QUANTITATIVE EASING AND STOCK MARKET BUBBLES: EVIDENCE FROM THE US AND JAPAN

by

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LIST OF ABBREVIATIONS

BoJ Bank of Japan

CAPE Cyclically Adjusted Price Earnings Ratio

CB Central bank

CME Comprehensive monetary easing

ECB European Central Bank

ETF Exchange Traded Fund

Fed Federal Reserve System

GDP Gross Domestic Product

GSADF Generalized Sup Augmented Dickey Fuller

LSAP Large-scale asset purchase

MBS Mortgage-backed securities

QE Quantitative easing

QQE Quantitative and qualitative easing

S&P 500 Standard & Poor's 500

TSY US Treasuries

UMP Unconventional monetary policy

ZLB Zero lower bound

CHAPTER 1. INTRODUCTION

When the Great Recession struck, central banks of major developed economies were forced to act with a view to stimulate the shrinking demand. As their main monetary policy tool – interest rates – approached the zero lower bound (ZLB), the decision-makers turned to an unconventional tool – the large scale asset purchases (LSAP), often referred to as quantitative easing (QE). However, it was neither the US nor Europe who came up with the QE. In fact, it was Japan who first introduced QE programs in 2001, as the Bank of Japan (BoJ) was reducing the policy interest rate and eventually reached ZLB in 1999. Since then, QE has become a regular instrument in the BoJ toolkit, as well as in the Fed, ECB, and BoE toolbox, starting from 2008. As a result, the balance sheets of central banks increased considerably.

It's not only government and corporate bonds that comprise the ever-increasing balance sheets of the central banks. As a matter of fact, BoJ for years has been buying stocks and exchange-traded funds (ETFs) in bid to break out of deflation spiral and reach a 2% price stability target (Nangle and Yates 2017).

The question remains of how could QE possibly lead to stock market bubbles. To understand that, it is necessary to explore the reasoning behind QE and its transmission mechanism.

QE programs are executed when the main policy instrument of CBs – interest rate – hits ZLB. So far, CBs remain unwilling to push the policy rate deep into negative territory, though the ECB has maintained its interest rate marginally negative since 2014 (-0.5% since 2019). When interest rates were far above the ZLB, CBs were quite successful in managing inflation and business cycles. Are they successful now, in the era of QE and low interest rates, in managing inflation and economic growth? Most probably, no. As recovery from the financial crisis didn't reach the desired pace and inflation has remained modest in the developed economies, the major central banks haven't managed to lift the interest rates substantially and unwind all the liquidity they've injected into the economy.

It is key to understand where the liquidity has been injected to. Bank lending, the byproduct of diminished interest rates, is the traditional source of new money creation. Does QE lead to higher volumes of bank lending? Potentially, but not necessarily. How do US Treasuries (TSY) end up in the Fed balance sheet? The Fed does not buy TSY directly from the Treasury, this would be inflationary. Furthermore, this would mean that Fed's liabilities are legal tender which would contradict the Federal Reserve Act. Primary dealers (banks) buy TSY and then flip them to Fed. However, banks do not get cash in return. Instead, the Fed credits their reserve account in some of the regional Fed banks. The banks can't use the money from the reserve account, because it's a collateral account. They could lend against it but they have enough money to do it anyway.

Lending becomes the question of demand, and if interest rates were falling, consumers would want to borrow more, wouldn't they? Yes, but it's not as easy as it seems. During recessions, when the economy needs stimulus most, lending standards often tighten, and lending volumes shrink.

Nevertheless, there could be inflation in some parts of the economy. When TSY end up on the Fed's balance sheet, a big part of the supply is removed from the market, which lets the yields on TSY stay low or even fall. This effect rolls over into capital markets where yields also don't rise. Moreover, CBs often buy corporate bonds, sometimes even the highest-quality bonds from Apple, Berkshire Hathaway as Fed did in 2020. Why would the Fed do that? These actions lead to a fall in yields on high-quality bonds and worse bonds, junk bonds, as well. When the rates on an AAA-rated bond are low, investors turn their attention to worse bonds in the hunt for yield. That is why corporate bond issuance in 2020 are at the highest levels in years despite the worst recession in decades. How do the companies spend the borrowed money? During the last decade, we saw very large volumes of stock buybacks as executives sometimes tried to increase their bonuses that are often tied up to stock prices.

Where else do investors look to in the hunt for yield as their fixed income portfolio yield diminishes? To the stock market that could still offer yield, at least in the US. This is one of the reasons for quick market recovery in 2020 after the March lows. The narrative that the Fed will always step in and won't let the stock market fall too much also spurs the recovery. Even retail investors started to pile up into stocks in 2020 after receiving fiscal stimulus from the US Government. Their options activity was one of the main drivers of the stock market rally in August 2020.

This is how QE could create inflation and even distortions in asset prices. Furthermore, subsequent forms of QE, such as yield curve control, could eliminate any volatility in bond markets as yield rise is dangerous at the current record-high debt levels. A lot of investors look into bond markets' signals to anticipate movement in the stock markets and the economy in general. False signs or the absence of signals could become an issue.

That is precisely where the investors' worries lie – has the Fed and other CBs distorted the market completely with artificial liquidity? Perhaps, the Fed just saved the economy from even deeper recession, and its actions don't contribute to unnatural equity valuations. In fact, there have been a few papers that looked at the effects of central banks' balance sheet expansion on the equity market, though none studied the effects of the 2020 QE programs, as little time has passed. Still, some studies focus on the response of markets to the QE announcements, for instance, the study of Rosa et al. (2012) shows that LSAP news have substantial and significant effects on asset prices. Logan and Bindseil (2019) examine the effect of large central bank balance sheets on market functioning and find out that the effect is predominantly positive, though sometimes causes asset scarcity issues.

Little is known, however, regarding the impact of QE interventions on exuberant[1] equity market activity, i.e. whether these unconventional monetary policy programs lead to the formation of "bubbles" in asset prices. Asset bubbles emerge when market prices rise over a certain period of time, while the fundamentals do not, which, in turn, causes prices to deviate from the fundamental component that causes the bubble itself. These bubbles are sometimes considered to be the underlying causes of recessions. Hudepohl et al. (2019) study the impact of QE on asset bubbles in the euro area countries and confirm that QE interventions indeed lead to formation of bubbles. This paper studies the asset bubbles formations on the US and Japan equity markets and looks at whether excess liquidity provided by the central banks does lead to exuberant behaviour of investors. The results of the study can be used by investors to anticipate potential severe market corrections.

This paper focuses on the stock markets of the US and Japan and examines what was QE impact in the existence of bubbles in the respective stock markets over two different periods: January 2005 – September 2020 for the US and January 1997 – September 2020 for Japan.

As a main equity valuation indicator, we use the so-called Buffet Indicator, the market capitalization to GDP ratio. The indicator is popular among investors and is often used to showcase the level of valuations and give warning signals. Kuvshinov and Zimmermann (2018) find out that the ratio is effective in predicting equity returns compared to the traditional price-dividend ratio. This metric is tested for bubbles by applying the generalized sup augmented Dickey-Fuller test (GSADF) to the time series. The test is known to be a good recent development in the field of econometric research with regard to asset bubbles identification. It was developed by Phillips et al. (2015) and is considered to be one of the best techniques in bubble detection, a very difficult and controversial subject in itself.

