Further Notes on Event Study Standard Errors

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In her published comment on Chodorow-Reich (2014), Annette Vissing-Jorgensen suggests an alternative methodology for computing the significance levels in table 2 of the paper. In this note, I further elucidate the issues she raises, and provide standard errors following her methodology for the same specification as reported in table 2 of Chodorow-Reich (2014). For most coefficients I find little difference relative to the significance levels reported in the paper, with significance levels actually rising for some key episodes.

Background

Table 2 of Chodorow-Reich (2014) reports the value-weighted log stock price change, bond yield change, and CDS spread change of different sectors around monetary policy announcement surprises. The table contains significance stars from a t-test of common movement across all of the entities in each sector during the event window. For example, the t-test for insurance company stock prices around event k comes from the weighted least squares cross-sectional regression:

$$y_{i,k} = \beta_k + u_{i,k}, \tag{1}$$

where $y_{i,k}$ denotes the stock price change of insurer i in the window around event k, and the weights reflect market capitalization. By construction, the regression residuals $u_{i,k}$ contain only the idiosyncratic component of the stock returns. The statistical significance of β_k in this regression answers the question of whether some event induces common movement across the individual securities.

Next, modify equation (1) to allow for a common non-monetary shock α_k:

$$y_{i,k} = \alpha_k + \beta_k + u_{i,k}. \tag{2}$$

Clearly, α_k and β_k are not separately identifiable in a given event window. Thus, quantitative statements attributing the movement in a particular window entirely to the monetary policy shock rely on an identifying assumption of a window small enough that $\alpha_k \to 0$. Vissing-Jorgensen argues, however, that statements about the statistical significance should incorporate information about the variance of α_k obtained from examining movements in non-event windows. The statistical test of β_k then gives the likelihood the realization of $y_{i,k}$ reflects only realized shocks to α_k. She advocates using standard errors from the regression:

$$y_t = \alpha_{\text{no event}} + \sum_{k=1}^{K} \beta_k \mathbf{I}\{\text{event } k \text{ at time } t\} + e_t, \tag{3}$$

where y_t is the value-weighted log price change at time t, $\alpha_{\text{no event}}$ is the average price change in all non-event windows, and β_k is the change in the k^{th} event window.

The β_k resulting from equations (1) and (3) are identical, but the standard errors differ. The standard error of β_k in equation (3) is given by

$$se(\beta_k) = \sqrt{\frac{1}{T-K-1} \sum_{r=1}^{T-K} \hat{e}_r^2}, \tag{4}$$

where T is the number of total observations in the regression, and without loss of generality I have re-ordered the observations such that the first $T-K$ observations correspond to the $T-K$ non-event windows in the sample. Because $\hat{e}_r = y_r - \bar{y}_r$, where $\bar{y}_r$ is the average return in non-event windows, the standard error of β_k in equation (4) is also equal to the standard deviation of the returns computed over the set of non-event windows. Intuitively, the corresponding t-statistic scales the movement around event k by the "normal" standard deviation in a window of the same length.

Results

Table 1 reports the stock price results from table 2 in Chodorow-Reich (2014) but with significance levels based on implementing equation (4). Specifically, I randomly draw 125 non-event dates between December 2008 and September 2013, and for each date construct a value-weighted log stock price change between 2:00pm and 2:30pm.[1] I then split the sample into three equal length subperiods, and use standard errors constructed separately for each subperiod. The sample split constitutes a crude but likely conservative adjustment for the much higher stock return volatility during the financial crisis covering the early part of the sample.

A comparison of table 1 and table 2 of Chodorow-Reich (2014) reveals in general small differences in the significance levels reported. The announcements on December 16, 2008 and March 18, 2009, emphasized in the paper, remain strongly statistically significant across sectors. The September 23, 2009 announcement ceases to have a statistically signifcant effect on life insurers or banks under the alternative procedure, although this in part reflects the grouping of this date into the first tercile of the sample; instead grouping it with the second tercile would result in a

[1] The period December 2008 and September 2013 covers the period of monetary policy announcements studied, and most announcements occurred as FOMC statements released around 2pm.

t-statistic above 2. The dovish surprises in July and September, 2013 have a statistically much stronger effect on insurance company stock prices.

