The effect of quantitative easing on US sector returns

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Abstract

In this study, we used event analysis to examine whether abnormal returns can be observed for US sector returns at the time when quantitative easing was announced. In our investigation, we sought to identify the sectors in which the amount of money introduced into the economy as a result of quantitative easing. In addition, since the programme is basically implemented by the central bank in order to stabilise the economy, an examination of its effect on the sectors may provide guidance on which segments have reacted negatively, thus possibly requiring additional central bank or public intervention. In our results, we found consistency for all four QE programme in some sectors In the examination of the S&P 500 sector indices, surprisingly no significant abnormal return was found in the financial sector, by contrast, for the healthcare sector, as well as discretionary and general consumer goods, the stocks included in the sector index reacted in the same way for all 4 announcements.
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Introduction

Mechanisms of action of asset purchase programmes

It is extremely interesting and at the same time difficult to examine and compare economic recessions, since their root causes are not always clear to analysts. Some recessions are caused by macroeconomic imbalances, while others are caused by exogenous economic shocks. In such cases, central banks use the usual tools to stimulate aggregate demand, increase the supply of money, and thus ensure the liquidity of banks, for which the most commonly used tool is adjustments to the base rate.

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However, unconventional instruments are also available to stimulate the economy. During the financial crisis of 2008, central banks pushed to the limit in terms of using conventional monetary policy instruments. However, there were some situations where these did not seem to be sufficient to stabilise the economy. One was the crisis of confidence and liquidity following the Lehman bankruptcy. In the process, the interbank market froze almost completely, driving up short-term returns, which significantly increased the cost of funds for banks. In addition, the fact that the efficiency of transmission mechanisms had been impaired due to the freezing of the markets further exacerbated the situation. There was a need for immediate intervention, which the Fed eventually implemented through the use of liquidity-providing instruments. These include, for example, the permission of a broader range of collateral and central bank counterparties, changes to the reserve rules, unlimited availability, or various swap agreements. Today, central banks have a number of other unconventional instruments at their disposal, such as negative interest rate policies (NIRPs), forward guidance, or increasing central bank assets (Joyce et al. [2012]). This latter is referred to as quantitative easing, which is a monetary policy instrument where the central bank launches a large-scale asset purchase programme, providing liquidity to banks, reducing bond yields, while increasing the amount of money in the economy (Thornton [2013]).

The effects of the programme are mainly transmitted to the economy through two channels (Eggertsson & Woodford [2003]). One of these is the announcement channel. This is a verbal intervention in which the central bank sends a strong signal to the market that it is intervening in order to create stability, as a result of which the expectations of market participants are adjusted accordingly. Thus, the announcement of a central bank asset purchase programme is an agent that is ultimately reflected in investors' future expectations through the announcement channel, as it conveys the message that the central bank's accommodative monetary policy conditions will be maintained in the longer term (Borio & Zabai [2016]). The other prevailing mechanism of action is the portfolio rebalancing channel. The return on securities (mainly long-term) purchased by central banks, is reduced, which makes them less attractive to market participants, who then replenish their portfolios with instruments with higher expected returns. The higher volume of demand drives up the prices of these assets, thereby increasing the wealth of their holders, which may encourage them to invest further. The direction or magnitude of the announcement effect may vary by stock where the investor groups are not homogeneous, i.e. have different preferences. On this basis, it is plausible that quantitative easing, due to these mechanisms of action, can have a demonstrable effect on stock returns, and according to the efficient markets theory (Brealey & Myers [1999]), this should be priced into stock prices at the time an announcement is made.

A number of studies have examined the effect of quantitative easing on interest rates, bond yields, or the mortgage market, which we will discuss later, but there have been few studies on its effect on the stock market, so our research focuses specifically on this area.

Review of previous asset purchase programmes

Asset purchase programmes (APPs) have a long-standing history, as this type of procedure was already used during the Great Depression of 1929. The term "quantitative easing" was first used by the Japanese central bank between 2001 and 2006, when this unconventional monetary policy instrument was used to contain the housing market crisis and deflationary pressures. (Girardin & Moussa [2011]).

The method became truly widespread during the economic recession that started in 2008, when many of the world's central banks used it to deal with the crisis. The first round of quantitative easing (QE1) was announced by the US central bank in November 2008. In the early 2010s, the central bank announced another two rounds of quantitative easing, which were smaller in volume than QE1, but they had an effect on stock prices.

The reason for this is that the APP reduces long-term bond yields (Hartley & Rebucci [2020]), which play an important role in stock pricing, and the huge amount of money flowing into the economy helps the recovery of the economy, as it stabilises aggregate demand, which improves the revenues of companies, and thus indirectly has a positive effect on the stock exchanges. In addition, it can be said that quantitative easing has a positive effect on the economy as a whole in the medium term (Thornton [2013]), but it is difficult to show only the effect of this factor on the real economy and capital markets, as many other factors also influence them.

In 2020, the Fed responded to the economic recession with a new quantitative easing programme (QE4) which increased the Fed's assets by almost 3 trillion USD, the equivalent of nearly 15 per cent of US GDP, in the space of two months (Hartley & Rebucci [2020]).

