuller test results shown in table 1 indicate that the first difference of the series in logarithm (i.e the growth rate) is stationary at 1% level of significance.

IV.Empirical results

In this study we estimate four MS-ARCH specification with p=1 to 2 AR terms, q=1 ARCH term and with Normal and Student t errors[3]. The innovations obtained from real exchange rate equation with AR(1) and AR(2) specifications have a large kurtosis (13.22 and 13.04 respectively). This can reflect the fact that the tails of the distributions of these innovations are fatter than the tails of the normal distribution.

The estimation results with different MS-ARCH specifications are illustrated in table 2. The terms LR values at the bottom of table 2 indicate Hansen's (1992, 1996) standardized likelihood ratio statistic. According to LR test statistics we can reject the null hypothesis of linearity in favor of regime switching.

The estimated values of λ_2 indicate how much the variance of real exchange rate in state 2 (high volatility state) is higher than that of state 1(low volatility state). We can see that the

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[2] The wholesale or producer price indexes are not available for a long period.

[3] For instance MSARCH-N(2,1) means MS-ARCH specification with AR(2) and ARCH(1) terms and with normal distribution

values of λ_2 obtained with MSARCH-N(1,1) and MSARCH-t(1,1) are seven times higher than those obtained with MSARCH-N(2,1) and MSARCH-t(2,1) specifications.

The estimated values of μ_1 and μ_2 represent the average growth rate of real exports in state 1 and in state 2 respectively[4]. It turns out that the average growth rates of real exports are positive in state 1 and they are negative in state 2 for all MS-ARCH models. The transition probabilities (p_{11}^{exr} and p_{22}^{exr}) obtained from MS-ARCH models are shown in rows 6 and 7 of table 2. For example the first element of row 6 (0.63) indicates the probability that state 1 is followed by state 1.In other words it shows that the probability of export performance being high when exchange rate volatility is low is 0.63. Likewise the probability of export performance being low when exchange rate volatility is high is equal to 0.58 for the first MSARCH model. According to these probabilities the first state or regime tends to last on average 1/(1-0.62)=2.70 month while the second state lasts on average 1/(1-0.58)=2.38 month. Thus the duration of state 1 is higher than that of state 2.This result is consistent with theoretical expectations.

Using the transition probabilities we can also compute the ergodic probabilities for each regime. The ergodic probabilities for state 1 and state 2 can be computed as follows:

$$\text{Prob}(s_t^{exr}=1)=\frac{1-p_{22}^{exr}}{2-p_{11}^{exr}-p_{22}^{exr}}=\frac{1-0.63}{2-0.58-0.63}=0.46$$

$$\text{Prob}(s_t^{exr}=2)=1-\text{Prob}(s_t^{exr}=1)=0.54$$

These probabilities show that the economy being in state 1 (i.e low volatility and high export performance state) at any given date is 0.46 and in state 2 is 0.54.

The smoothed probabilities obtained from MS-ARCH models are illustrated on figures 2-5.The second graphic in figures 2-5 shows the probabilities that economy is in the high volatility and low export performance state at date t. Similarly the third graphic in these figures indicates the probabilities that economy is in the low volatility and high export performance state at date t. Comparison of real exchange rate growth graphics (the first graphic in figures 2-5) with the smoothed probabilities graphics suggests that the periods of high volatility in real exchange rate corresponds to the periods of low export performance and vice-versa in most of the cases. Therefore we can argue that the high volatility of real exchange rate is a leading cause of low export performance.

V.Exchange rate and Exchange rate volatility

In this sub-section we try to find out the effects of different exchange rate policy adopted in Turkey on exchange rate volatility. According to " De jure" exchange rate classification, Turkey adopted adjustable peg policy between 1981-1999 and crawling peg policy between 1999-2001. Since 2001, Turkey has implemented free floating exchange rate policy (Kasman and Ayhan, 2006). To find out the effects of different exchange rate policies on exchange rate volatility we construct two dummy variables and regress the volatility estimated from MS-ARCH models on these dummy variables. The variable DUMFF takes the value 1 for the period 2001:3-2006:12 and takes zero otherwise. The variable DUMCP takes the value 1 for the period 1999:12-2001:2 and takes zero otherwise.We estimate the following regression model using different exchange rate volatility measures.

