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GDP Volatility Spillovers from the US and EU to Turkey: A Dynamic Investigation

P. Fulya Gebeşoğlu[*] - *Hasan Murat Ertuğrul*[**]

Abstract

Our paper examines the dynamics of GDP volatility spillover from the US and the EU to Turkey. The associated volatilities are derived through the SWARCH (switching autoregressive conditional heteroscedasticity) model, proposed by Hamilton and Susmel (1994). We use the Kalman filter to analyze these spillover effects between first-quarter 1995 and fourth-quarter 2013. We identify significant cross-country spillover effects from the US to Turkey, especially during global financial crises. However, we do not find any notable volatility spillover from the EU to Turkey.

JEL Codes: E32, F41

Keywords: GDP volatility spillover, ARCH, Kalman filter, spillover effect

[*] Undersecretariat of Treasury, Ankara, Turkey. fulya.ozorhan@hazine.gov.tr
[**] Undersecretariat of Treasury, Ankara, Turkey. murat.ertugrul@hazine.gov.tr

1. Introduction

The deleterious effects of globalization have been in the spotlight for the last few decades. In particular, a series of reverberating outward crises, ranging from the October 1987 stock-market crash in the US through the ERM crisis of 1992 in Europe to the Latin American breakdowns of 1994 have served to draw attention to the concept of spillover and contagion effects.[1] Recently, the profile of this concept rose even higher in the wake of the global financial crisis of 2008 and 2009. Although conventional wisdom holds that globalization is the main driver of macroeconomic co-movements across the globe, the impact of trade activities and financial integration on macroeconomic volatility is ambiguous.[2]

For instance, greater integration does not necessarily induce synchronization if integration is primarily associated with increased specialization (Köse, Otrok, Prasad, 2008). In other words, the nature of globalization, as well as the specific properties of the shocks being considered, determines the net effects of spillovers. Nevertheless, the correct identification of spillovers remains important, given their contribution to a country's economic volatility (Carare, Mody, 2010). Therefore, an in-depth analysis of the prevailing spillover effects is required in order to identify the origins of GDP volatility and design effective policy prerequisites for minimizing the risks that are associated with globalization.

There is voluminous literature on the effects of cross-border economic interdependencies. Specifically, much has been written about contagion and spillover propelling business-cycle synchronization.[3] However, a concrete measure of causality has proven elusive in light of the growing influence of common factors (such as supply shocks or global financial turmoil) that also affect business-cycle synchronization. Hence, an assessment of volatility spillover is crucial if we are to understand its transmission mechanisms and the details of its dynamics.

There is consensus in the empirical literature on the existence of spillover effects, although their magnitude is left to be speculated about. This is so

[1] Although there are different definitions for the concepts of spillovers and contagion effects, the distinction usually focuses on the unanticipated nature of contagion, whereas interdependencies and spillovers are often perceived as expected (Masson, 1999, and Pericoli and Sbracia, 2003). Throughout our paper, contagion and spillover effects are used interchangeably, both meaning co-movements of macroeconomic indicators.

[2] Krugman (1993), Razin and Rose (1994), Mendoza (1994), Baxter and Crucini (1995), Easterly, Islam, and Stiglitz (2001), and Bekaert, Harvey, and Lundbland (2002).

[3] Köse et al. (2003); Perez et al. (2003); Stock and Watson (2005).

due to the variability of the result with respect to the model specifications, country- or region-specific samples, and the time span chosen. Another vein in the literature focuses on the transmission channels conveying the spillover effects.[4] In practice, the main culprits here have been the rising share of international trade, global capital flows, and the contagious nature of the herding mentality accompanying financial speculation. For their part, Helbling et al. (2007) and Bagliano and Morana (2011) argue that the trade channel appears to be the top transmission mechanism for US GDP volatility spillovers to the rest of the world, whereas Bayoumi and Swiston (2009) emphasize financial transfers.