A year and a half after the launch of the QE4 programme, Jerome Powell hinted that they would respond to the situation with a tighter monetary policy than expected. Since then, the Fed has embarked on quantitative tightening, i.e. the reduction of its total assets. The market responded to the news immediately: stock exchanges came under pressure from sellers. Furthermore, the yield curves which are supposed to have strong predictive power for crises (Granát et al. [2023b]) turned to negative.

Literature Review

According to the efficient markets theory, a transaction with a positive net present value cannot be made when trading securities (Brealey & Myers [1999]), as all available information is already priced into the market. If the exchange rate moves in an unconventional way, the efficient markets theory suggests that new information has emerged. These movements are referred to as abnormal returns. One example is the announcement of a quantitative easing programme.

Numerous studies have already been conducted on the effects of quantitative easing, despite the fact that the method itself has not been used by central banks for so long. In most of these studies, the main problem was that the effect of asset

purchases could not be separated from other factors affecting the economy and capital markets. Furthermore, due to the diversity of recessions, it is difficult to show whether quantitative easing in particular has caused a positive abnormal return in the stock market or whether other monetary and fiscal policy instruments have had a positive effect. A number of studies have been carried out on the effect of quantitative easing on long-term interest rates. In their research, Gagnon et al. [2010] showed a change of 30 and 100 basis points due to the intervention of the central bank, proving that the method was effective in reducing interest rates, which was essential for the management of the housing market crisis.

Eggertson and Woodford [2003] argued in their study that quantitative easing programmes cannot have a significant effect on the market if they only cover the purchase of securities, but not direct lending to the private sector, or if the central bank is unable to change the future expectations of market participants regarding interest rate policy.

In his study, Thornton [2013] used the event analysis methodology to examine the effect of FOMC announcements on the US capital markets as a whole. In 17 of 28 announcements, returns were either not significant, or were not related to the event itself. For the remaining 11 events, significant returns could already be found and these were typically linked to the announcement of quantitative easing. It is important to note, however, in only one of those 11 events could it be established that abnormal returns were solely attributable to the central bank's announcement.

Joyce et al [2011] used event analysis to investigate the impact of quantitative easing on different asset classes in the UK. In the case of the stock market, they assumed that QE would reduce stock-price-relevant yields, which would affect stock prices. Their analysis produced different results for different equity indices, but compared to international equity returns, the UK equity market has outperformed as a result of QE.

Another study (Corbet et al. [2019]) used high-frequency event analysis to examine the intraday effect that the announcement of quantitative easing had on US equity returns and volatility. The intraday investigation largely excluded other factors affecting the market, indicating that only the effect of the announcement was priced in. Immediately after the announcement of QE1, a highly significant negative anomalous return occurred in the S&P 500, followed by a rapid correction, while the volatility of the market increased by 1 per cent in the hour following the event. For QE2 and QE3, there was a much greater change in the volatility of the S&P 500, which lasted for 6 hours in the latter case.

A similar result was obtained by Balatti et al [2017], who examined programmes announced in the US and the UK using a VAR model. Overall, they were able to show a positive effect, but due to monetary and information shocks, this occurred in two stages. In both countries, there was a fall in stock prices at the time of the announcement, followed almost immediately by a larger rise in stock prices.

Haldene et al [2016] studied the spillover of APP programmes announced in one country to other countries. Significant asset price increases were observed in the UK, Japan and the euro area, and a positive direction of asset price change was also observed for the US, but it was smaller.

The literature most closely related to this study comprises sectoral reviews of the effects of the asset purchase programmes used during the global financial crisis (GFC) or the economic recession caused by COVID-19. The effect of quantitative easing during the 2008 crisis was examined by Rai et al. [2020] at the sector level within the European Union. In their study of 15 sectors, they showed that typically there were significant negative returns for the European sector indices on the day of the event. Their most interesting discovery was that there were no significant abnormal returns in the banking, financial and insurance sectors, which was highly contradictory to their expectations, as during the quantitative easing, banks' balance sheets changed greatly due to the asset purchase programme. The reason for this is explained in more detail in Chapter V. The effect of QE programmes on the stock market is confirmed by other studies as well. Lima et al. [2016], examining the US, UK and Japanese markets, attributed the effectiveness of the unconventional tool, which is priced in by the market at the moment it is announced, to the drastic increase in the amount of cash in circulation.

One of the most recent studies on this subject (Hartley & Rebucci [2020]) examines the effect of the announcement of quantitative easing in developed and emerging countries. Their research examined not only the first three quantitative easing programmes, but also the impact of QE4 as an unconventional crisis management tool during the economic recession caused by COVID-19. The results are very similar to the previous ones, with statistically significant negative returns on the stock market after the announcement by the central bank, and an immediate drop in long-term bond yields.

Methodology

In order to investigate our research question, we used the methodology of event analysis known from the international literature (MacKinlay [1997]). The determination of abnormal returns within the event window and the examination of their significance provide the basis for the event analysis methodology. In addition, we determined the returns using log return calculation, as this gives a more accurate picture of the rate of return in the case of compound interest (MacKinlay [1997]), and its distribution is closer to the normal distribution.