1 Throughout the paper, the concepts of exuberant activity and asset bubbles will be used interchangeably, as the meaning of both is very similar.

Afterward, a probit model is applied to determine the explanatory factors that are the causes of the bubbles.

The initial hypothesis is the following: there is a positive impact of QE on exuberant activity in the stock markets in the US and Japan over the studied period. The existence of exuberant activity does confirm in the case of the US, though at a 10% confidence level as the GSADF test was completed at the aforementioned confidence level to better capture smaller episodes of exuberance. The hypothesis was also confirmed in the case of Japan where several episodes of exuberant market activity were recorded over the period. Probit models were applied to the available data, and the finding is that the Fed's QE interventions explain the stock market bubble. In the case of Japan only one period of QE is significant.

The business community should find the research useful as it shows which macroeconomic variables influence the emergence of stock market bubbles. Though financial markets are unpredictable and complicated, sometimes one could predict a general trend when multiple indicators are moving in a particular direction. If several metrics indicate exuberance, an investor could either increase his or her cash position or try to look for some kind of another hedge asset. The paper does not offer any investment advice, and its results should be evaluated carefully before making any investments.

The rest of the paper is organized as follows. Chapter 2 reviews the literature related to the asset price bubbles and their identification. Chapter 3 provides a detailed outline of the methodology. Chapter 4 describes the data. Chapter 5 offers an overview of the results and Chapter 6 concludes.

CHAPTER 2. LITERATURE REVIEW

The influence of monetary stimulus on the economy as a whole, and on financial markets, in particular, is a well-studied problem. There are a lot of papers that cover both traditional monetary policy tools, such as interest rate shifts, and unconventional instruments, like QE and forward guidance. The literature can be split into three groups. The first group studies the impact of QE on economy. The second one looks at the QE in relation to financial markets. The last one describes asset bubbles and exuberant market activity with regard to the QE.

2.1. QE and its impact on the economy

"Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment" by Bernanke and Reinhart 2004 is one of the classical papers describing QE as an alternative to the conventional instruments of monetary policy, such as the overnight Federal funds rate in the case of the United States. Mr. Bernanke, who was the Chair of the Fed at the time of the Great Recession, when Fed for the first time began QE interventions, recognized the problem of interest rates hitting ZLB and studied the use of unconventional instruments, like monetary policy announcements, commonly referred to as forward guidance, and QE in the case of Japan that has already utilized it. In relation to forward guidance, Bernanke confirmed a potentially important role for central bank communications to shape public expectations of future policy actions. Regarding the changing the size of the central bank's balance sheet (or quantitative easing) by BoJ, Bernanke noted that yields in Japan were noticeably lower during the QE period than the model would have predicted that is an evidence for the effectiveness of this policy, though admitting that it was difficult to parse out the exact effects of QE on the economy at the time. He remained cautious in relation to QE policies and advised that the best policy approach is one of avoidance, achieved by maintaining a sufficient inflation buffer and easing preemptively as necessary to minimize the risk of hitting the ZLB. November 5, 2008 was the start date of QE1 in the US, when the Fed started buying direct debt obligations issued by Fannie Mae and Freddie Mac. Thus, QE interventions officially began in the US[2]. Later in 2015 Ben Bernanke in his memoir "The Courage to Act" writes the following: "We can't know exactly how much of the U.S. recovery can be attributed to monetary policy since we can only conjecture what might have happened if the Fed had not taken the steps it did." The effects of the first three stages of QE in the US have been thoroughly analyzed by other researchers. For instance, Luck and Zimmermann (2018) agree with Darmouni and Rodnyansky (2017) that certain banks are more influenced by the Fed's asset purchase programmes than others. Furthermore, they show that QE1 spurred local demand, and QE3 led to a rise in the supply of additional credit to firms that, in turn, increased employment. Beck et al. (2019) study the QE effects in a number of countries and found out that QE policies result in a steady increase in the CPI and inflation expectations. According to Beck, the main transmission channel of inflation was not stronger aggregate demand, but rather the exchange rate depreciation. Moreover, Beck did not find any evidence for side effects and increases in risk, with no downward effect on stock market volatility.

2.2. Impact of QE on financial markets

Let us first examine the QE impact on yields. Various literature sources suggest that QE has a large impact on the yields of Treasury and mortgage-backed securities and the effect varied across the different rounds of QE. For example, Krishnamurthy and Vissing Jorgensen (2011, 2013) illustrate that QE1 and QE3 decreased the yields of MBS and US Treasuries.

[2] There were four major QE interventions in the US. QE1 lasted from November 2008 to March 2010. QE2 was firstly hinted in August 2010 and officially started in November 2010 and lasted until June 2011. QE3 was announced in September 2012 and ended in December 2013. QE4, the last and largest one up to date, started in March 2020.

Though, they also illustrate that different QE rounds have dissimilar effects on yields (one could observe that the same happened with the effects of different QE stages on employment as described earlier). MBS yields were more strongly affected, though QE3's effect on MBS yields was much smaller than that of QE1. Moreover, the authors show that QE2, which consisted only of Treasury purchases, had very weak effects on yields.

There are also a lot of papers that study the QE impact on the stock prices, for instance, Balatti et al. (2016) use a six-variable VAR model and discover the existence of positive effect on equity prices, and a 'V' shaped response of volatility to the monetary stimulus in the US and UK. Rosa et al. (2012) discover that QE measures led to higher stock prices in the US. Barbon and Gianinazzi (2019) look at BoJ QE programs and illustrated that purchases of price-weighted Nikkei 225 ETFs lead to significant pricing distortions in comparison to a value-weighted criterion. Haistma et al. (2016) examine the response of stock markets to ECB policies and identify that unexpected QE announcements influence the EURO STOXX 50 index.

2.3. Asset bubbles and QE influence on exuberant market activity

There has been a lot of research on the definition of an asset bubble and on empirical methods that identify the bubbles. However, there is still no consensus on both questions.

Most economists agree that bubbles exist and divide them into numerous classes. Nevertheless, some respectable researchers dismiss the sheer existence of bubbles in asset prices. For instance, Eugene Fama, the "father of modern finance", in his 2014 paper considers the term "bubble" to be treacherous and not reliable at the very least. He argues that since academics define a bubble as a strong irrational increase in asset prices which is then followed by a predictable severe drop, they should be able to easily predict the decline, which they never do. Fama also questions the forecasters who predict the bubbles and encourages to assess their background. Nonetheless, this paper is based on the assumption that bubbles do exist and should be taken into consideration.

There are different approaches to bubbles classification but Wöckl (2019) identifies two major classes of theoretical bubbles: rational and behavioral bubble models. We are not going to focus on the nature and principal features of theoretical bubbles. However, it is important to point out that one could empirically detect only rational bubbles. That is why this section is devoted to the identification methods of rational bubbles.