Discussion

In her comment, and following the practice in Krishnamurthy and Vissing-Jorgensen (2011), Vissing-Jorgensen estimates equation (3) at a daily frequency. She finds coefficients and signfi-cance levels similar to those reported in Chodorow-Reich (2014) and in table 1. The similarity in results across different window lengths and different groupings of insurers reinforces the main message of Chodorow-Reich (2014) that insurers benefited from monetary policy easing.

Although the bottom line results change little, Vissing-Jorgensen does report standard errors substantially larger than those in either Chodorow-Reich (2014) or table 1. Because she uses the same formula for standard errors as table 1 of this note, the difference must stem from the use of daily frequency rather than the narrow window length. To illustrate why this difference might arise, suppose the underlying (log) price p_t follows a geometric brownian motion with a jump process around monetary announcements:

$$dp_t = \rho + \gamma dB_t + \sum_{k=1}^{K} \beta_k, \tag{5}$$

where B_t is a standard Wiener process. Clearly, the variance of the log change on non-event dates will increase linearly with the length of the window, while the magnitude of the jump β_k does not depend on window length. Scaling β_k by a daily standard deviation will therefore result in much smaller t-statistics than scaling by the standard deviation constructed over a narrower window. Comparing the standard errors in Vissing-Jorgensen's table 2 and table 1 of this note, the difference appears to be a factor of 5-10.

References

Chodorow-Reich, Gabriel, "Effects of Unconventional Monetary Policy on Financial Institutions," *Brookings Papers on Economic Activity*, 2014, *Spring*, 155–204.

Krishnamurthy, Arvind and Annette Vissing-Jorgensen, "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy," *Brookings Papers on Economic Activity*, 2011, *Fall*, 215–287.

Table 1: Event study effects

	Dependent variable: change in value-weighted stock price of:								
	Life insurers			Banks			S&P 500 ex. fin.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Event date:									
12/1/2008	−0.4			−0.6			-0.5^{*}		
12/16/2008	3.6^{**}			2.2^{*}			1.3^{**}		
1/28/2009	−1.2			−0.3			−0.3		
3/18/2009	4.0^{**}			2.5^{**}			1.5^{**}		
9/23/2009	0.6			0.6			0.6^{*}		
8/10/2010		0.8^{**}			0.9^{**}			0.7^{**}	
9/21/2010		0.6^{*}			0.7^{**}			0.5^{**}	
8/9/2011		-2.0^{**}			-1.7^{**}			-1.4^{**}	
1/25/2012		-0.6^{*}			−0.0			0.3^{+}	
9/13/2012			1.3^{**}			1.0^{**}			0.5^{**}
5/22/2013			-0.4^{**}			-0.5^{**}			-0.5^{**}
6/19/2013			0.1			0.2			-0.2^{+}
7/10/2013			0.3^{+}						0.3^{**}
9/18/2013			0.4^{*}			0.9^{**}			1.0^{**}
Standard error	0.70	0.25	0.15	0.85	0.26	0.14	0.26	0.17	0.08
Pooled sample standard error	0.42	0.42	0.42	0.49	0.49	0.49	0.18	0.18	0.18
p_{val}(Initial QE)	0.000	.	.	0.000	.	.	0.000	.	.
p_{val}(Taper)	.	.	0.119	.	.	0.055	.	.	0.000
p_{val}(Sample end)	.	.	0.003	.	.	.	.	.	0.000
R^2	0.643	0.682	0.673	0.307	0.616	0.701	0.667	0.709	0.853
Observations	41	44	51	42	44	52	42	44	53

Notes: The dependent variable is the value-weighted mean change in the log stock price during announcement window covering two minutes before to eighteen minutes after announcement, in log points, or the change during an identical length window beginning at 2pm on a non-announcement date. Standard errors are based on the value-weighted return between 2pm and 2:30pm on 125 randomly drawn non-announcement dates between December 2008 and September 2013. The table splits the sample into three equal length subperiods, with the standard error in each subperiod equal to the standard deviation of returns during non-event windows. The pooled standard error reports the standard deviation of the return on all 125 non-announcement dates. +,*,** indicate significance at the 0.1, 0.05, 0.01 levels, respectively.