To define abnormal return, we first need to define normal return (Fama et al. [1969], Jaffe [1974]). For this study, we have used a market model as did Swanson et al. [2011] and Thornton [2013] in their research on the effects of quantitative easing announcements. This is a statistical model that compares the return on a stock i with the return on the market portfolio at time t:

$$E(R_{it}) = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{1}$$

where R_{mt} denotes the return on the market portfolio at time t, α and β are coefficients calculated from the regression models showing the fit and sensitivity of stock i, and ε_{it} is an error term.

In summary, the days when we assumed that new information was priced into the exchange rate were determined, and then the normal return was calculated from the calculation window, which was compared with the ex post return calculated from the event window using the following formula (MacKinlay [1997]):

$$AR_{it} = R_{it} - E(R_{it}) \tag{2}$$

where AR_{it} is the abnormal return on stock i in time period t, R_{it} and $E(R_{it})$ are respectively the ex post return or expected (normal) return on stock i in time period t. In order to be able to examine the effect of the abnormal returns around the event together in a given period, we need to aggregate the previously determined abnormal returns using equation (2) according to the following formula:

$$CAR_{i(t_1,t_2)} = \sum_{t=t_1} AR_{it} \tag{3}$$

where $CAR_{i(t_1,t_2)}$ is the cumulative abnormal return on stock i in time periods t_1 and t_2. For the purpose of the study, $T_{-1} - T_{+4}$ we examined the occurrence of abnormal returns associated with the announcement of quantitative easing in an asymmetric event window of 6 days.

With this, the first four of the steps of event analysis (Henderson [1990]) have been completed, the final step remaining to examine whether the results obtained can be considered statistically significant. We did so using a two-sided Student's t-test. Essentially, in this test we have a null hypothesis, which in this case is that the abnormal return on stock i at time t is equal to zero, while our alternative hypothesis is the opposite:

$$H_0: AR_{it} = 0 \qquad H_1: AR_{it} \neq 0 \tag{4}$$

It is important to note that H_0 and H_1 are mutually exclusive, that is, they cannot be true at the same time, but together they must cover all possibilities. Thus, if the ex-post return differs significantly from the normal return, H_0 is rejected and obviously H_1 is accepted, which confirms the existence of the abnormal return. For this, we need the value of the t-test, which can be obtained as follows:

$$t_{AR_{it}} = \frac{AR_{it}}{S_{AR_i}} \tag{5}$$

where the numerator contains the abnormal return on stock i in period t, and the denominator contains the standard error of the abnormal return estimated from the calculation window. Since the announcement can cause both positive and negative abnormal returns, our test is a two-sided one, which means that if the t-test value is outside the range between –1.96 and –1.96, the measured data contradict the null hypothesis at a significance level of 95 per cent, causing us to reject it and accept the alternative hypothesis.

A number of studies have been published showing that parametric tests are less reliable than non-parametric tests because the former presupposes the normality and homoscedasticity of the sample. However, Brown and Warner [1985] showed in their study that stock prices do not follow a normal distribution, so parametric tests give a higher proportion of erroneous results. Nevertheless, numerous studies using event analysis methodology were conducted using parametric testing to measure the significance of the results. Ederington et al. [2015] examined the bond market using both parametric and non-parametric tests. To do this, the various tests were first tested on a random sample of 10,000 elements, where it was concluded that although the non-parametric tests are more effective, the parametric tests are also suitable for the reliable detection of the abnormal event.

Parametric tests are accepted in both Hungarian and international literature and are often used, which has already been used to examine the effect of COVID-19 on the stock price of European airlines (Kökény et al. [2022]), the impact of the Russian-Ukrainian conflict (Granát et al. [2023a]), the relationship between the quarterly reports and the S&P 500 (Rácz & Huszár [2019]), the impact of a Central Bank's speeches (Neszveda & Siket [2023]), or the effect of the QE program on interest rates (Krishnamurthy & Vissing-Jorgensen [2011]).

Data

At the beginning of our research, before we started to investigate whether we could find an abnormal return on the stock market around the time of the announcement of the quantitative easing, we had to first determine when the US central bank launched an asset purchase program to control the crisis, and in what size. At this point, a large body of data is not yet available, because it is a completely new monetary policy instrument, which has been mostly used by the Fed and many other central banks during the recession. As this research examines the anomalies of the US stock market, I downloaded the announcements of these asset purchase programmes from the reports of the Federal Open Market Committee (FOMC), and these data are included in Table 1.

In the calculations, the date of each event was taken to be the corresponding date from Table 1, and the event window was created according to the method described in Chapter III. In order to determine the historical market return, a 100-day calculation window was taken in each case, which ended 10 days before the event window. I have taken the market return to be the S&P 500 index, as arguably it provides the most comprehensive picture of the US stock market as a whole, since it does not focus specifically on technical or value-based stocks as does the Nasdaq Composite or the Dow Jones Industrial Average. After determining the regression parameters, we determined the abnormal return according to equation (2), which was aggregated using equation (3). To define the event window, we used the symbols 0 and 1, the latter in cases where the date represents a day close to the event. For the statistical analysis of abnormal return, we used the STATA 14 software. Once our downloaded

data were ready, we imported them into the program, where the cleaning process began. In the process, we did not have any data series that were incomplete, as we mainly examined the sectors followed by Standard & Poor's or stocks with high market capitalisation. They were then sorted by sector/company and date, and the data cleaning was completed.

