Finance Research Letters 23 (2017) 65–68

Contents lists available at ScienceDirect

Finance Research Letters

journal homepage: www.elsevier.com/locate/frl

Estimating volatility persistence under a Brexit-vote structural break

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ARTICLE INFO

Article history:
Received 10 January 2017
Revised 30 January 2017
Accepted 28 March 2017
Available online 29 March 2017

JEL classification:
G120
G110
G010

Keywords:
Volatility persistence
Structural break
Brexit

ABSTRACT

We model volatility dynamics and explore volatility persistence under a supposed Brexit-vote structural break. We find that following the Brexit vote, volatility persistence increased significantly in the stock markets but decreased in the foreign exchange market. However we uncover similar patterns in the dynamics of volatility across both markets, with the post Brexit-vote news effect generally contributing less to volatility persistence. Our findings suggest that the increased post Brexit-vote volatility persistence is mainly driven by rising forecast variance from previous periods and that investors may have already priced in the news from the Brexit vote. Therefore, a Brexit-vote structural break may be irrelevant in modelling volatility dynamics.

1. Introduction

The UK's vote to leave the European Union ("Brexit") sent shockwaves through the UK financial markets, particularly the foreign exchange and stock markets. Although such events are expected to lead to volatility in financial markets, financial theory dictates that investors should be more concerned about the persistence in the volatilities. This expected investor behaviour is in line with the seminal works of Poterba and Summers (1986) who argue that the extent to which market volatility affect prices via a time varying risk premium depends fundamentally on the persistence of shocks to the variance.

In the few days following the Brexit vote, the foreign exchange markets and the stock markets were significantly hit, with the Pound value falling as much as 11% relative to the US Dollar over such a short period. Some of the burgeoning post Brexit-vote research that currently exist highlight a number of negative effects of the Brexit vote on financial markets comparable to previous major financial crises. Schiereck et al. (2016) for instance found that the Brexit announcement led to a short-run drop in stock prices that was more pronounced than the Lehman Brothers' bankruptcy in the build up to the 2008 global financial crisis.

This raises concerns as to whether the Brexit vote can be seen as a point of structural break when modelling volatility dynamics. Furthermore, these sudden declines brought significant volatility clustering to these markets around the Brexit-vote dates (as observed in Figs. 1 and 2 below), and there is little evidence as to the degree of the persistence of such volatilities, and therefore the size of the long-term risk premium adjustment expected in the financial markets. According to Bollerslev et al. (2006), persistent volatilities are expected to be priced into the financial markets by raising the required rate of return which in turn necessitates an immediate stock price decline to accommodate for higher future returns. For

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http://dx.doi.org/10.1016/j.frl.2017.03.004
1544-6123/

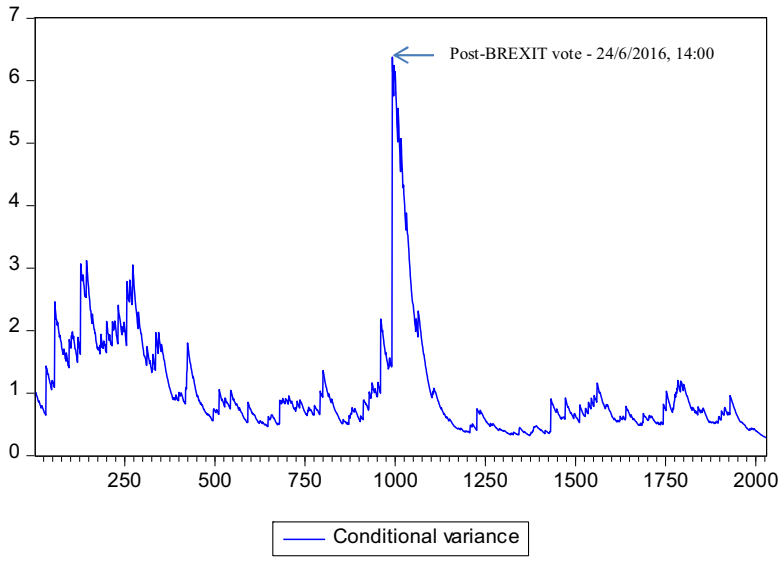

Fig. 1. Conditional variance of FTSE100 returns: 23/12/2015 – 23/12/2016.