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[4] Because we employ the first difference of real exports in logarithm.

$$VOL_t = a + b_1\ DUMCP_t + b_2\ DUMFF_t + e_t \quad (10)$$

The regressions are carried out using ordinary least squares. The results obtained are illustrated on table 3. The coefficients on DUMCF are negative and statistically significant in all regressions while the coefficients on DUMFF are positive and statistically insignificant. In addition the intercept terms which represent the effect of adjustable peg regime on exchange rate volatility are positive and statistically significant. These findings suggest that crawling peg regime is more favorable regime for diminishing the volatility of real exchange rate in Turkey and that free flaoting regime does not have significant effect on exchange rate volatility. However from this finding we can not conclude that crawling peg regime is an appropriate regime for Turkey. It should be noted that since the adoption of free floating regime, although the central bank of Turkey does not target the level of exchange rate, it intervenes into exchange rate market to control exchange rate volatility. Thus the central bank interventions can offset the unfavorable effects of free floating exchange rate regime on exchange rate volatility. This explains the unprecedented rise of Turkish real exports since 2001 as shown in figure 1.

VI.Conclusion

This study investigated the links between Turkish real exports and real exchange rate volatility using a two state MS-ARCH model. The results obtained from different MS-ARCH models indicate that the episodes of high exchange rate volatility correspond to the periods of negative real export growth and that the periods of low volatility generally match with the periods in which real export growth rates are positive. In addition regressions of the estimated exchange rate volatility on exchange rate regime dummies show that adjustable peg and free floating exchange rate regimes cause an increase in exchange rate volatility and crawling peg regime decreases the volatility. These findings can have important implications for exchange rate policy to be adopted in Turkey. To promote export growth Turkey can adopt an exchange rate policy aiming to control or reduce the volatility of exchange rate. In this respect Turkey's free floating exchange rate policy adopted since 2001 seems to be an appropriate policy because not only does it target inflation but also it aims to control exchange rate policy.

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Table 1. ADF test results

	τ(No intercept no trend)	τ_{μ} (Intercept)	τ_{t} (Intercept and Trend)
Ln(REXR)	-1.07	-2.57	-3.09
Ln(REXP)	1.93	-0.67	-2.84
ΔLn(REXR)	-19.77***	-19.74***	-19.71***
ΔLn(REXP)	-5.67***	-6.04***	-6.02***

REXR:Real Exchange Rate, REXP:Real Exports
***: Test statistics are significant at 1 % level of significance

Table 2. MS-ARCH Results

	MSARCH-N(1,1)	MSARCH-N(2,1)	MSARCH-t(1,1)	MSARCH-t(2,1)
β_0	-0.033***	-0.0351***	-0.0326***	-0.0335***
	(0.00816)	(0.009)	(0.00813)	(0.0088)
β_1	0.963***	0.793***	0.962***	0.796***
	(0.01092)	(0.0673)	(0.0110)	(0.0654)
β_2	-	0.167**	-	0.165***
		(0.0648)		(0.063)
ϕ_0	0.00296***	0.00332***	0.00267***	0.00290***
	(0.000784)	(0.00085)	(0.000837)	(0.0012)
ϕ_1	0.512***	0.463***	0.480***	0.447***
	(0.160)	(0.141)	(0.211)	(0.0672)
p_{11}^{exr}	0.63	0.585	0.778	0.707
	(0.352)	(0.28)	(1.27)	(0.726)
p_{22}^{exr}	0.58*	0.615*	0.503	0.485
	(0.351)	(0.33)	(0.55)	(0.570)
λ_2	7.63***	1.26***	7.69***	1.03***
	(0.037)	(0.034)	(0.077)	(0.081)
μ_1	0.0279	0.0359**	0.0315**	0.0343**
	(0.0175)	(0.020)	(0.0132)	(0.0145)
μ_2	-0.0237	-0.0311	-0.145***	-0.124***
	(0.0313)	(0.0378)	(0.0499)	(0.0454)
α_1	-0.4664 ***	-0.618***	-0.9282***	-0.948***
	(0.1696)	(0.188)	(0.152)	(0.154)
LR	9.470**	9.942**	17.554***	18.571***

MSARCH-N(1,1): MS-ARCH specification with 1 AR and ARCH terms and with normal distribution
MSARCH-N(2,1): MS-ARCH specification with 2 AR and 1 ARCH terms and with normal distribution
MSARCH-t(1,1): MS-ARCH specification with 1 AR and ARCH terms and with student t distribution
MSARCH-t(2,1): MS-ARCH specification with 2 AR and ARCH terms and with student t distribution
* Statistics are significant at 10 % level of significance
** Statistics are significant at 5 % level of significance
*** Statistics are significant at 1 % level of significance
The numbers in parentheses are standard errors