Table 1: Dates of quantitative easing announcements by the Federal Open Market Committee and ceiling for each asset purchase programme

Event	Date of announcement	Volume of quantitative easing
QE1 announcement	2008. 11. 25	$600.000.000.000
QE1 extension	2009. 03. 18	$1.750.000.000.000
QE2 announcement	2010. 11. 03	$600.000.000.000
QE3 announcement	2012. 09. 13	$1.955.000.000.000**
QE3 extension	2012. 12. 12	Prolonged*
QE4 announcement	2020. 03. 16	$700.000.000.000
QE4 extension	2020. 03. 23	Unlimited asset purchase

Source: Fed, Yardeni Research

*-the target was not reached before the target date, so the FOMC prolonged the asset purchase programme

**In the case of QE3, the central bank purchased $85 billion worth of assets on a monthly basis, which represents asset purchases of approximately $1,955,000,000,000 over the almost 2-year period of the programme

Next we created new variables in order to get a more accurate result in the calculation. From both the market return and the sector/company returns, a chain ratio was determined for the sample as a whole, and then the natural logarithm of these was taken. After the log return calculation, a regression analysis was carried out using a rangestat, during which we obtained, among other things, the values α and β, so we calculated the abnormal return based on the following equation:

$$AR_{it} = R_{it} - (\alpha + \beta_i * R_{mt}) \tag{6}$$

where R_{mt} denotes the market return, and $\alpha + \beta_i * R_{mt}$ is equal to the value of $E(R_{it})$ as per equation (2). The final step is to test the data obtained so far, which we carried out using t-statistics. In doing so, we removed data where the value "1" was not assigned to the date, at which point only the event windows and the associated abnormal return remained in the program. The t-statistics were run in several ways in each case, as the examination covered not only the sum of the events, but also the sectors and periods. We explain these in the presentation of the results.

For the purpose of our analysis of US sector returns, the data was consistently downloaded from the Thompson Reuters database. Since we primarily examined the

existence of abnormal return in this study, we were not concerned with measuring and testing the change in traffic even if abnormal returns did occur.

This was followed by the examination of the sector returns of the S&P 500 and the cumulative performance of these returns in the period between 2008 and 2020, where the QE1, QE2, QE3 and QE4 announcements were examined In the case of the latter programme, we also examined whether there is a significant AR at the end of the phase-out, in order to examine whether there is an adverse market reaction after the announcement.

Table 2: The S&P 500 sectors analysed in this study broken down into 11 elements

Breakdown of the sectors of the S&P 500	2008 (%)	2020 (%)
Consumer Staples	12,9	7,7
Materials	2,9	2,2
Consumer Discretionary	8,4	9,9
Health Care	14,8	13,0
Energy	13,3	4,0
Real Estate*		2,7
Industrials	11,1	8,7
Information Technology	15,3	22,1
Utilities	4,2	3,0
Financials	13,3	12,7
Communication Services	3,8	13,8

Source: Seeking Alpha

Note: The table contains the sectors examined and their percentage distribution based on market capitalisation. The data were taken from the first trading day of the given calendar year, so they show the distribution before the crisis. The table is sorted by name.

*As a sector of the S&P 500 index, property was part of the financial sector until August 2016, which is why it is not included in the 2008 data.

Results

The results presented below relate to the sectors of the S&P 500 listed in Table 2. The results of our investigation will be presented for the extension of QE1, the announcement of QE2 and QE3, and the declaration of the 2020 asset purchase programme, and its subsequent phase-out. The reason for this was that the announcement of QE1 took place in an overly volatile environment and fell short of its extension in terms of volume, so its measurable impact on the market was also negligible, causing us to take the latter as the event day. In our study, we observed the significance of each day of interval separately for each sector index, and not the mean AR of the interval. After calculating the abnormal returns based on the previously mentioned methods and running the t-statistic, we obtained clear results. The effects of the

quantitative easing announced in the period 2008–2012 were essentially the same. However, only four of the 11 sectors had a significant abnormal return for least three out of the three dates, while the other sectors did not meet this criterion. Although there were days for these sectors that were significant, it could not be clearly established that the abnormal return was caused by the announcement of the central bank intervention. These values are shown in Tables 4 to 6.