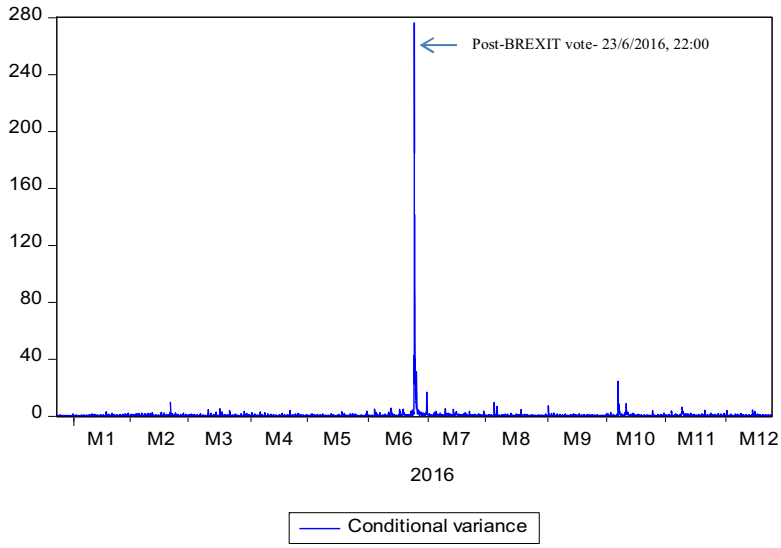

Fig. 2. Conditional variance of GBP/USD returns: 23/12/2015 – 23/12/2016.

financial markets, it is therefore imperative that volatility dynamics are understood so as to help explain potential investor behaviour to changing volatility patterns.

To this end, using high frequency hourly data, our study seeks to achieve two things. First, using a standard univariate GARCH (1,1) model, we independently explore and compare volatility persistence in FTSE100 and GBP/USD returns six months pre and post the Brexit vote; second, using an augmented GARCH with structural break model that accommodates for a Brexit-vote structural break, we explore volatility persistence in both markets over a one year period.

Although previous similar studies on volatility persistence in financial markets generally document persistent volatilities, the varying degree of persistence still provides a lot of information as to the volatility dynamics in financial markets (see Anderson and Bollerslev, 1997). To the best of our knowledge, our study is the first to explore volatility persistence in the UK financial markets following the Brexit vote. Generally, we find evidence of highly persistence volatility in the stock market which tends to be significantly more pronounced post the Brexit-vote. The foreign exchange market however seems to exhibit lesser volatility persistence which tended to reduce even further following the Brexit vote. A closer evaluation of the dynamics of volatility persistence in both markets however shows consistent patterns in the ARCH and GARCH effects with evidence of reduced effects of news in driving volatility persistence after the Brexit vote. Our findings mostly point to

Table 1
Volatility estimation results: stock market.

Model	ω	α	β	D	$\alpha+\beta$
Pre Brexit-vote	0.593755	0.024070***	0.598551*		0.622621
	(0.369600)	(0.005503)	(0.259466)		
Post Brexit-vote	0.013555***	0.013690***	0.957427***		0.971117
	(0.001575)	(0.003142)	(0.004915)		
GARCH with structural break	0.026018***	0.020534***	0.962121***	−0.017629***	0.982655
	(0.003638)	(0.002833)	(0.004679)	(0.002513)	
GARCH without structural break	0.005569***	0.027985***	0.967294***		0.995279
	(0.000872)	(0.002334)	(0.002924)		

an insignificant effect of a Brexit-vote structural break in modelling volatility dynamics and this has significant implications for understanding volatility dynamics in the UK financial markets around the Brexit vote period.