There are a great many tests for bubble detection, however, there is no universally accepted reliable method. Moreover, sometimes there is no unanimity among economists on whether there is a bubble in a particular time series. As Gürkaynak (2008) aptly remarks in his survey of bubbles identification methods, "for each paper that finds evidence of bubbles, there is another one that fits the data equally well without allowing for a bubble."

For the sake of brevity, we are going to review advanced econometric methods as defined by Wöckl (2019) that include regime-switching, fractional integration and recursive unit tests.

It is worth mentioning the Evans' critique which is based on the fact that unit-root and cointegration-based tests, that are primarily used for identifying bubbles, are ill-fitting in the case of sporadically collapsing bubbles since these tests erroneously perceive collapsing bubbles as stationary processes, hence rejecting the hypothesis of a bubble in the time-series (Evans 1991). Markov regime-switching models instead allow for splitting the bubble part of the time series into expanding and bursting. For instance, Balke and Wohar (2009) apply Bayesian Markov chain Monte Carlo procedures to locate the bubble component in the log price/dividend ratio.

The next branch of research is related to the fractional integration concept. To obtain a stationary I(0) process researchers often use the integer order of differencing. Fractional integration constitutes a fractional order of integration. If time series are fractionally integrated, they possess a so-called long memory and are mean-reverting. Koustas and Serletis (2005) use fractional integration technique on S&P 500 log dividend yield and conclude that the data has no bubbles because fractionally integrated series are considered as such that could not contain a rational bubble. Cuñado et al. (2005) achieve an interesting conclusion applying the fractional integration method – bubble detection is contingent upon the sample frequency. They are not able to reject the null hypotheses of the unit root using monthly data on the NASDAQ index, thus confirming the existence of a bubble, while they are able to do so by using weekly and daily frequency data, hence denying the presence of a bubble.

The latest branch of the advanced methods is recursive unit root tests established by Phillips et al. (2011). The first major development in the series of these tests is the right-tailed sup augmented Dickey-Fuller test that tests the unit root hypotheses vs the explosive root by dividing the whole sample into smaller subsamples that start at the first and advance by one step.

Phillips et al. (2015) point out that recursive procedures have been found to be effective in defining and determining a specific date of financial bubbles in real-time. However, the authors point out that a profound econometric challenge arises when these methods are used over long historical periods. The main reason being that multiple bubbles that occur within the same sample period possess break mechanisms and a sophisticated nonlinear structure. That is why the authors develop the method that is a better fit for practical application with long historical time series - recursive flexible window method. The main distinction from the previous variation is that the window is flexible, and subsamples are no longer fixed to the initial observation. The test is known as the Generalized Sup Augmented Dickey-Fuller (GSADF) test. The method makes it possible to test for the formation of a bubble in a time-series that could include numerous bubbles.

There hasn't been a lot of studies that looked at asset bubbles and exuberant market activity with relation to QE, apart from Hudepohl et al. (2019) and van Lamoen et al.

(2017). The latter studied exuberance in European government bond markets, while the former examined European stock markets. Both papers apply a relatively new procedure GSADF that was developed by Phillips et al. (2015) that was explained earlier in the section.

Using this procedure, van Lamoen et al. (2017) analyze QE policies as a driver of sovereign bond yields, separate from traditional determinants, and finds virtually no evidence of exuberance in the bond markets. However, Hudepohl et al. (2019) examine QE in the euro area countries and, after controlling for raising macro fundamentals, find out that QE periods correspond with exuberant investor behavior.

Afsar and Dogan (2018) apply the GSADF test while looking for bubbles on the Turkey housing market. No evidence of asset bubbles was found. Caspi et al. (2018) look for explosive behavior of oil prices in comparison to the world prices and inventory levels of oil in the US. They utilize the GSADF test and manage to detect numerous periods of exuberant behavior.

This paper contributes to the existing literature by exploring the most recent and the largest QE intervention in history and its potential impact on stock market bubbles amid central banks' efforts to lessen the impact of COVID-19 outbreak on financial markets and the real economy.

CHAPTER 3. METHODOLOGY

Based on the existing literature and the current situation in the stock markets, the preliminary hypothesis would be a positive impact of QE on exuberant activity in the stock markets. Hudepohl et al. (2019) find strong evidence of this phenomenon in some eurozone countries. As the central banks of the US and Japan have a similar monetary policy as the ECB has and comparable level of economic development, we expect the QE to have an impact on bubbles formation in the US and Japan as well.

We focus on the US and Japan stock markets, hence we extract data on Wilshire 5000 and TOPIX indices. Why do we use the Wilshire 5000 as the valuation index for the US instead of the S&P 500? The main reason is the usage of the so-called Buffet Indicator for identifying exuberant activity. Buffet Indicator is the ratio of market capitalization to GDP. The name comes from the legendary investor, Warren Buffet, who called it "probably the best single measure of where valuations stand at any given moment" (Buffet and Loomis 2001). Traditionally, the Wilshire 5000 index is used in this indicator. How does it differ from the S&P 500? Wilshire 5000 includes far more companies than S&P 500, 3486 vs 500. Wilshire 5000 comprises all US stocks, whereas the S&P 500 covers only stocks with market capitalization higher than $6 billion. Technically, Wilshire 5000 is better than the S&P 500 as it covers the whole US market, though investors prefer to use S&P 500 as a benchmark.

What is the rationale for using the market cap to GDP ratio instead of the index itself? As Hudepohl et al. (2019) point out, it would be inaccurate to test the prices of these indices on exuberant behavior, because in that case, the GSADF test could falsely identify a bubble when an increase in price is justified by improving fundamentals and make a type I error. To prevent this from happening, we are going to use a more robust indicator for testing, the market capitalization to GDP ratio.

How does the indicator compare to other traditional valuation metrics? Kuvshinov and Zimmermann (2020) analyze the market cap to GDP ratio and the price-dividend ratio. They find out that the former ratio is superior to the latter in terms of return predictions, though the former falsely predicts the dividend growth compared to the latter. The researchers explain a higher predictive power of stocks return of the market capitalization to GDP ratio by comparing the composition of the ratios, i.e. the two indicators have different numerators and denominators – market cap vs prices and GDP vs dividends respectively. Furthermore, Kuvshinov and Zimmermann (2020) argue that market cap could be a more appropriate tool as a valuation measure compared to prices, and that GDP is a more suitable measure for fundamentals evaluation as opposed to dividends.

Then, to identify asset price bubbles we apply the GSADF procedure on the Buffet Indicator. The procedure is thoroughly explained in Phillips et al. (2013, 2015), Hudepohl et al. (2019), and the implementation in EViews is outlined in Caspi (2017). The methodology of the test is similar to the sup ADF (SADF) test with the purpose of investigating the presence of a bubble and is premised on a series of forward recursive right-tailed ADF unit root tests. Phillips et al. (2015) conduct empirical application of the methodology on S&P 500 index over a period from January 1871 to December 2010. The authors detect all big asset bubbles implementing this test, including the Black Friday, the 1954 postwar boom, October 19 1987 crash, and the dot-com bubble. In the meantime, other procedures tend to identify fewer episodes of market exuberance.