Table 4: Abnormal returns of the S&P 500 sector indices and the corresponding t-test values under QE1

	T_{-1}		T_0		T_1		T_2		T_3		T_4	
	AR	t-test	AR	t-test	AR	t-test	AR	t-test	AR	t-test	AR	t-test
Cons. staples	-0,49%	-0,63	-2,15%	-2,79*	-0,43%	-0,56	1,68%	2,19*	-0,99%	-1,29	1,11%	1,45
Cons. Discr.	0,16%	0,12	3,50%	2,63*	1,26%	0,95	0,32%	0,24	1,99%	1,50	-0,28%	-0,21
Financials	1,44%	0,59	4,33%	1,76	-5,65%	-2,30*	-1,24%	-0,51	3,91%	1,59	-2,95%	-1,20
Health care	-0,68%	-0,87	-1,80%	-2,29*	-1,71%	-2,18*	1,37%	1,75	-1,50%	-1,92	-0,13%	-0,16

Table 5: Abnormal returns of the S&P 500 sector indices and the corresponding t-test values under QE2

	T_{-1}		T_0		T_1		T_2		T_3		T_4	
	AR	t-test	AR	t-test	AR	t-test	AR	t-test	AR	t-test	AR	t-test
Cons. staples	-0.40%	-1.21	-0.20%	-0.59	-0.03%	-0.10	-0.40%	-1.21	-0.08%	-0.25	-0.13%	-0.40
Cons. Discr.	0.53%	1.02	1.11%	2.12*	0.65%	1.24	0.40%	0.75	0.19%	0.35	-0.41%	-0.78
Financials	-0.57%	-1.07	0.48%	0.91	0.75%	1.42	1.46%	2.74*	-0.53%	-0.99	-0.81%	-1.53
Health care	-0.27%	-0.64	-0.17%	-0.40	-0.93%	-2.24*	-0.82%	-1.97*	-0.30%	-0.73	0.07%	0.17

Table 6: Abnormal returns of the S&P 500 sector indices and the corresponding t-test values under QE3

	T_{-1}		T_0		T_1		T_2		T_3		T_4	
	AR	t-test	AR	t-test	AR	t-test	AR	t-test	AR	t-test	AR	t-test
Cons. staples	-1.09%	-3.53*	0.68%	2.19*	-0.93%	-3.01*	0.59%	1.91	0.37%	1.19	0.08%	0.26
Cons. Discr.	0.29%	0.49	-0.91%	-1.55	1.43%	2.41*	-0.37%	-0.63	0.29%	0.49	0.79%	1.33
Financials	0.34%	0.80	0.53%	1.25	0.39%	0.93	-0.45%	-1.08	-0.04%	-0.09	-0.35%	-0.83
Health care	-0.10%	-0.26	-0.18%	-0.47	-0.84%	-2.14*	0.90%	2.29*	0.41%	1.06	-0.18%	-0.46

Note: Tables 4 to 6 show abnormal returns due to QE programmes announced after the 2008 crisis and their t-values in the 6-day event windows examined. The first column shows the S&P 500 sector indices, while the first row shows the days covered by the event window. In each case, we plotted the abnormal return and the associated t-value. The date of each event was taken to be the corresponding date in Table 1, which indicates the date on which the asset purchase programme was announced. For each of Tables 4 to 6, the t-tests were tested at a 95 per cent confidence level, with a critical value of ±1,96. Significant values are marked with * in the table.

The results show that quantitative easing has a measurable effect on individual sector indices. In the post-GFC period, for three sectors, abnormal returns were measured each time, with one exception, on the day of the announcement or one day after, the strong exception being the financial sector. This result is the same as what Rai et al. [2020] found for European sector returns. In their study, they explained the lack of significance by the fact that when quantitative easing is announced, two factors are priced into market prices: monetary policy and information shock. In the case of the European sectors, the information shock had a negative effect on each sector, while the former had a positive effect, so their combined effect can easily neutralise the effect of quantitative easing, which happened in the case of the financial sector. This study does not cover the measurement of the magnitude of monetary policy and information shocks for US sector returns, but it can be assumed that this may be the reason for the financial sector's lack of abnormal returns in the period after 2008.

However, the examination of abnormal returns alone provides little information when the effect of quantitative easing is to be measured. In the aforementioned case, it was seen that the financial sector was still significantly affected by the announcement of quantitative easing, despite the fact that it could not be detected with this methodology in the given time period. However, the impact of the central bank in-

tervention can already be demonstrated by examining the cumulative abnormal returns of the event windows.

Table 7: Abnormal returns accrued before and during the quantitative easing period for significant sectors

	Consumer Staples		Consumer Discretionary		Financials		Health care	
	AR_{t-1}	$CAR_{(t-1, t4)}$	AR_{t-1}	$CAR_{(t-1, t4)}$	AR_{t-1}	$CAR_{(t-1, t4)}$	AR_{t-1}	$CAR_{(t-1, t4)}$
QE1	-0,49%	-1,26%	0,16%	6,95%	-1,36%	0,50%	-0,68%	-4,44%
QE2	-0,40%	-1,25%	0,53%	2,46%	-0,57%	1,60%	-0,27%	-2,42%
QE3	-1,09%	-0,31%	0,29%	1,50%	0,34%	0,41%	-0,10%	0,01%

Note: Abnormal returns before the day of the event were compared with the cumulative abnormal return that occurred in the market within the event window after the announcement of quantitative easing. shows the value of the abnormal return on the day before the day of the event, while shows the cumulative value of the abnormal returns on the day before and on the day of the event, and on the four days following the day of the event.

