An Experimental Study on Quantitative Easing

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Abstract

Several empirical studies have demonstrated that Quantitative easing (QE) affects the prices of financial assets. Nevertheless, only a few studies aim to replicate such an effect in the Lab and investigate its mechanism. This study re-examines the interpretation of Penalver et al. (2020) on the effect of QE under the experimental framework of Crockett et al. (2018), where participants earn the payment by smoothing the consumption instead of just speculating. In the experiment, participants can trade the bonds to each other by experimental currency each period. In the treatments where QE operation exists, the computer purchases a certain amount of bonds from participants after a certain number of periods experienced. The data reports that QE operation can raise the bond market prices significantly before the QE operation occurs. As a result, our data provided support for the interpretation of Penalver et al. (2020).

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1. Introduction

Quantitative easing (QE) which aim to influence the level of economic activity by buying or selling government bonds from the secondary market in exchange for central bank reserves should have no temporary or permanent effects on any macroeconomic variables under rational expectations equilibrium (Eggertsson and Woodford, 2003). Nevertheless, some empirical studies, such as Joyce et al. (2011), report evidence that this kind of policy have influenced the bond prices.

Penalver et al. (2020) propose and experimentally test a possible explanation, namely the lack of competition in the QE operation due to the failure of common knowledge of rationality. Note that the central bank can be regarded as an unusual participant in the bond market who is not deterred from buying at a higher market price. Because of this, it is possible that there are some na¨ıve market participants who believe the central bank intervention can indeed raise the price of bond. If there are such na¨ıve participants, more sophisticated market participants are better off by not engaging in fierce competition among themselves to profit from selling their bond to the central bank at the higher price. Penalver et al. (2020) finds a support for their hypothesis in an experimental setting that extends the framework of Smith et al. (1988) where no-trade theorem holds.

However, as Crockett et al. (2019) shows, the assets tend to be mis-priced in the experimental framework of Smith et al. (1988) because participants trade them to speculate. And it is not clear the same results will be obtained if the effect of QE is examined in an experimental framework where participants trade asset not just to speculate but to smooth consumption. To address this issue, this study conducts a set of control laboratory experiment to re-examine the finding of Penalver et al. (2020) in the framework where participants trade asset not just to speculate but to smooth consumption.

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2. Experiment setting

The experiment extends the framework of Crockett et al. (2018) and introduces, in a 2×2 design, the QE operation as well as an alternative mean for participants to smooth consumption over time a part from trading the asset.

In the Benchmark setting, participants are initially given some units of bond and cash, which they can trade among themselves. While the cash held at the end of a period will be consumed (based on which participants are paid) and cannot be carried over to the next period, the bonds can. The game ends at the end of each period with probability 1/6. With probability 5/6, it continues to the next period. At the beginning of the next period, participants receive dividend for each unit of bond they hold as well as cash income. The amount of dividend per unit of bond is known and fixed. The cash income, however, vary across periods. Thus, if participants want to smooth their consumption across periods, for example, by saving when cash income is high and dis-saving when cash income is low, they need to trade the bond. To ensure that we can gather data from enough periods, we employ the random block termination method (Fr´echette and Yuksel, 2017) with a block consisting of six periods.

In the second treatment (QE), the computer acts as a QE operator, who intervene in the market and buy a fixed number of bonds from participants in the fourth period. QE operation will be implemented as a uniform price auction. In the third treatment (BS), the participant can carry over the cash to the next period by savings, which can be regarded as an alternative way for them to smooth consumption over time. The interest rate is fixed at the rate of return on bonds when the bond is priced at its fundamental value. Finally, in the fourth treatment (QES), the QE operation exists exactly as in QE treatment, and participants can smooth the consumption by savings just as in BS treatment. In all the treatments, eight participants constitute a group.

Under the above experimental settings, according to what Penalver et al. (2020) hypothesize, participants overprice much more in QE (QES treatment) than in Benchmark (BS treatment) in the pre-intervention periods (until the third period). And the market prices of QES (QE) treatment and BS (Benchmark) should be the same in the post-intervention periods (after QE operation).

Each session experiment consists of at least one round. And each round consists of at least one block of 6 periods. At the start of each round, the endowments of all participants are reset.

In order to control the experimental duration, in practice, we let the program randomly determined the number of the period (the number of the block) of each round in advance. Then, we used this realization for the all sessions experiment. Therefore, each round of all sessions have the same number of the period (block), and all the sessions consist of at least two rounds of the experiment. We didn't tell participants this information.[1]

3. Main result

In order to statistically test the effect of intervention in mispricing, we compute the geometric deviation (GD) of the median normalized prices[2] of each group introduced by Powell (2016). For group m in round r, $GD^{m,r}$ is defined as

[1] Such a design is also adopted by Duffy and Puzzello (2014), Duffy and Puzzello (2020), and Fr´echette and Yuksel (2017).