The bubbles are identified if the test value exceeds the simulated critical value. We create a dummy variable to specify the periods of exuberance in the markets. If a bubble is detected in a current period, there is a high probability that it could also carry over to the next one, even if it is deflating right now. As Hudepohl et al. (2019) note, this may possess explanatory power for the likelihood that equities are expressing exuberant behavior. To account for that, we use a dynamic probit model with random effects that is known to account for the persistence of explosive behavior over time.

We add different QE dummies, and the effect of each QE period may be different from other periods, which was described earlier in the case of the Great Recession in the US. The model specifications include the macroeconomic and financial drivers of the valuations in the stock markets. All the variables included in the model are known to influence stock prices. An exhaustive list of other indicators is presented in Table 1.

Table 1: Indicators and the reasons behind inclusion in the model

Metric	Relation to stock prices	Literature
Monthly real GDP growth	Relationship is not clear. Fama (1981) discovers that GDP growth and equity price are positively related. Though, some other papers either find no relationship or even negative.	Fama (1981), Dimson et al. (2002), Ritter (2005), Wu (2012)
10-year government bond yield	In the 20th century, correlation was negative. However, the financial markets crisis and the subsequent uncertainty drove the correlation positive in the 21st century.	Rankin and Shah-Idil (2014)
Monthly unemployment rate	Albeit unemployment is mentioned to be an economic growth metric that informs us about the stock market (Asprem (1989), link is recognized to be dubious or even non-existent. Gonzalo and Taamouti (2017) also discover that a high level of unemployment rate is usually followed by the Fed monetary policy measures, which, in turn, stimulates stock prices.	Asprem (1989), Farsio and Fazel (2013), Gonzalo and Taamouti (2017)

Table 1 - Continued

Metric	Relation to stock prices	Literature
Monthly growth in industrial production	It is expected to be positively related to stock prices as growth in production often leads to higher demand that, in turn, could drive companies' cash flows and, hence, stock prices. Moreover, the relationship is also confirmed on the sectoral level and the relation appears to strengthen with longer horizons.	Fama (1981), Humpe and Macmillan (2009), Schwert (1990)
Shadow short rate (SSR)	SSR estimates a possible level of short-term interest rate, if ZLB didn't exist. It is used as a measure of monetary policy in both unconventional and conventional environments.	Bullard et al. (2013), Wu and Xia (2016), Krippner (2012)
Monthly credit growth to the non-financial sector,% of GDP	Positive relationship with stock prices booms that were followed by the busts.	Jorda et al. (2015)
CPI	Unforeseen inflation announcements influence the stock market behavior.	Schwert (1981)
Volatility	Positive, found to be related to asset price bubbles	Narayan et al. (2013)

To make sure that the results are robust we also estimate logit and least-squares models with the same parameters. Furthermore, lagged bubble dummy is added to the list of explanatory variables, which is another way to perform robustness check.

CHAPTER 4. DATA

This paper is focused on stock price dynamics in two countries: the US and Japan. Thus, we extract data on stock market capitalization using free sources: Federal Reserve Economic Data (FRED) for Wilshire 5000 Total Market Full Cap index and Japan Exchange Group (JPX) for Tokyo Stock Price Index (TOPIX) and its sub-indices that together comprise market capitalization of all domestic-listed Japanese stocks.

The time period of the study is different for both countries. The main reason is the central banks of both countries started their QE interventions at different times, i.e. BoJ in March 2001, Fed in December 2008. So, the time frame for the US starts in January 2006 and for Japan – in January 1998 as we allow for bubble formation and an opening test window inserted in the data before the start of QE and famous historical recessions. One could argue for longer time periods, but we think it will be sufficient to stick to shorter ones as several papers analyzed the stock market of both countries for lengthy time periods.

Monthly data is used for all the calculations. It is considered to be a low frequency in relation to the stock market, though it should still be effective as multiple studies use it for bubble formation and to explain the discovered bubbles.

The resulting values of the Buffet Indicator for the US and Japan are depicted in Figures 1 and 2 respectively. Shaded areas represent time periods of QE interventions of the central banks as defined by the official sources, such as the New York Fed and the BoJ.

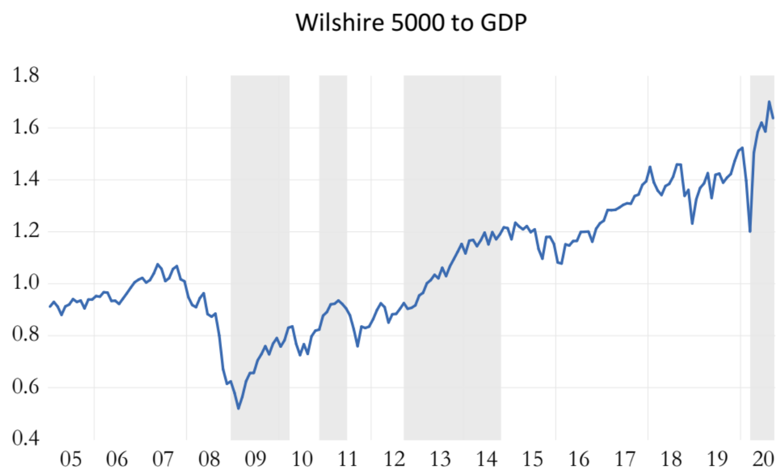

Figure 1. The Buffet Indicator, the US

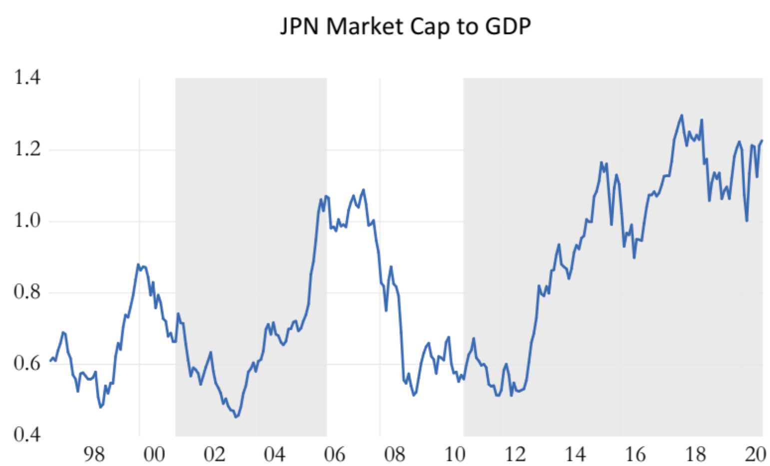

Figure 2. The Buffet Indicator, Japan

As we can see, the Buffet Indicator is far more volatile in Japan compared to the US. This is due to slower and weaker recovery from the Great Recession of the Japanese economy and the stock market. Japan has also had more often QE interventions than the US, though these interventions differed in volume and intensity of asset purchases. Tables 2 and 3 show the timeline and main features of QE interventions in the US and Japan respectively.