Although it is inarguable that trade linkages generate both demand- and supply-side spillovers, the degree to which this is true depends on the specialization of production, which, in turn, is based on the comparative advantages of the trade partners being considered (Köse, Otrok, Prasad, 2008; Baxter and Kouparitsas, 2005). As for the herding behavior of financial agents, this might well incite spillover effects as much as the two other factors. This is especially the case for small open economies like Turkey that rely heavily on capital inflows to power their economic growth. Therefore, as one such country, Turkey's reliance on foreign capital rather than domestic savings to boost investment points to a major source of vulnerability to international spillover effects. The goal of reducing this vulnerability provides us with the motivation to investigate the details of volatility spillovers from the US and the EU to Turkey.

Studies of Turkey typically concentrate on first moments (mean). Business-cycle linkages among the economies of the US, the EU, and Turkey were examined previously by Sayek and Selover (2002), where the VAR model was used to seek business-cycle transmissions between Turkey and the EU. As one of Turkey's largest trading partners, Germany was chosen as a proxy for the EU. The authors performed the same analysis on both annual and quarterly data, with the data of the former covering 1956-1998 and the latter 1981-1998. They concluded that the business cycles of Turkey and the EU were separate, despite the structural-vector-autoregression analysis pointing to moderate transmission from Germany to Turkey. Furthermore, no Granger causality was identified, so it was decided to categorize Turkey as a country more subjected domestic economic and political phenomena than foreign ones.

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4 Masson (1999), Kaminsky and Reinhart (2000), Pritsker (2001), Karolyi (2003), Pericoli and Sbracia (2003), Claessens, Dornbusch and Park (2001), and Kaminsky, Reinhart, and Vegh (2003).

Likewise, Berument, Kılınç, and Yücel (2005) analyzed the synchronization of the business cycles between Turkey and the EU. They focused on the cyclical component of the monthly industrial-production indices of both parties, which yielded a cross-correlation pattern. This indicated countercyclical linkages between Turkish and European business-cycle dynamics, which implied that the EU's timing of its implementation of its economic policies (in order to decrease the volatility of output) may have actually increased the output volatility for Turkey. On the other hand, when only the data for non-crisis periods of Turkey are considered, a pro-cyclical linkage is revealed between the Turkish and the European economies.

Akkoyun, Günay, and Doğan (2012) looked at the co-movements of business cycles in Turkey, the EU, and the US by using a wavelet method enabling the decomposition of cycles into different frequencies. They stated that the contention of trade relations being a direct transmission channel did not hold up as expected: the correlation between EU and Turkish cycles was no higher than that between the US and Turkey. Although the authors found something of note in the post-2001 period—a major advance in businesscycle correlations between Turkey, the US, and the EU—which they explained as a sign of the structural transformation going on in the Turkish economy during that time, determining true patterns of correlation must be left to future researchers.

Özkan and Erden (2014) scrutinize the international transmission mechanisms arising from the business cycles in Turkey with the Longest Common Subsequence (LCS) method. Industrial-production indices of 32 countries are decomposed into business-cycle components with the application of an HP filter; the countries are then clustered with respect to their degrees of business-cycle synchronization. The US, Japan, the UK, Canada, and South Korea are found to be the leading transmitters of their business cycles to Turkey.

We examine the dynamics of GDP volatility spillover from the US and the EU to Turkey, and, unlike our predecessors in the recent literature, focus on the second moment (conditional heteroscedasticity) for determining the transmission effect. The associated volatilities are derived from the SWARCH (switching autoregressive conditional heteroscedasticity) model, which has superior properties to conventional ARCH-type models. Then, we use the Kalman filter to measure the time-varying volatility spillover of GDP growth rates among the US, the EU, and Turkey over the period from first-quarter 1995 to fourth-quarter 2013.

The rest of the paper is organized as follows: Section 2 provides the data and the methodology. Section 3 presents the empirical results. Section 4 is the conclusion.