Summarising the results so far and the data in Table 7, it can be said that despite the turbulent market movements, the effects resulting from quantitative easing can be detected. Shares included in the discretionary consumer goods index, i.e. companies whose products are not essential for consumers, performed spectacularly as a result of the announcement. It can be seen that the values of the cumulative abnormal return were significantly positive in the event window examined around the announcement of all three asset purchase programmes, while negligible, statistically insignificant values were observed on the day before the event (t_{-1}). This was due to the fact that, after the announcement, the AR values were very different from the market model estimation in most cases and positive in terms of direction, which were mainly related to the intervention of the central bank.

The opposite effect can be observed for general consumer products, which are essential for consumers. According to our assumption, this is due to the fact that during recessions, when households' wealth deteriorates, the demand for non-essential consumer goods decreases, thus the stock prices of companies operating in this sector fall. Quantitative easing, as noted in Chapter I, increases the amount of cash in the economy and stimulates the aggregate demand, as a result of which the demand for discretionary goods also increases.

In addition, Table 7 shows that the cumulative abnormal returns become smaller in absolute value as we move from QE1 to QE3. While the CAR value of the consumer discretionary sector index calculated in the event window is 6.95% at the announcement of QE1, it is only 1.50% in the event window of QE3. The same is observed (in absolute value) for the consumer discretionary and health care sector indices. These results are partly consistent with the study by Da Silva and Rungcharoenkitkul [2017], who found that the effectiveness of quantitative easing declines significantly over time. While the first quantitative easing programme resulted in a 25-100 basis point decline in 10-year US Treasury yields, QE2 was only able to re-

duce them by 15-45 basis points. As mentioned above, a number of studies (Hartley & Rebucci [2020]; Joyce et al. [2011]) highlight that quantitative easing can have an impact on the capital market by reducing long-term yields. Thus, to the extent that the yield-reducing efficiency of QE programmes declines over time, it may also have a more muted effect on capital market asset prices, and the results found for cumulative abnormal returns are not surprising.

In Tables 4–6 we have shown that in the case of the index covering stocks in the financial sector, apart from the odd day, a significant abnormal return was almost nowhere to be found after the announcement. Looking at the CAR values, however, it can be said that while a negative AR value could be measured on the day before the event, the cumulative abnormal return was positive in all cases by the end of the period under review, but its t-value was also not significant.

The most surprising result of our study came from the health sector, which produced a significant negative abnormal return at a 95 per cent confidence level on the day after the announcement of all three QE programs, and the CAR value of the event window examined during the first asset purchase program was –4.44 per cent.

Table 8: Abnormal returns of the S&P 500 sector indices, supplemented by the corresponding t-test values and the cumulative abnormal return

	T-1		To		T+1		T+2		T+3		CAR
	AR	t-test	AR	t-test	AR	t-test	AR	t-test	AR	t-test	
Energy	5,77%	5,51	-3,56%	-3,40	6,07%	5,80	3,45%	3,29	0,03%	0,03	**+8,36%**
Real estate	-2,33%	-2,57	-3,51%	-3,88	1,62%	1,79	3,57%	3,95	3,08%	3,40	**+4,90%**
Industrials	-0,75%	-1,49	-1,60%	-3,18	3,18%	6,35	4,09%	4,93	0,29%	0,57	**+4,24%**
Utilities	-5,40%	-6,17	-3,38%	-3,86	3,91%	4,47	1,94%	2,22	3,68%	4,20	**+3,69%**
Consumer Discr.	1,17%	2,72	3,00%	7,00	0,45%	1,04	0,13%	0,29	-1,06%	-2,48	**+3,30%**
Financials	1,53%	3,48	-3,02%	-6,88	2,34%	5,35	1,45%	3,30	-0,27%	-0,61	**+2,45%**
Materials	0,71%	1,27	-2,12%	-3,77	2,41%	4,27	1,14%	2,02	-0,97%	-1,72	**+0,63%**
IT	0,82%	1,82	2,57%	5,72	-1,23%	-2,75	-1,76%	-3,93	-1,33%	-2,96	**-1,55%**
Health Care	-0,01%	-0,01	-2,33%	-4,60	-1,34%	-2,66	0,09%	0,19	0,91%	1,80	**-1,90%**
Consumer Staples	-3,33%	-5,87	-0,79%	-1,39	-1,91%	-3,36	-1,03%	-1,82	0,97%	1,71	**-4,24%**
Communication S.	-0,69%	-1,62	2,34%	5,48	-2,58%	-6,05	-2,65%	-6,21	0,32	0,76	**-4,29%**

Note: The sectors in the table are sorted in descending order according to the CAR values, the value of which shows the cumulative abnormal return on the 4th day after the event. The first column shows the S&P 500 sector indices, while the first row shows the days covered by the event window. The length of the event window is the same as the length of the window examined for the first three QEs, and the value of t+4 days is calculated from the cumulative abnormal return (CAR). In each case, we plotted the abnormal return and the associated t-value.