Table 2. QE timeline in the US

	Time period	Main features
QE1	December 2008 - March 2010	Acquisitions of agency securities ($175 bln) and MBS ($1.25trln)
QE2	November 2010 - June 2011	Acquisitions of long-maturity Treasuries ($600bln)
QE3	September 2012 - October 2014	Acquisitions of long-maturity Treasuries and MBS, fixed amount per month ($45bln and $40bln respectively)
QE4	March 2020 - Present	"Unlimited QE". Acquisitions of Treasuries, MBS and corporate bond ETFs

Source: NY Fed

Table 3. QE timeline in Japan

	Time period	Main features
QE	March 2001 - March 2006	Acquisitions of government bonds
CME	October 2010 – April 2013	Acquisitions of government bonds and ETFs
QQE1	April 2013 – January 2016	Acquisitions of longer-dated government bonds, corporate bonds and ETFs, higher volumes
QQE2	January 2016 – September 2016	Targeting of negative interest rates, Acquisitions of government bonds with longer maturity, corporate bonds and ETFs
QQE3	September 2016 – April 2020	Yield curve control. Acquisitions of government bonds, ETFs
QQE4	April 2020 - Present	"Unlimited QE". Limits on government bonds purchases removed, limits on corporate bonds and corporate paper increased

Source: BoJ, Pelizzon et al. (2019)

The BoJ has far more significant volumes and diversity of LSAP, e.g. the Fed has not yet started to purchase equities, while the BoJ started buying equity ETFs in December 2010, the BoJ also undertakes yield curve control that requires significant amounts of government bonds purchases. It has not stopped QE interventions from 2013 and until now. The volumes differed, but it's safe to say that Japan has become entirely dependent on QE programs. Figures 5 and 6 take a closer look at the dynamics of the balance sheet and its components of both CBs.

Tables 4 and 5 below depict descriptive statistics of the variables used in the US and Japan analysis respectively. The number of observations differs due to data availability. For instance, data on credit to non-financial corporations is available on the BIS site only up until March 2020.

Table 4. Descriptive statistics, the US

	Mean	Median	Max	Min	Std. Dev.	Obs.
CPI_CHN	2.012	1.985	5.600	-2.097	1.339	188
CREDIT	242.395	248.2	264.6	213.6	12.878	183
FED_ASSET	3190570	3385128	7097316	828901	1504352	177
FUNDS_RATE	1.382	0.37	5.26	0.05	1.701	189
IND_PROD	101.498	102.113	110.552	87.074	5.307	188
MBS	1082497	1164934	1982775	0	675011.2	177
SSR	0.606	0.418	5.263	-2.986	2.217	177
TREAS	1744504	1883559	4445477	474643	883135.1	177
UNRATE	6.222	5.2	14.7	3.5	2.187	189
VIX	19.108	16.3	59.89	9.51	8.717	189
WILSHIRE_5000_TO_GDP	1.067	1.022	1.701	0.519	0.242	189
_10Y_YIELD	2.852	2.66	5.15	0.55	1.088	189

Source: FRED, Yahoo Finance, BIS, OECD, Wu and Xia (2016)

Table 5. Descriptive statistics, Japan

	Mean	Median	Max	Min	Std. Dev.	Obs
_10_YEAR_YIELD	0.978	1.169	2.117	-0.28	0.647	273
CALL_RATE	0.094	0.05	0.715	-0.076	0.175	273
CORP_BONDS	24751.53	31756	53482	20	12911.28	139
CPI_CHN	0.118	0	3.7	-2.5	0.986	272
GOV_SECUR	1747802	902931.5	5357122	473373	1532040	270
ETFS	108079.7	64465	341861	142	104820.9	118
IND_PROD	102.692	101.907	119.473	79.593	6.843	272
JPN_MARKET_CAP_TO_GDP	0.805	0.738	1.298	0.452	0.234	285
TOT_CREDIT	28911.09	321.9	693974	301	138115.7	267
TOTAL_ASSETS	2263874	1372977	6899931	680064	1716178	270
UNRATE	4.093	4.2	5.5	2.2	0.901	272
VXJ	24.813	23.33	96.69	12.03	8.968	273

Source: FRED, BoJ, OECD, JPX, BIS

The full names of the variables and the units of measurements are shown in Table 13.

CHAPTER 5. RESULTS

5.1. Exuberant behavior in stock markets

GSADF tests for both countries were run in EViews using the methodology of Phillips et al. (ibid) and Caspi (ibid). 189 observations were included, and the initial window size was determined to be 27. 2000 Monte-Carlo iterations were conducted to identify the critical levels. The test was completed at the confidence level of 10% to capture more periods of exuberance than it is possible at a 5% level. The null hypothesis is that the examined time series have a unit root. Table 6 shows results for the US and the GSADF value indicates that there is exuberant behavior at a 95% level over the period January 2005 – September 2020. To calculate the Buffet Indicator values in Q3 2020 we use Atlanta Fed GDPNow projections.

Table 6. GSADF test results, the US

		t-Statistic	Prob.
GSADF		2.102131	0.0490
Test critical values:	99% level	2.723875	
	95% level	2.100742	
	90% level	1.864356	

Subsequent Figure 3 illustrates the same test graphically over the period. It is clear that there was an exuberant behavior detected in 2008-2009, during the Great Recession. Also, a small period of exuberance was observed in the run-up to the financial crisis in 2007. After that, however, the SADF sequence just exceeded the critical level in late 2013-first half of 2014 and once in January 2018, though it wasn't enough to consider it a proper bubble. However, the test did not detect any exuberance in 2020 as stock markets rebounded from their March lows. Though the Buffet Indicator reached record high levels recently, it wasn't enough to consider it a bubble.