2. Data and Methodology

Quarterly GDP data from Turkey, the US, and the EU (15 of the 28 member countries) for the relevant period are obtained from the OECD database.

We decide on the SWARCH model, in which the parameters of the ARCH process are allowed to vary over time, as proposed by Hamilton and Susmel (1994), to model GDP growth volatility.

Despite their widespread mention in the empirical literature, the ARCH-type models are criticized as deficient for their high persistence. Hamilton and Susmel (1994) claimed that the structural change in the ARCH process might explain its poor forecasting performance and high persistence in its models. This spurred them to develop a specification that would allow ARCH-model parameters to occasionally change. Furthermore, the SWARCH model captures the time-series properties of dramatic events in an economy, such as a stock-market crash, more realistically. The SWARCH model, in which volatility depends on past news and the present state of the economy, outperforms other ARCH models with respect to econometric model-selection criteria and forecast performances (Susmel, 1999), (Ertuğrul and Öztürk, 2013).

SWARCH models are also found to be better than traditional ARCH-type models for different financial-market segments, including exchange rates for Beine et al. (2003), Cheung and Erlandsson (2005), and Gür and Ertuğrul (2012), and interest rates for Cai (1994). They have value for GDP volatility modeling as well, including Rashid and Karaarslan (2013), Chen (2006), and Bhar and Hamori (2003).

Hamilton (1989) suggested the following regime-switching model for the conditional mean

$$y_t = \mu_t + \tilde{y}_t \tag{1}$$

where μ_{s_t} denotes the parameter μ_1 when the process is in the regime represented by $s_t = 1$, while μ_{s_t} indicates μ_2 when $s_t = 2$, and so on. The variable $\tilde{y}_t$ was assumed to follow a zero-mean q^{th} order autoregression:

$$\tilde{y}_t = \varphi_1 \tilde{y}_{t-1} + \varphi_2 \tilde{y}_{t-2} + ... + \varphi_q \tilde{y}_{t-q} + \mu_t \tag{2}$$

In the SWARCH framework, the error process is described by the following equations,

$$\mu_t = \sqrt{g_{st}}\tilde{\mu}_t , \tag{3}$$

Here $\tilde{\mu}_t$ is assumed to follow a standard ARCH process,

$$\tilde{\mu}_t = h_t v_t \tag{4}$$

with v_t, a zero mean, unit variance i.i.d. sequence, and

$$h^2{}_t = a_0 + a_1\tilde{\mu}^2{}_{t-1} + a_2\tilde{\mu}^2{}_{t-2} + ... + a_q\tilde{\mu}^2{}_{t-q} \tag{5}$$

The underlying $ARCH(q)$ variable $\tilde{\mu}_t$ is then multiplied by the constant $\sqrt{g_1}$ when the process is in the regime represented by $s_t = 1$, multiplied by $\sqrt{g_2}$ when $s_t = 2$, and so on. We can say that μ_t in (3) follows the state K, q^{th} order Markov-switching ARCH process, denoted as $SWARCH(K, q)$ (Hamilton and Susmel, 1994 and Özün and Ertuğrul 2014).

In this study, it is assumed that there are two volatility states: low volatility $(state1)$ and high volatility $(state2)$. Hence, the transition-probability matrix is simplified to:

$$\mathrm{P} = \begin{bmatrix} \mathrm{P}_{11} & \mathrm{P}_{12} \\ \mathrm{P}_{21} & \mathrm{P}_{22} \end{bmatrix} \text{ where . } \sum_{j=1}^{2} p_{ij} = 1.$$

After obtaining the volatility series of GDP growth for Turkey, the US, and the EU, we investigate dynamic spillover relationship between output growth volatilities by working with the Kalman Filter model. In this way, we uncover the spillover relationship between GDP growth volatilities through the use of second moments (variance) instead of mean variables, as in the paper of Özün and Ertuğrul (2014). Then we take a dynamic approach with the Kalman Filter method—based on recursive estimation—to detect the statistically significant spillover relationship between output growth volatilities (Ertuğrul and Öztürk, 2013).