Central bank intervention in the coronavirus crisis was significantly different because the Fed waited for much shorter time before it deployed the unconventional toolbox, and it consequently did so in the most volatile period of 2020. In this part, we examined the announcement of two events, the first being the announcement of the quantitative easing programme, where the event date is 23 March 2020, when the Fed extended the volume of the asset purchase to make it unlimited, and the other event being 15 December 2021, when the US Central Bank Governor Jerome Powell announced the acceleration of the phase-out of the QE4 programme. In both cases, we used the 6-day event window described in Chapter III and used for previous results. The results of the March announcement for the various sectors are shown in Table 8 in a daily breakdown.

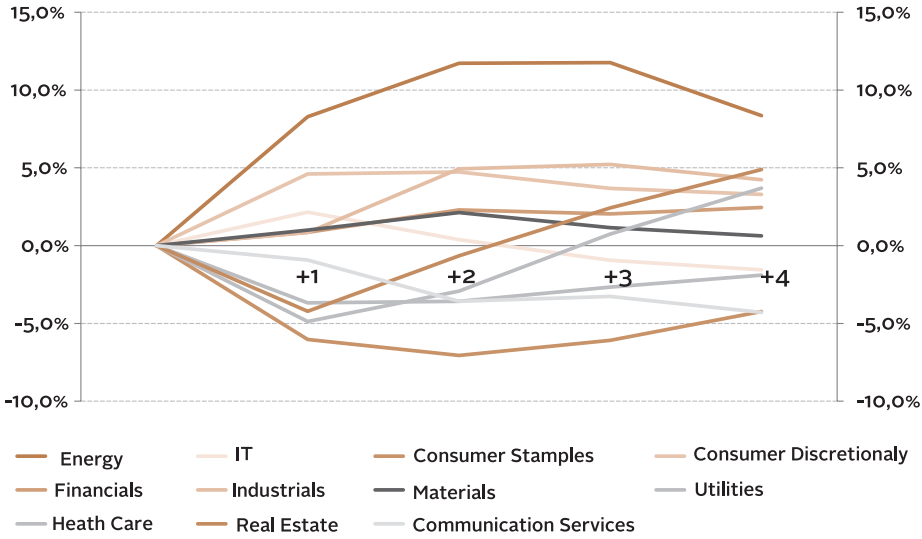
If we look at the cumulative value of abnormal returns in the event window, we can see that seven of the 11 main sectors accumulated positive values during the given period. Only for IT, telecommunications, health and general consumer products can negative CAR values be observed. The latter two results are the same as those observed during the 2008–2012 period, as the announcement of the QE programmes had a negative impact on these two sectors. The sector with the highest CAR value was energy, which accumulated an abnormal return of 8.36 per cent in the 6-day interval, while a significant negative AR value was still observed on the day of announcement.

It is important to note that the announcement was made on day after the closing of the market, so its effect could only be observed from day . On this day, a significant abnormal return was measured at a 95 per cent confidence level in nine of the 11 sectors, which remained in place for 8 sectors on day . However, it can be seen that there was a significant AR on the market the day before the event, which shows that the market environment under review in this period was highly turbulent. The announcement of the extension of the quantitative easing resulted in a trend reversal regarding the stocks, which is clearly linked to the intervention of the central bank.

Comparing the significant results examined for the first three programmes with the QE4 results, clear conclusions can be drawn. As we have already mentioned, general consumer goods and the health sector have been negatively affected by all four asset purchase programmes, which, in our view, in addition to the central bank's crisis management measure, may warrant other targeted interventions in these two sectors in order to stabilise them. Discretionary consumer goods, which was the most responsive sector in the previous QE programmes, performed positively in the examined event window as well, with a cumulative abnormal return of 3.30 per cent. The most interesting observation in the case of the financial sector is that we received a significant negative AR value on the day of the event, this was before the announcement, followed by a significant abnormal return at a 99.9 per cent confidence level on days and . In this case, the effect of the unconventional instrument was already clearly measurable.

Chart 3 shows the cumulative abnormal return of the announcement, expressed as a percentage, starting from the same base.

Chart 3: Cumulative abnormal return expressed as a percentage after the announcement of the start of the quantitative easing programme



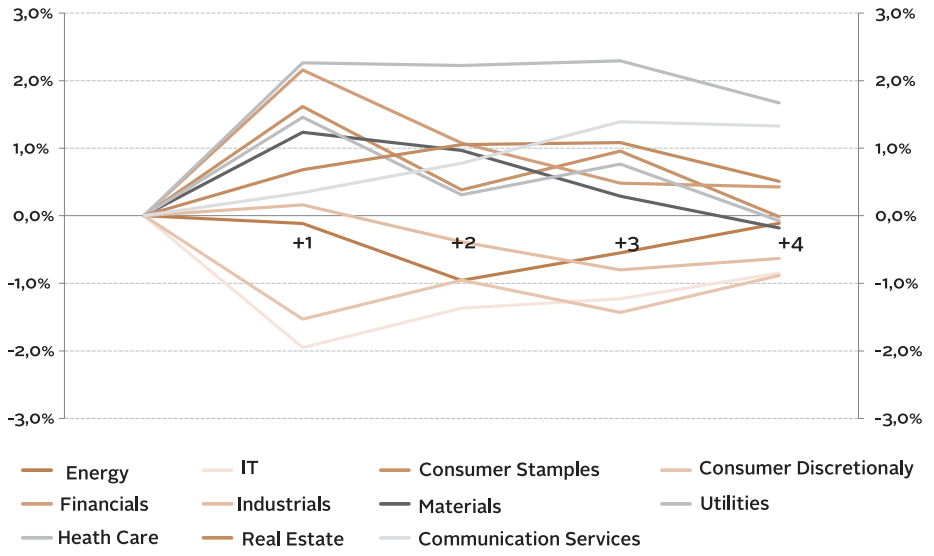
It is readily apparent that the magnitude and direction of the announcement effect can be clearly established for most sectors, while there were sector components, such as IT or materials where this was less so, whereas the real estate and utilities sectors produced negative abnormal returns on the first day after the event and closed with positive CAR values at the end of the period. It is worth comparing the figure with the cumulative abnormal return of the event window examined around the announcement of the phase-out of the QE4 programme.