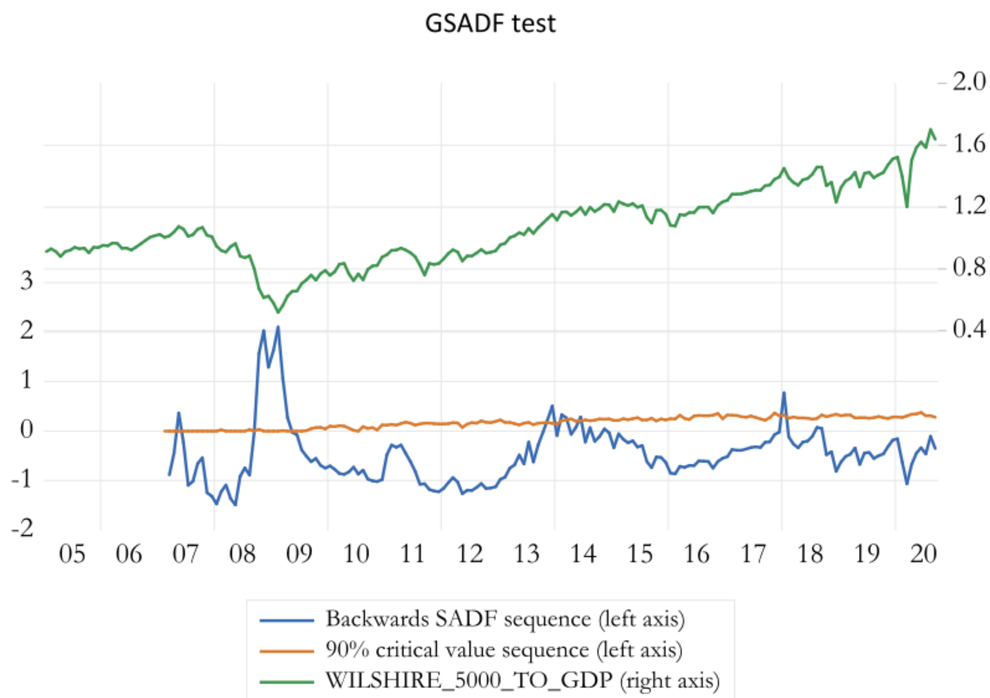

Figure 3. GSADF test, the US

The same exercise was carried out for Japan. The number of observations was increased to 285 and the window size to 33. The results are shown in Table 7 and Figure 4.

Table 7. GSADF test results, Japan

		t-Statistic	Prob.
GSADF		2.942532	0.0080
Test critical values:	99% level	2.914188	
	95% level	2.138069	
	90% level	1.924360	

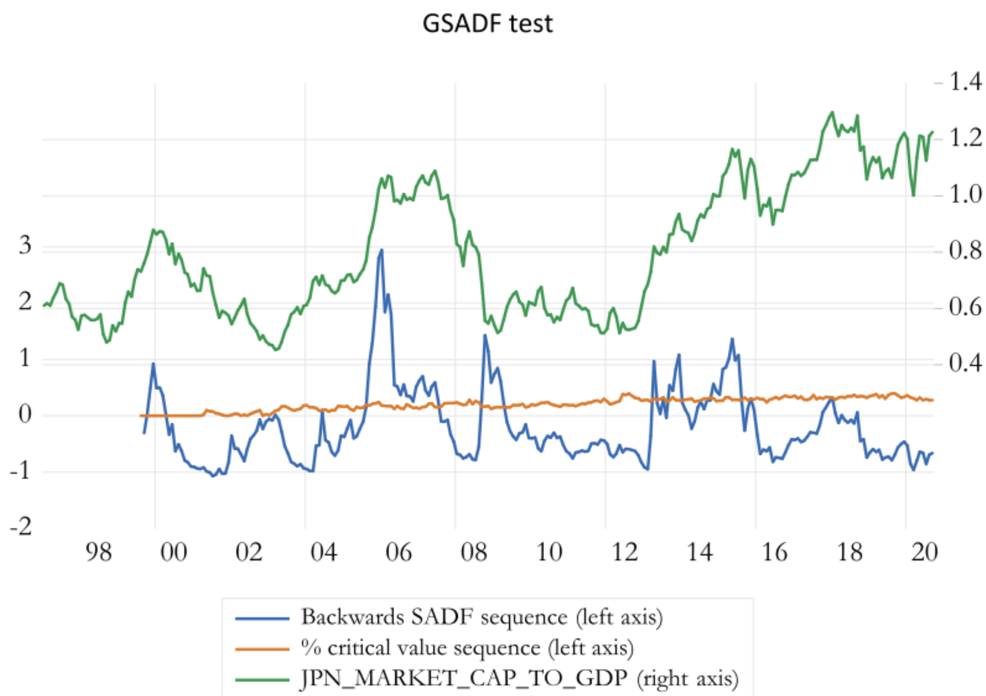

Figure 4. GSADF test, Japan

Japan, on the contrary, has significant results, i.e. there is evidence in favor of exuberant stock market activity over the period January 1997 – September 2020. There is a remarkable difference compared to the US data as the Japan Market capitalization to GDP ratio is more volatile, and there were significant selloffs and a quick surge in the valuations on the stock market over the period, which influenced the test results. There is a notable spike in the ratio during 2012-2016, just when Shinzo Abe became the Prime Minister of Japan and started his Abenomics policy that included large QE programs implemented by BoJ. Part of the stimulus was purchasing Japanese stock ETFs in large quantities that undoubtedly spurred the market rally.

5.2. Drivers of stock bubbles

Though we didn't get a lot of period of exuberance for the US, it still makes sense to try to estimate the probit model and determine the factors that influenced the bubble in

2008-2009. The dependent variable bubble is a dummy-type variable that equals one when the SADF sequence exceeds the simulated critical values and zero otherwise. The lagged bubble dummy is added to the list of explanatory variables to make our models more robust. Tables 8 and 9 depict the subsequent results.

Table 8. Probit model #1, the US

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	10.8478797	28.387689	0.3821332	0.702363
LAGGED_BUBBLE	1.241852	0.5583845	2.2240086	0.026148*
_10Y_YIELD	3.48001446	1.3407428	2.595587	0.009443**
CPI_CHN	-0.5439159	0.3790098	-1.435097	0.151259
VIX	0.06935597	0.0359821	1.9275129	0.053916.
UNRATE	-2.2735809	1.0854044	-2.094686	0.036199*
FED_ASSET_LOG	0.1588738	1.5233347	0.1042934	0.916936
FUNDS_RATE	-1.5187691	0.8011424	-1.895754	0.057993.
IND_PROD	-0.1205515	0.1550063	-0.77772	0.436734
ALL_QE	3.96493824	1.4899302	2.6611571	0.007787**

Table 9. Probit model #2, the US

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.90925	1.8297411	-0.49692	0.61924
LAGGED_BUBBLE	1.0388352	0.6082984	1.707772	0.087679.
_10Y_YIELD	2.733369	1.3717272	1.992648	0.0463*
FUNDS_RATE	-1.143219	0.6883291	-1.66086	0.096741.
CPI_CHN	-0.510308	0.3357565	-1.51987	0.128542
VIX	0.0904419	0.0366363	2.468645	0.013563*
UNRATE	-1.709957	0.7139271	-2.39514	0.016614*
QE1	3.9017501	1.8701963	2.086278	0.036953*
QE3	3.6341165	1.2486453	2.910447	0.003609**

The main difference between the two models is in the first one all QE periods are combined into one dummy variable, whereas in the second one there are only two distinct QE dummies – QE1 and QE3. Why all separate QE periods are not included? The reason is that the inclusion of either QE2 or QE4 dummy leads to binary response failure as these variables don't intersect with periods of exuberant activity specified by the bubble dummy.

The following variables turn out to be significant at either 5% or 1% confidence level in both model specifications: 10-year US Treasury yield, , unemployment rate, ALL_QE, QE1 and QE3. VIX (a proxy for volatility) is significant at a 10% confidence level in the 1st model and at a 5% level in the second one. The Federal funds rate is also significant at a 10% confidence level in both models.