We rely on Harvey (1989), who introduced the Kalman filter to the state-space approach. In fact, the Kalman filter is based on the form of state-space representation. A linear state space of the dynamics of an equation can be represented as

$$y_t = c_t + Z_t a_t + \varepsilon_t \tag{6}$$

$$a_{t+1} = d_t + T_t a_t + \vartheta_t \tag{7}$$

where in our case a_t is the vector of unobserved state variables, where, c_t, Z_t, d_t and T_t are adaptable vectors and matrices, and where ε_t and ϑ_t are vectors of mean zero, Gaussian disturbances. As stated in equation (7), the unobserved state vector a_t is assumed to change over time as a first-order vector auto-regression.

3. Results

3.1 The SWARCH Model

The results of the SWARCH (2, 1) model (with 2 states and ARCH of order 1) estimations for GDP growth in Turkey, the US, and the EU are presented in Table 1 below.

Table 1. SWARCH (2, 1) Model Results

Variable	**Turkey**	**The US**	**The EU**
Mean Equation			
Constant	0.039**	0.099**	0.024**
Y*t-1*	0.222*	0.327*	0.554*
Constant	0.170**	0.110**	0.089*
ε_{t-1}^2	0.544*	0.426*	0.320*
P^{11} **	0.93*	0.61*	0.91*
P^{22} **	0.99**	0.99*	0.99**
g_2 ***	5.821	7.606	4.152
Log-Likelihood	-102.708	-64.621	-70.549

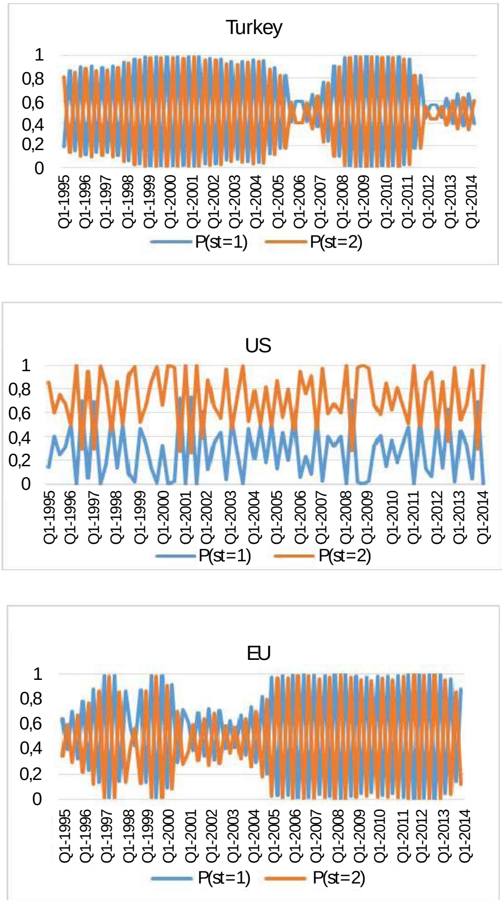
* 1% significance level and ** 5% significance level

** P^{11} and P^{22} show transition probabilities

*** g_2 shows scale coefficients

The coefficients are statistically significant, and the stability conditions specific to SWARCH models are also met.[5] Smoothed probability graphs for every model are presented in Figure 1.

Figure 1. Smoothed Probability Graphs for Turkey, the US, and the EU



5 In order to check the nonlinearity of the growth-rate variables before SWARCH modeling, we first conduct the BDS test. BDS test results show nonlinearities at the variables. For an additional nonlinearity check, we define an AR/MA structure for all the variables and check the ARCH effect by running the ARCH-LM test. We find ARCH effects for all the variables. These results could suggest time-varying effects. The test results are available from the authors upon request.