2. Data and methodology

We use high frequency hourly data to model volatility persistence within the stock and foreign exchange markets. For the stock markets, our data consists of 2029 hourly observations and for the foreign exchange markets[1] our data contains 6113 observations, spanning between 23/12/2015 and 23/12/2016 and sourced from Bloomberg. To accommodate for intraday periodicity in return volatility which has been found to vary symmetrically over the trading day and which may invalidate our results, we follow Bollerslev et al. (2006)'s approach to using hourly high frequency data in modelling volatility dynamics. The approach uses the standardised hourly return, where each of the return is divided by the sample standard deviation for that particular hour of the day. Also, similar to their approach, we omit the first hour of trading in each trading day due to the unusually high volatility often observed at the start of the trading day.

In the first stage of our analysis, we split our sample period into two sub-periods, with the pre Brexit-vote period spanning 23/12/2015 to 23/06//2016. We then estimate a standard univariate GARCH (1,1) model and compare volatility persistence between the two sub-periods. Our standard mean and variance equations are given as:

$$R_t = \mu + \rho R_{t-1} + \varepsilon_t \tag{1}$$

$$h_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \tag{2}$$

Where R_t denotes our hourly standardised returns; and α and β are our ARCH and GARCH coefficients which capture volatility persistence for $\omega > 0$, $\alpha > 0$, $\beta > 0$.

Lamoureux and Lastrapes (1990) provide evidence that the standard univariate GARCH (1,1) model above may overestimate the underlying volatility persistence where significant structural breaks exist within the sample period. Therefore, structural breaks should be incorporated into the model to improve parameter estimates. For the second part of our analysis, we therefore follow their specification and augment our standard univariate GARCH (1,1) model with structural breaks in the variance equation as below:

$$h_t = \omega + d_i D_i + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \tag{3}$$

Where D_i is a dummy variable which takes the value of 1 from each point of the Brexit-vote structural break onwards and 0 otherwise.[2]

Subsequently, for robustness, we compare volatility dynamics between the standard univariate GARCH (1,1) model and the augmented structural break model to explore if the standard model accurately captures volatility dynamics under a Brexit-vote structural break.

3. Empirical results

Tables 1 and 2 show the results of volatility dynamics in the stock market and foreign exchange market respectively across our various models. We find all our parameters to be highly significant with the exception of the pre Brexit-vote GARCH effect for the stock markets which is only significant at the 10% level.

For the stock market, we observe significant increase in volatility persistence from 0.623 pre Brexit-vote, to 0.971 post Brexit-vote. We find that the increase in volatility persistence can mainly be attributed to a huge increase in the GARCH

[1] The Stock markets in the UK are open from 8.00 to 16.30 on Mondays to Friday while the Foreign Exchange markets are virtually open throughout the day.

[2] Given that the standard errors of dummy variables in this case can have a potential bias due to their unusual asymptotic properties, we further carry out bootstrapping approach proposed by Lamoureux and Lastrapes (1990) to capture any such potential bias. We find the bias to be inconsequential and do not change our results – results are available on demand.

Table 2
Volatility estimation results: foreign exchange market.

Model	ω	α	β	D	$\alpha+\beta$
Pre Brexit-vote	0.104690***	0.410433***	0.525963***		0.936396
	(0.005048)	(0.019215)	(0.013346)		
Post Brexit-vote	0.101629***	0.103662***	0.771765***		0.875427
	(0.006467)	(0.009133)	(0.012939)		
GARCH with structural break	0.098774***	0.252641***	0.614935***	0.058307***	0.867576
	(0.003625)	(0.009508)	(0.009082)	(0.003764)	
GARCH without structural break	0.118138***	0.230643***	0.641235***		0.871878
	(0.003826)	(0.008189)	(0.007809)		

*Notes: Normal Gaussian Standard Errors in parenthesis. $\alpha+\beta$ measures volatility persistence.
*,**, and *** denotes 10%, 5% and 1% level of significance respectively.

effect while the ARCH effect stays relatively similar across both sub periods. This implies that following the Brexit vote, increased forecast variance from the last period was mainly responsible for increased volatility in the stock markets rather than the news effects of the Brexit vote. Our expectations from such increasing volatility persistence is that stock prices should fall to accommodate for the increased expected risk premium, however our observation of market prices reflects an steady stock price rise of 13% in the FTSE 100 post the Brexit-vote up until the end of our sample period.