Chart 4 shows at first glance that the variation of abnormal returns is lower, because while the values fell roughly between –7 per cent and +12 per cent as a result of the announcement, the CAR values were within the range of –2 per cent and +3 per cent after the FOMC meeting in December 2021.

It is also clear that on the first day of Chart 3, the three best performing sectors (energy, discretionary consumer goods, IT) were the three worst performing sectors on the first day of the announcement of the phase-out of the QE programme, which is understandable, since if the announcement of the programme is priced into the market, it should have the opposite effect on the stocks at the time of the phase-out, and this was clearly so in this case. General consumer goods and health, which produced negative abnormal returns as a result of all four rounds of quantitative easing, are in positive territory as seen in Chart 4,

and the latter has become the best performing S&P sector component in the event window.

Chart 4: Cumulative abnormal return expressed as a percentage after the announcement of the phase-out of the quantitative easing programme



It is worth noting, however, that at the FOMC in December 2021, the Governor of the Central Bank, in addition to the phasing out of QE, raised a larger increase in the base rate, which is also an important factor in terms of market returns, so in this case the impact of QE is not clearly measurable, but, as mentioned previously, abnormal returns in a spectacularly opposite direction were present in this case than when the launch of QE4 was announced.

Conclusion

In our study, we examined the effect of the announcement of the quantitative easing used by the central bank through the event analysis methodology for the S&P 500 sector indices. It is clear from the results described in Chapter V that, despite the volatile market conditions, the impact of the examined event on stock market returns is clearly visible and somewhat separable from the other factors. The 100-day calculation window proved to be a good choice, as we were able to calculate the regression coefficients from a sufficiently large sample and they gave reliable results for the abnormal return calculated with the market model.

In conclusion, the announcement of quantitative easing has a clear effect on US stocks and thus on the main focus of the study, US sector returns. However, similar to the findings of Thornton [2013], there were some announcements (QE1, QE2, QE3) that did not have significant abnormal returns, while the findings of Joyce et al. [2011] are supported by the fact that the significant AR and CAR values we found pointed in a different direction. There were some sectors that reacted positively and some that reacted negatively to the announcement.

Stocks in the discretionary consumer goods sector are among the top gainers from the amount of money introduced into the economy by the programme, as they consistently responded positively to the announcement, without exception. In addition, it was seen that most of the market tended to respond positively to the announcement of quantitative easing, despite the fact that the Fed's primary goal is not market stabilisation, yet its action stimulates it indirectly. Sectors such as health and general consumer products, which have consistently reacted negatively to announcements, may require further intervention in order to stabilise. The reaction of the healthcare sector to the announcement was surprising, as none of the studies have shown that this sector significantly underperforms the market. However, by the end of the event window, it had delivered negative CAR values on 3 out of 4 announcements.

In examining the financial sector, typically no statistically significant abnormal return was found in the days following the announcement due to the opposite effect of the two factors, which is consistent with the study by Rai et al [2020]. However, in some cases, as in the first two days after the announcement of QE4, a significant AR value was detected at a 99.9 per cent confidence level, while before the announcement an AR value of –3.02 per cent was calculated. Here the impact of the central bank intervention is clear. This result is the same as our assumption that the financial sector is affected by the announcement of the programme, while the magnitude of this effect is significantly smaller than what we expected, which is evident from the fact that in the event window of the announcement of the fourth programme the financial sector only has the 6th highest CAR value.

As mentioned earlier, the declining trend in the cumulative abnormal returns of the first three quantitative easing programmes is partly consistent with the findings of Da Silva and Rungcharoenkitkul [2017], but contradicts the results presented in Corbet et al [2019], which found that the announcement of QE2 and QE3 had a more significant impact on capital markets. One of the reasons for this may be the different time horizon analysis.

In this study, we did not examine the intraday effect of the announcement, or the two factors mentioned that affect the price of stocks in the financial sector after the announcement, so these provide an opportunity to extend the study. Further research might investigate the role of media attention, which is known to be important for many fields, for instance, climate finance (Choi et al. [2020], Csillag et al. [2022]) or the application of new NLP techniques in finance (Zaremba & Demir [2023]). ■

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