3.2 The Kalman Filter Results

Having determined GDP growth volatilities, we examine the dynamic spillover relationship between them with the Kalman Filter model. First, we study the effects of US GDP volatility alone on Turkey's GDP volatility; then we investigate both US and EU GDP volatilities affect Turkey's.[6]

The Kalman Filter specifications that were central to our study of volatility spillovers are presented below in equations (8-11).

$$VOL\_TURKEY_t = a_0 + a_{1,t} VOL\_US_t + \varepsilon_t \tag{8}$$

$$a_{i,t} = a_{i,t-1} + v_{i,t} \tag{9}$$

$$VOL\_TURKEY_t = a_0 + a_{1,t} VOL\_US_t + a_{2,t} VOL\_EU_t \varepsilon_t \tag{10}$$

$$a_{i,t} = a_{i,t-1} + v_{i,t} \tag{11}$$

In Eq. (10), the $a_{2,t}$ coefficient is statistically insignificant.[7] Both in Eq. (8) and Eq. (10), $a_{1,t}$ coefficients are statistically significant.[8] Figure 2 shows dynamic (time-varying) $a_{1,t}$ coefficients in Eq. (8) and Eq. (10).

Both $a_{1,t}$ coefficients in Eq. 8 and Eq. 10 show similar patterns, bearing out the robustness of our results on the spillover effects of US GDP volatility on Turkish GDP volatility.

Figure 2 presents the change in the magnitude of the spillover effect over time. US volatility's impact on Turkey follows a rising trend over the years, consistent with the financial liberalization undergone by Turkey during the last two decades. Indeed, this spillover effect is almost steady except for crisis periods.

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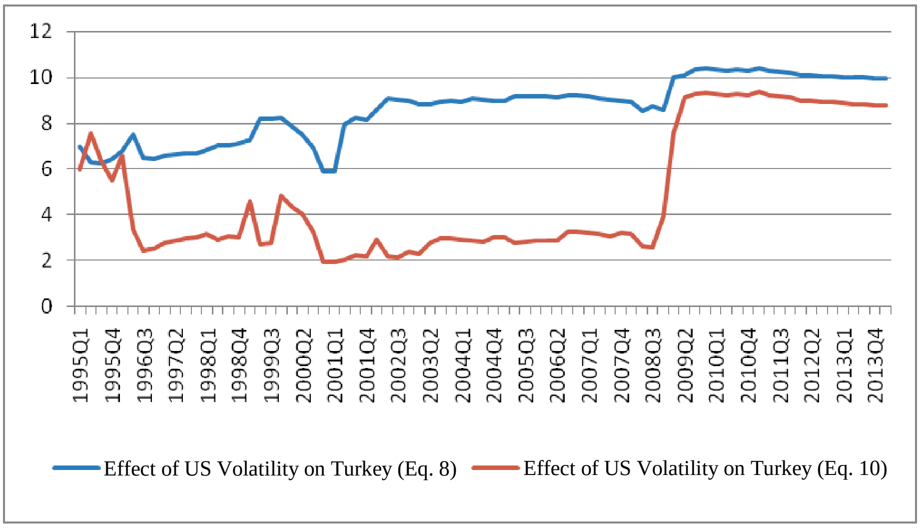
6 We also checked the effects of EU volatility alone on Turkey's volatility; however, the coefficients were statistically insignificant. So, we did not report these results.

7 This result is consistent with Footnote 2. Results indicated that EU GDP volatility has no significant effect on the GDP volatility of Turkey.

8 The effects of EU GDP growth volatility on Turkey's economy turn out to be statistically insignificant. However, when we omit this variable, no significant change appears in the results. In both cases, in Eq 8. and Eq. 10, the effects of US GDP growth volatility on Turkey are statistically significant, and the coefficients are similar. Both Eq. 8 and Eq. 10 serve as a robustness check.