The results are expected as during the Great Recession Fed's interest rate was at ZLB, hence the negative sign of the Federal funds rate, QE1 was underway to mitigate an economic and stock market shock, and volatility was at high levels. The 10-year yield has a surprisingly positive sign, which contradicts the logic as QE should lower the yields as the Fed was buying Treasuries at the time, thus lowering the yield. One could explain this result by arguing that later on, the yields were even lower as a higher volume of bond purchases weighed them down, especially in early 2020. The unemployment rate has a negative sign, because during the COVID-19 related recession it reached record high levels, while there were no periods of exuberance in 2020 according to the GSADF test.

Overall, QE is undoubtedly significant in both models as QE1, QE3 and ALL_QE dummies have strong positive effects on the creation of stock bubbles. Unfortunately, the same can't be said about the current QE4 period, however it is far from over, there still could be unforeseen consequences of Fed's stimulus.

The marginal effects of changes in the explanatory variables in the first probit model on the probability of exuberance in the stock markets are shown in the Table 10 below.

Table 10. Marginal effects, the US

Variable	Marg effects
C	0.779372944
LAGGED_BUBBLE	0.089221662*
_10Y_YIELD	0.250023894**
CPI_CHN	-0.03907799
VIX	0.004982925.
UNRATE	-0.16334689*
FED_ASSET_LOG	0.011414391
FUNDS_RATE	-0.10911695.
IND_PROD	-0.00866110
ALL_QE	0.284863557**

The interpretation is the following: 1 p.p. increase in the 10-Year Yield of UST is 25% more likely to correspond with a period of exuberant activity on the stock market. 10 points increase in VIX is associated with a 5% increase in probability of a stock market bubble. 1 percentage point decrease in unemployment leads to a 16% higher probability of a stock market bubble. 1 percentage point fall in the Federal funds rate is associated with a 10% higher probability of exuberance on the US stock market. QE periods are 28% more likely to coincide with a period of exuberance on stock markets than periods without LSAP.

The same exercise for Japan is completed below, the results are shown in Table 11 below.

Table 11. Probit model, Japan

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	10.056033	4.8459657	2.075135	0.037974
LAGGED_BUBBLE	2.4898028	0.3347439	7.4379322	1.02E-13***
_10Y_YIELD	3.2147126	0.9885427	3.2519715	0.001146**
CALL_RATE	-0.280035	1.4507985	-0.193021	0.846942
UNRATE	-1.865081	0.662568	-2.814927	0.004879**
IND_PROD	-0.077093	0.0370487	-2.080853	0.037447*
CPI_CHN	-0.250152	0.1979854	-1.263489	0.206413
CME	0.7878469	0.6859115	1.148613	0.250716
QQE1	1.813691	0.6216761	2.9174211	0.003529*
QE	-0.055055	0.6398513	-0.086043	0.931432

The following variables turn out to be significant at either 5% or 1% confidence level: lagged bubble, 10-year Japan government bond yield, unemployment rate, industrial production index and QQE1.

The results are partly similar to the US model: 10-year yields have a positive sign and the unemployment rate has a negative relationship with the bubble. Low unemployment contributing to the stock market bubble actually makes sense. Often it doesn't lead to high inflation in CPI. Thus, CBs in a bid to spur inflation inject liquidity in the economy. However, often it doesn't lead to inflation in CPI but to inflation in asset prices which, in turn, drive bubbles. QQE1 program that started in 2013 and was active until January 2016 also increase the probability of a bubble.

The marginal effects are depicted in Table 12 below.

Table 12. Marginal effects, Japan

Variable	Marg effects
C	0.854240791
LAGGED_BUBBLE	0.211503988***
_10Y_YIELD	0.27308369**
CALL_RATE	-0.02378842
UNRATE	-0.15843504**
IND_PROD	-0.00654888*
CPI_CHN	-0.02124997
CME	0.06692609
QQE1	0.154069586*
QE	-0.00467680

The interpretation is the following: 1 p.p. increase in the 10-Year Yield of Japanese Government bonds is 27% more likely to correspond with a period of exuberant activity on the stock market. 10 points decrease in industrial production index is associated with a 6.5% increase in probability of a stock market bubble. 1 percentage point decrease in unemployment leads to a 16% higher probability of a stock market bubble. QQE1 period is 15.4% more likely to coincide with a period of exuberance on stock markets.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

In response to the global financial crisis, the Fed announced unconventional monetary policy measures like QE. The BoJ started asset purchases even earlier as its interest rate reached ZLB, and the policymakers were faced with deflationary pressures.

What was once a one-time measure, now became a necessity, as the BoJ can't stop its market interventions for 7 years straight, and the Fed starts intervening once the stock market hit hard times. There is still a good case for QE and all its extensions in times of crisis when bond yields spike, and companies or even some countries can't borrow to survive. Though, QE barely lifts inflation, which was the primary target once of unconventional monetary policy measures. Japan was the first to start QE, but it still faces the same deflationary pressures as before and has become an exemplary country with low inflation and small growth. The US stock market is faring better than the Japanese one, partially thanks to the Fed, though the impact on the economy is not as straightforward as one might think. Data of the U.S. Bureau of Economic Analysis (BEA) and National Bureau of Economic Research (NBER) indicate that since the last recession that ended in 2009 the annualized real GDP growth rate was the smallest since 1950.

The exact impact of QE on the economy is still to be determined, though many researchers tried to estimate it, it still remains unclear as the sample size is too small (less than 12 years for the US and 19 years for Japan) and the biggest interventions ever are taking place right now, in 2020.

This paper looks at the consequences of QE on stock market exuberant activity. The analysis has uncovered several important outcomes. *First*, the Buffet Indicator, stock market cap to GDP, along with GSADF procedure does reveal significant evidence of the bubble on the US stock market in 2008-2009 and several smaller spikes of exuberance afterwards.

Second, the first and third QE interventions, as well as all QE period together, along with 10-year US Treasury yield, unemployment rate and volatility influenced several periods of exuberant stock market activity in the US. In particular, 10 points increase in VIX is associated with a 5% increase in probability of a stock market bubble. Also, 1 percentage point fall in the Federal funds rate is associated with a 10% higher probability of exuberance on the US stock market. QE periods are 28% more likely to coincide with a period of exuberance on stock markets than periods without LSAP.

Third, there is significant evidence that Japan stock market experienced a bubble over the period January 1997 – June 2020. The third QE intervention that was taking place during 2013-2016 turned out to be significant in the bubble creation - it is associated with a 15.4% increase in probability of coinciding with a period of exuberance on stock markets. Also 10-year Japan government bond yield, unemployment rate, industrial production impacted 5 episodes of exuberant activity in the stock market. In particular, 10 points decrease in industrial production index is associated with a 6.5% increase in probability of a stock market bubble. 1 percentage point decrease in unemployment leads to a 16% higher probability of a stock market bubble.

It is difficult to give clear recommendations to the Fed and BoJ since we haven't seen decades of QE and all of its consequences. However, it is clear that multiple periods of exuberance happened in Japan and several less in the US, which should alert the policymakers and business community. QE could potentially not only pull the economy and stock market out of a crisis but also lead to long-term overvalued companies and to the survival of the so-called "zombie" firms that could borrow just enough to repay the interest but not the principal, thanks to the easy money policy, which has become the consequence of monetary easing policies. Although, the jury is still out on that.