Table 3.Volatility regressions

	$VOL_{MSARCH-N(1,1)}$	$VOL_{MSARCH-N(2,1)}$	$VOL_{MSARCH-t(1,1)}$	$VOL_{MSARCH-t(2,1)}$
a	0.0035	0.0033	0.0036	0.0034
	(0.00017)***	(0.00023)***	(0.00019)***	(0.00018)***
b_1	-0.0011	-0.00089	-0.0010	-0.00091
	(0.00038)***	(0.00023)***	(0.00024)***	(0.00023)***
b_2	0.00061	0.00061	0.00085	0.00084
	(0.0010)	(0.00085)	(0.0011)	(0.00099)

$VOL_{MSARCH-N(1,1)}$:Volatility estimated from MSARCH-N(1,1) model
$VOL_{MSARCH-N(2,1)}$:Volatility estimated from MSARCH-N(2,1) model
$VOL_{MSARCH-t(1,1)}$:Volatility estimated from MSARCH-t(1,1) model
$VOL_{MSARCH-t(1,1)}$:Volatility estimated from MSARCH-t(1,1) model
*** Statistics are significant at 1 % level of significance
The numbers in parentheses are standard errors

Figure1: Real Exchange Rate and Real Exports

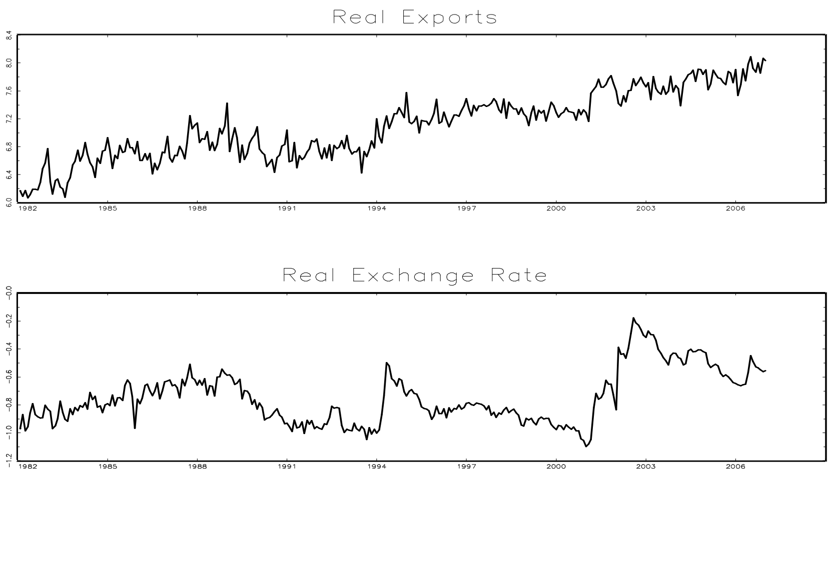

Figure 2 :MS-ARCH(1,1)-Normal

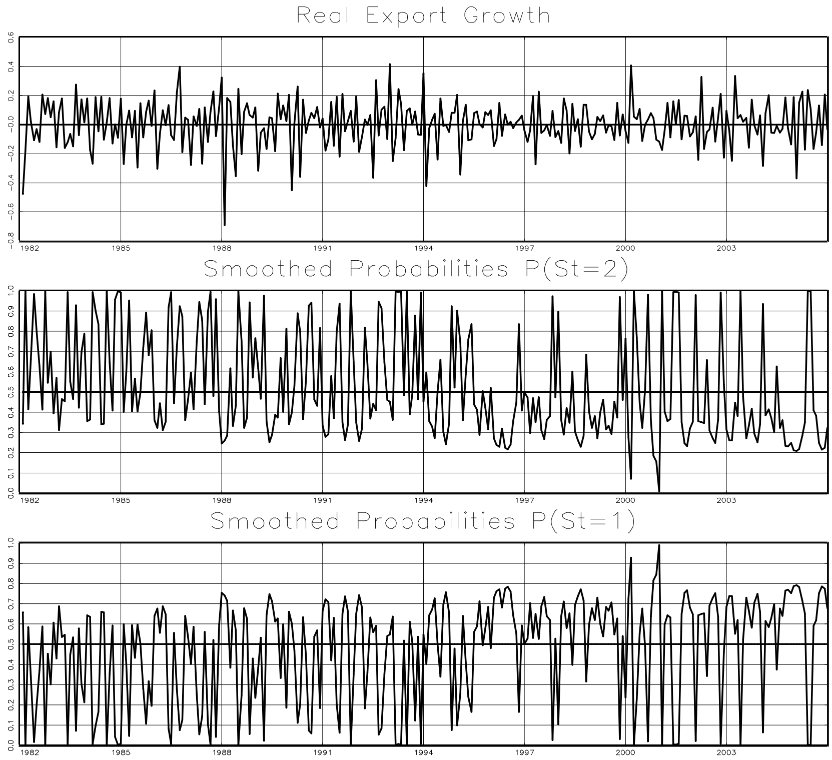

Figure 3 :MS-ARCH(2,1)-
Normal

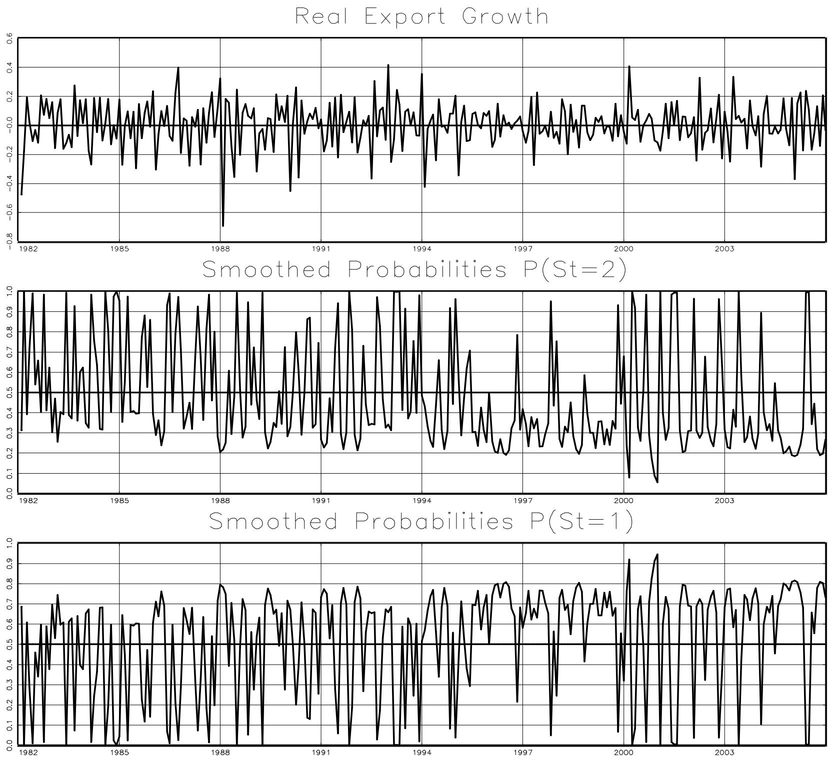

Figure 4 :MS-ARCH(1,1)-t distribution

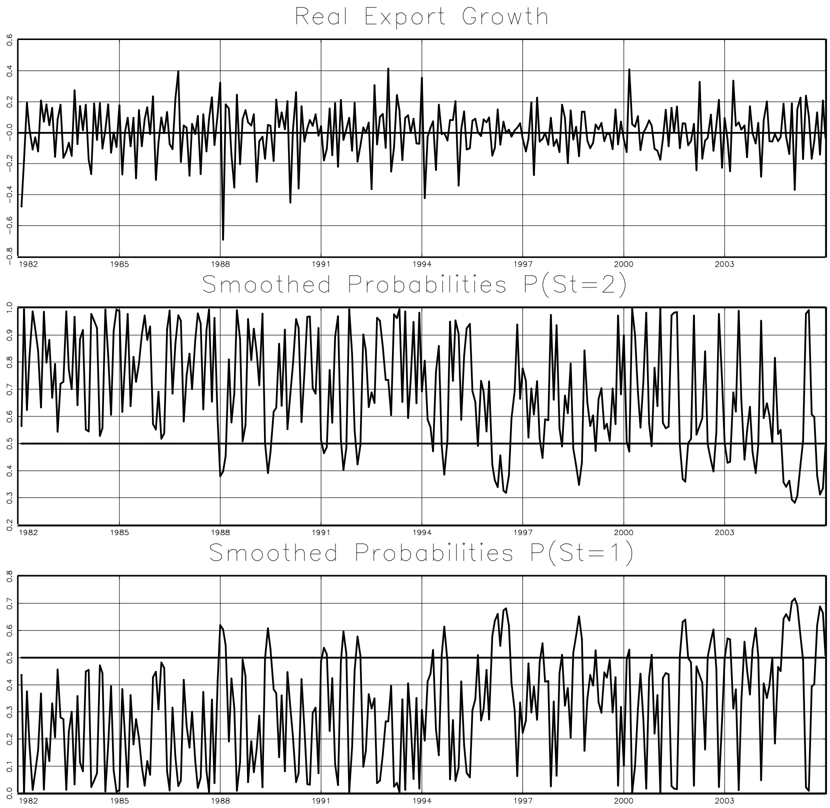

Figure 5 :MS-ARCH(2,1)-t distribution