[2] The normalized price equals $\frac{Realized\ market\ price}{equilibrium\ price} - 1$.

$$GD^{m,r} = exp\left(\frac{1}{N^{m,r}}\sum_{n=1}^{N^{m,r}}\frac{p_n^{m,r}}{p^{*m}}\right) - 1$$

where the $N^{m,r}$ is the number of transactions that occurred in round r, $p_n^{m,r}$ is the realized price of the n-th transaction in group m, and p^{*m} is the rational expectations equilibrium (REE) prices of group m in the period when n-th transaction occurred.

Figure 1 and Figure 2 display the empirical cumulative distributions (ECDs) of GD separately by the round number and the sub-period. The p-values from the pairwise Wilcoxon rank-sum test are reported just below each panel. Since all the sessions adopted the same sequence of pre-determined dice numbers, the length of each round is the same across them. Precisely, each round consists of 1 block (6 periods).

The upper left panel in Figure 1 (Figure 2) shows a significant difference in the GDs between Benchmark and QE treatments (BS and QES treatments) at the 5% significance level. It suggests the intervention raises the transaction prices in pre-intervention periods regardless of whether saving is absent, implying that some participants, who expect the bond can sell at a higher market price to the computer in the intervention, raise the bond prices before the intervention.

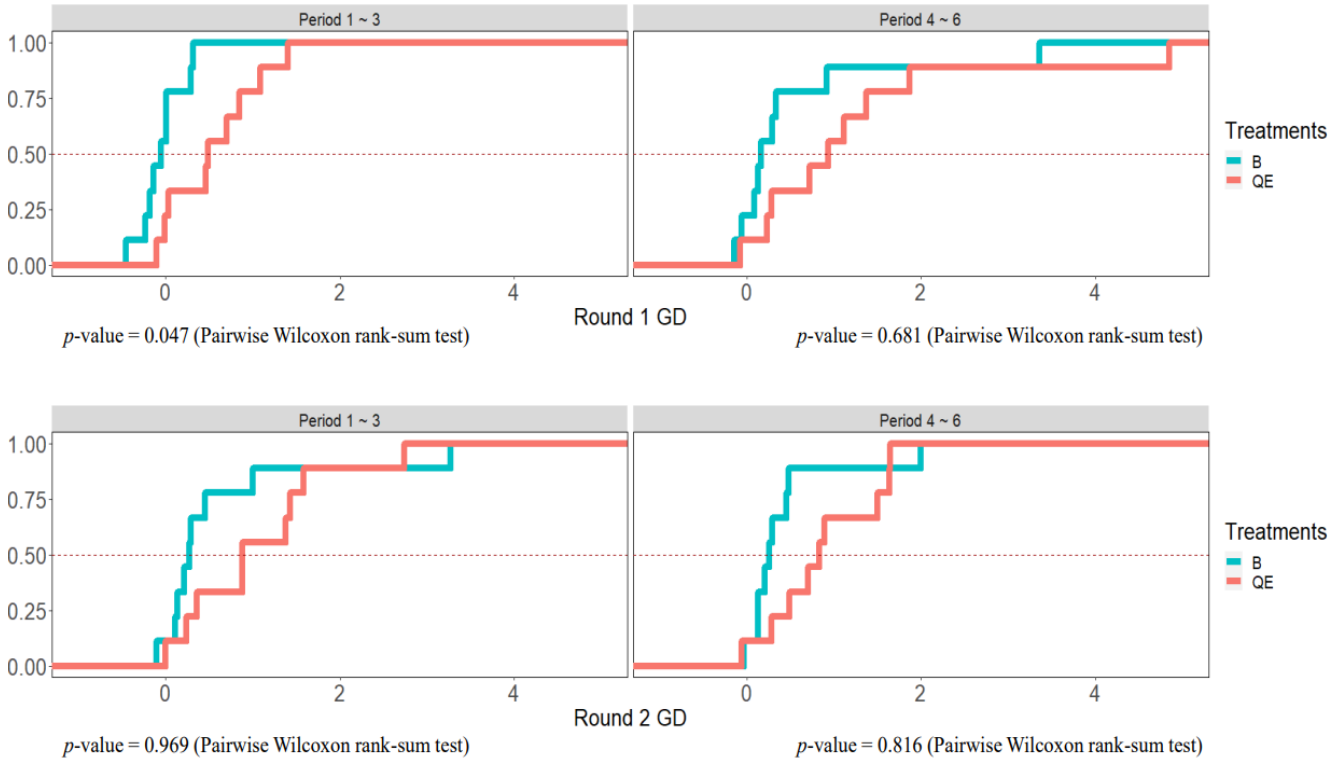

Figure 1: GDs for the first round (top) and the second round (bottom) in treatments without saving.