Given that it is only the unforeseen rise in volatilities that should cause a negative fall in prices (see Chou, 1988), our findings may therefore suggest that the markets had fully priced in the Brexit vote as it happened. Our results may also be explained by Campbell and Hentschel (1992)'s findings on volatility asymmetry which suggests that periods of lower volatility persistence as observed in the pre Brexit-vote period lead to little or no estimated volatility discounts in subsequent stock prices. Our findings further suggest that the standard univariate GARCH model slightly but not significantly, overestimates volatility persistence in the stock markets when a Brexit-vote structural break is ignored. These results are somewhat consistent with the findings Lamoureux and Lastrapes (1990).

With the foreign exchange market, we observe a fall in volatility persistence post the Brexit-vote to 0.875 from 0.936 pre the Brexit-vote. However we uncover similar dynamics between the GARCH and ARCH effects which again confirm our previous finding that the news effects contributed less to volatility after the Brexit vote despite increasing forecast variance from the last period. As with the stock markets, our expectations for a rise in the value of the Pound following reduced volatility persistence is nullified as we observe the Pound to have instead fallen 17% in value following the Brexit vote. Again these results suggest that the reduced volatility persistence had little or no impact on the value of the Pound as the Brexit vote was anticipated and already priced in. Finally, we once more find that the standard univariate GARCH model fairly estimates volatility persistence under a Brexit-vote structural break, with the model producing similar parameters as the augmented GARCH model with structural breaks incorporated.

4. Conclusions

In this paper, we model volatility dynamics and explore volatility persistence under a supposed Brexit-vote structural break. In the first instance, we compare volatility persistence in the stock and foreign exchange markets pre and post the Brexit-vote and find that volatility persistence increased significantly in the stock markets but decreased in the foreign exchange market following the vote. We however uncover similar patterns in the dynamics of volatility across both markets following the vote. The effect of news on volatility is observed to fall in both markets following the vote, while the past period forecast variance mainly contributes to increasing volatility persistence. These findings may suggest that investors had already priced in the news from the Brexit vote, hence post Brexit-vote volatility persistence in this case may be irrelevant in influencing market prices. This argument is corroborated by the market price observations which do not seem to theoretically support our findings.

Finally, we find that a Brexit-vote structural break may be irrelevant in modelling volatility dynamics as the basic GARCH model without structural break performs just as well as our augmented GARCH with structural break model. Our findings therefore have important implications for understanding the role of a Brexit-vote structural break in modelling volatility dynamics and may further suggest that the financial system was resilient enough to accommodate the volatility shocks from the Brexit vote.

References

Andersen, T.G., Bollerslev, T., 1997. Intraday periodicity and volatility persistence in financial markets. J. Empirical Finance 4 (2), 115–158.
Bollerslev, T., Litvinova, J., Tauchen, G., 2006. Leverage and volatility feedback effects in high-frequency data. J. Financ. Econ. 4 (3), 353–384.
Campbell, J.Y., Hentschel, L., 1992. No news is good news: an asymmetric model of changing volatility in stock returns. J. Financ. Econ. 31 (3), 281–318.
Chou, R.Y., 1988. Volatility persistence and stock valuations: some empirical evidence using GARCH. J. Appl. Econ. 3 (4), 279–294.
Lamoureux, C.G., Lastrapes, W.D., 1990. Persistence in variance, structural change, and the GARCH model. J. Bus. Econ. Stat. 8 (2), 225–234.
Poterba, J., Summers, L., 1986. The persistence of volatility and stock market fluctuations. Am. Econ. Rev. 76, 1143–1151.
Schiereck, D., Kiesel, F., Kolaric, S., 2016. Brexit: (Not) another Lehman Moment for Banks? Finance Res. Lett. 19, 291–297.