Figure 2. TVP Estimates for $a_{1,t}$ coefficients in Eq. 8 and Eq. 10



We observe local peak points at 1996 Q2, 1999 Q4, 2002 Q2, 2006 Q3, and 2009 Q4, which coincide with the crises. The fallout from the relatively recent global financial crisis of 2008 and 2009 for the Turkish economy is also discernible in the figure above. The strong uptick in the estimated parameter of the effect of US volatility on Turkey is observed to follow immediately after the worldwide slowdown.

Table 2 presents the timetable for the business-cycle turning points of Turkey and the US, as well as the time-varying parameter estimate of the effect of US volatility on Turkey. NBER's US business-cycle reference dates and the quarterly GDP growth rates of the US and Turkey are used to mark the contraction and trough periods of the respective economies. Table 2 demonstrates that the rise in the spillover effect of US volatility on Turkey follows either contraction or trough periods in the US, with one or two quarter lags on average.

4. Conclusion

The volatilities in quarterly GDP for Turkey, the US, and the EU are determined through use of the SWARCH model, as proposed by Hamilton and Susmel (1994). Afterward, we turn to the Kalman filter to detect any spillover effects of GDP volatilities in the US and the EU on Turkey's economy between the first quarter of 1995 and the fourth quarter of 2013. We find evidence of significant cross-country spillover from the US to Turkey, especially

Table 2. Timetable for Peak Points of Estimated Spillover of US Volatility on Turkey and Contraction and Trough Phases of the Business Cycles in the US and Turkey

		Spillover Effect	**US**	**Turkey**			**Spillover Effect**	**US**	**Turkey**
	Q1					Q1			
	Q2		-			Q2			
1995	Q3				2003	Q3			
	Q4			-		Q4			-
	Q1		-			Q1		-	
	Q2	**X**		-		Q2	**X**		
1996	Q3			-	2004	Q3			
	Q4					Q4			
	Q1					Q1			
	Q2					Q2			
1997	Q3				2005	Q3			
	Q4					Q4			
	Q1					Q1		-	
	Q2					Q2		-	
1998	Q3			-	2006	Q3	**X**	-	-
	Q4			-		Q4			
	Q1		-	-		Q1			
	Q2		-			Q2			
1999	Q3				2007	Q3			
	Q4	**X**				Q4		-	
	Q1					Q1			-
	Q2					Q2		-	
2000	Q3				2008	Q3		-	-
	Q4					Q4		-	-
	Q1		-	-		Q1		-	-
	Q2			-		Q2		-	-
2001	Q3				2009	Q3			
	Q4		-			Q4	**X**		
	Q1			-		Q1			
	Q2	**X**				Q2			
2002	Q3				2010	Q3			
	Q4					Q4			

in times of crisis. However, when we study the record of the EU, either alone or in tandem with the US, its GDP volatility emerges as insignificant as far as affecting Turkey is concerned. Our results are consistent with those in the empirical literature who argue for no meaningful spillover effect from the EU to Turkey, as in Sayek and Selover (2002) and Berument, Kılınç, and Yücel (2005).

On the other hand, we provide empirical evidence for significant volatility spillover effects from the US to Turkey, as stated in the paper of Özkan and Erden (2012). It is worth mentioning that interestingly, although the EU is Turkey's largest trading partner, there appears to be no volatility spillover from the former to the latter.

This empirical result suggests that either the trade channel does not constitute the main transmission mechanism for GDP volatility moving into the Turkish economy or the turbulent depreciation of the exchange rates serves to constrain any European regional spillover of volatility, as argued by Shih and Wang (2009). In any case, further in-depth investigation is called for in order to understand the lack of a volatility spillover effect from the EU to Turkey. Also left to future researchers is the question of which transmission channels are responsible for spreading such volatility outward, now that we have established that the US is a major source of Turkey's unstable economic behavior via the spillover effect of its GDP volatility.

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