The business community should stay alert as well since CBs have become significant players in the financial markets, and, as research shows, their actions could lead to exuberance.

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APPENDIX A

Table 10. Explanatory variables

Variable	Series title	Units of measurement
CPI_CHN	Consumer Price Index for All Urban Consumers: All Items in U.S. City Average; Consumer Price Index of All Items in Japan	Percent Change from Year Ago
CREDIT_NONFIN	Credit to Non financial sector from All sectors at Market value	Percentage of GDP
IND_PROD	Industrial Production Index	Index
SSR	Shadow Short Rate	Percent
FUNDS_RATE	Effective Federal Funds Rate	Percent
CALL_RATE	Uncollateralized Overnight Call Rate	Percent
VIX	CBOE Volatility Index	Index
VXJ	Volatility Index Japan	Index
TREAS	Assets: Securities Held Outright: U.S. Treasury Securities: Notes and Bonds, Nominal: Wednesday Level	Millions of U.S. Dollars
MBS	Assets: Securities Held Outright: Mortgage-Backed Securities: Wednesday Level	Millions of U.S. Dollars
FED_ASSET	Assets: Total Assets: Total Assets (Less Eliminations From Consolidation): Wednesday Level	Millions of U.S. Dollars
GOV_SECUR	Bank of Japan Accounts/Assets/Japanese Government Securities	100 Million Yen

Table 10 - Continued

Variable	Series title	Units of measurement
CORP_BONDS	Bank of Japan Accounts/Assets/Corporate Bonds	100 Million Yen
TOTAL_ASSETS	Bank of Japan Accounts/Total Assets	100 Million Yen
GDP_GROWTH	Real Gross Domestic Product	Percent Change from Year Ago
10Y_YIELD	U.S. 10 Year Treasury Bond Yield; Long-Term Government Bond Yields: 10-year: Main (Including Benchmark) for Japan	Percent
WILSHIRE_5000 TO_GDP	Total Market capitalization of Wilshire 5000 Index to GDP Ratio	Units
JAPAN_MARKET_CAP_TO_GDP	Total Market capitalization of TOPIX Index to GDP Ratio	Units

APPENDIX B

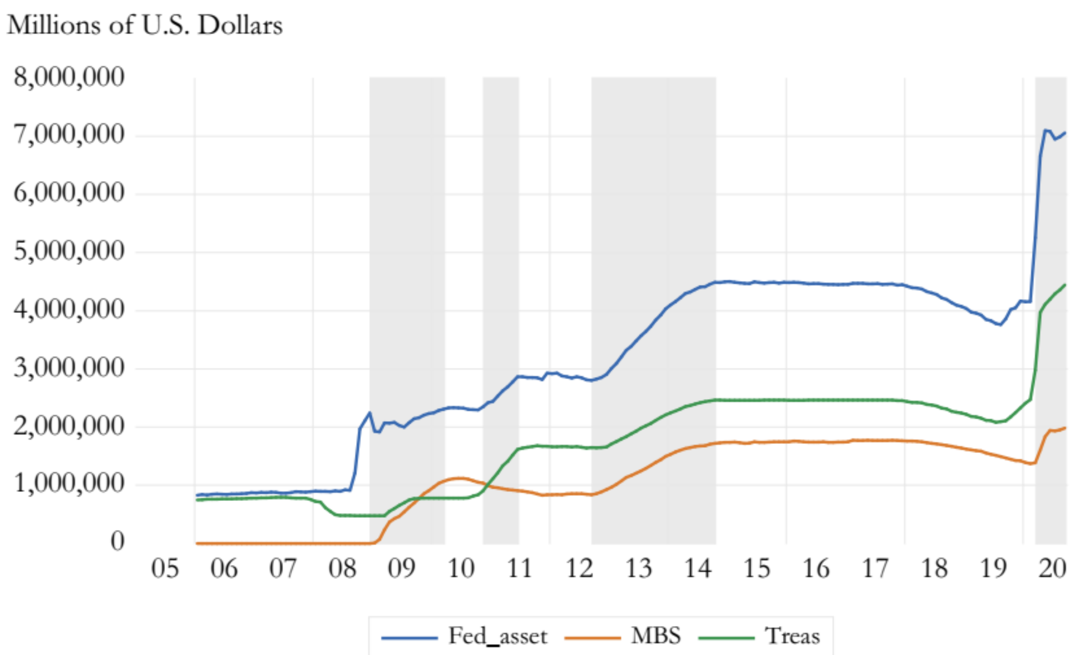

Figure 5. Fed balance sheet and its components

APPENDIX C

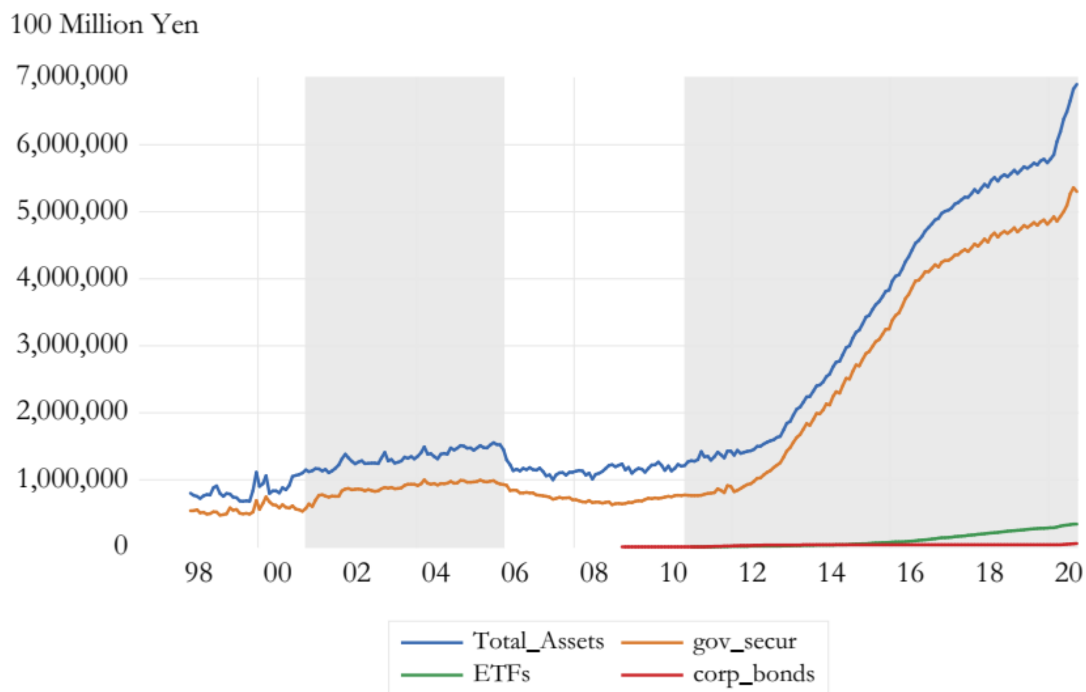

Figure 6. BoJ balance sheet