Note. The red lines present the GDs when the intervention exists (QE treatment); the blue lines presents the GDs when the intervention is absent (Benchmark). Bonferroni method is used for correcting p-values for multiple comparisons.

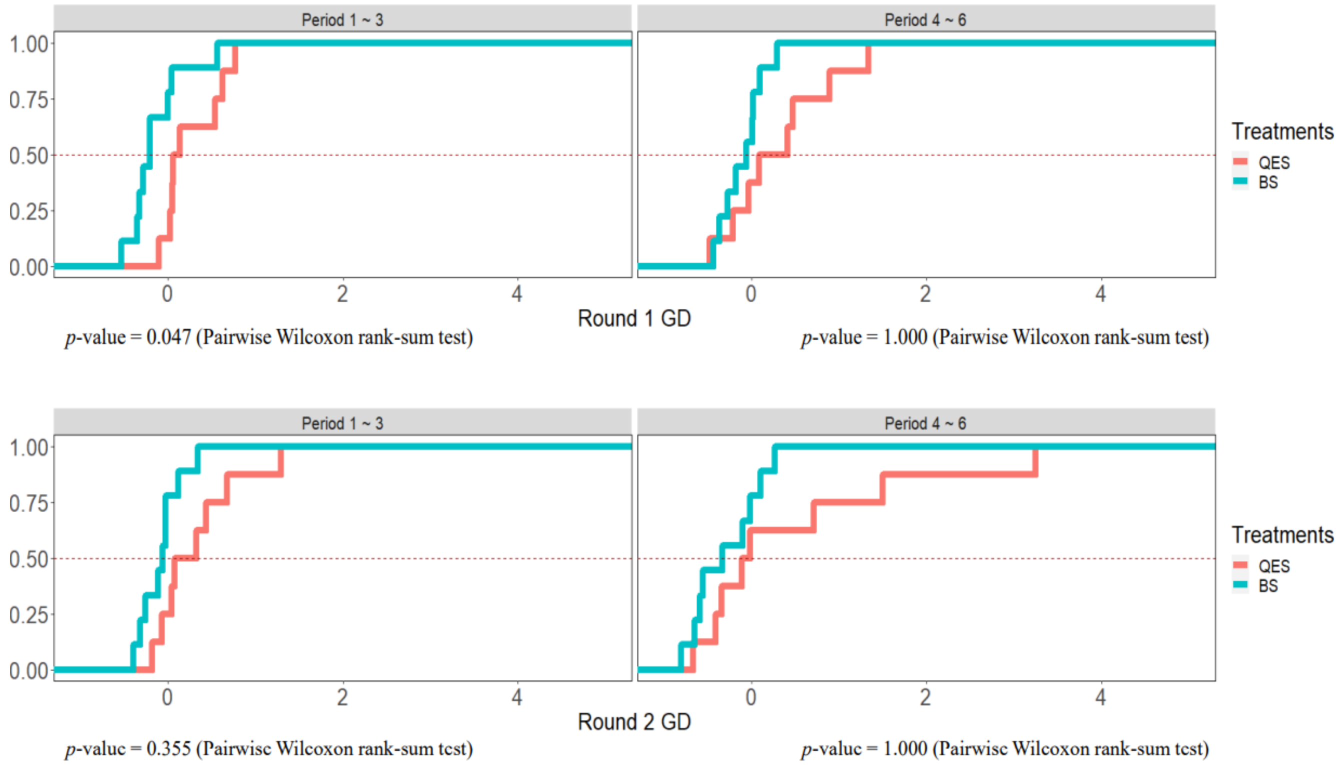

Figure 2: GDs for the first round (top) and the second round (bottom) in treatments with saving.
Note. The red lines present the GDs when the intervention exists (QES treatment); the blue lines presents the GDs when the intervention is absent (BS treatment). Bonferroni method is used for correcting p-values for multiple comparisons.

4. Conclusions

In conclusion, the data shows a significant treatment effect that market intervention leads to bond overpriced much more regardless of whether the saving is absent, supporting the proposition of Penalver et al. (2020).

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