SPILLOVER EFFECT OF QUANTITATIVE EASING: CASE OF UKRAINE

by

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Date _____

Kyiv School of Economics

Abstract

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This thesis examines the spillover effect of quantitative easing adopted by the Fed and ECB on Ukrainian sovereign bond yields. Ukraine since 2008 experienced immense economic volatility due to the global financial crisis, the war in the Eastern part of the country, political crisis and external debt restructuring (technical default), which makes the impact not apparent. Using OLS regression, we found the statistically significant impact on yield of Ukrainian bonds by the Fed's quantitative easing during 2009-2013. However, our results indicate that after events on Maidan starting from November 2013 this effect deteriorate.

To Daria

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LIST OF ABBREVIATIONS

BOJ. Bank of Japan

BOE. Bank of England

CB. Central Bank

ECB. European Central Bank

EU. European Union

Fed. Federal Reserve System

LSAP. Large-scale asset purchase

OLS. Ordinary least squares

QE. Quantitative easing

ZLB. Zero lower bound

Chapter 1

INTRODUCTION

Quantitative easing programs adopted by major central banks (CBs) starting from the end of 2008 featured the unprecedented scale of purchases of long-term assets. The programs designed for domestic markets, nevertheless, have international spillovers effects. Emerging economies during the programs implementation periods were likely to experience higher demand on their bonds and therefore a reduction in the long-term bond yields (as well as currency appreciation and gains in stock markets).

We can consider the idea of QE on the US example. As a countercyclical response to economic downturn at the end of 2007 the US Federal Reserve System (the Fed) starts cutting its target federal fund rate – the policy rate that is a conventional monetary policy instrument. As the federal funds rate reached zero lower bound (ZLB) at the end of 2008, the Fed was engaged in unconventional monetary policies to provide further stimulus to the economy.

Through the large-scale asset purchase (LSAP) program, the Fed purchased a long-term Treasury and agency bonds, mortgage-backed securities and corporate bonds[1]. The primary goal of the program, often referred to as quantitative easing (QE), was to lower long-term interest rates and thus inducing economic activities in the situation where the short-term interest rate was stuck at the ZLB.

Overall, comparable programs were implemented by four major central banks: the Fed from 2008, European Central Bank (ECB) from 2015, Bank of Japan (BOJ)

[1] Bank of Japan (BOJ) under QE program besides long-term government and corporate bonds also purchased exchange-traded funds, real estate investment trusts and other commercial papers.

from 2010[2] and Bank of England (BOE) from 2009. Lenza et al. (2010) concluded that QE adopted by the Fed, ECB and BOE are very similar and the observed differences could be explained by "cross-national variations in the financial structure".

Krishnamurthy and Vissing-Jorgensen (2011) suggest that main theoretical channels through which QE operates are signaling (i.e. credible commitment of the central bank), duration risk (purchases of long-term bonds), liquidity (central bank increased liquidity "in the hands of investors" and thus decreasing liquidity premium) and portfolio balance[3].

Since the scale of QE programs adopted by four major central banks is relatively grand[4], there were potential international spillover effects. Bauer and Nelly (2014) propose that such an effect would go through the signaling and portfolio balance channels. The signaling channel implies that QE could lead to more optimistic expectations on economic growth by global investors. On the other hand, the portfolio balance channel implies that a "purchase of the U.S. assets would tend to push down the real yields on those bonds and the real yields of other sovereign bonds of similar duration until a new equilibrium was reached".

According to Fratzscher et al (2013) the US QE significantly reduce the asset prices and increase the capital flows to emerging economies (similar findings were presented by Ahmed and Zlate (2013), Tillman (2016) and Khatiwada (2017)). Fratzscher et al (2014) contributed to the empirical studies showing that ECB's QE has positive spillovers on global capital prices and capital flows. Ganelli and Tawk

[2] BOJ implemented first QE program in 2001 and completely unwind it until 2006. The scale of the program was relatively small and in this study we would focus on the second QE program implemented in 2010.

[3] Authors also pointed in the paper about safety, prepayment risk, default risk and inflation channels.

[4] President of Brazil Dilma Rousseff named US QE as a "monetary tsunami".

(2016) showed that BOJ's QE made a significant contribution to the rise of capital flow to the Asian emerging countries.

Financial markets and monetary policy inherently linked. The former contain expectations of market players about the future economic performance while the latter is based on expectations. Bond markets, whose instruments were the primary tools for QE and that are relatively big and liquid, are widely used in the literature for analysis of monetary policy spillover effects.

Many researchers concentrated on bonds of emerging economies (like Asia, Latin America and Fragile Five[5] countries) since the differences in interest rates and growth dynamics in these countries relative to developed economics create incentives for investors to engage in such a "portfolio rebalance". Still, the impact on Eastern Europe countries was not much covered by the researchers. Moreover, many authors mainly concentrate only on QE adopted by one of four central banks (typically, the Fed[6]) and virtually ignore actions of other central banks which took place within more or less period.

Our central question of interest is whether the quantitative easing policy implemented by two central banks (the Fed and ECB) had a significant effect on Ukrainian sovereign bond yields? The impact is not apparent, since Ukraine experienced immense economic volatility due to the war in the Eastern part of the country, political crisis and external debt restructuring (technical default) during this period.

The paper is aimed to find the empirical evidence of the QE impact on Ukraine. We expect that the policy implemented by two central banks decreased the yield

[5] Brazil, India, Indonesia, South Africa and Turkey

[6] One of the exceptions is the work of Rogers et al. (2014) that examines the effects of QE implemented by four major central banks on bond yields, stock prices, and exchange rates by using the event study methodology.

on Ukrainian sovereign bonds controlling for main macroeconomic indicators and performance of global financial markets (i.e., risk aversion and prices of commodities).

We will empirically estimate the impact of actual purchases of long-term assets by the Fed and ECB on the Ukrainian bond yields utilizing a methodology standard to the literature. The data for the study is primarily obtained from Bloomberg (for yields on bonds) and central bank's informational resources (for QE volumes and macroeconomics indicators).

Such research could be particularly interesting to monetary authorities. Firstly, for four central banks that performed the adopted QE such findings could indicate some unintended outcomes. For instance, the real domestic sector could allocate some part of resources not to the domestic market but to markets of other countries. This potentially could weaken the effect of QEs on the inflation targets and the output.

Secondary, the National Bank of Ukraine (NBU), which does not implement the QE program, could observe the policy as exogenous impact on the economy of Ukraine, which could overlap with NBU's monetary policy. The same argument could be applied in a case when CBs would start to unwind their balance sheet (known as "QE tapering") and potentially have a reverse effect on Ukraine as well.

Other policymakers (like Ministry of Finance of Ukraine) could use such findings as well. If the effect is present, it could potentially create a lucrative opportunity to attract relatively cheap debt under certain external conditions. For example, Ukraine's placement of USD 3 bn Eurobonds in late 2017 was called "deal of the year" by Global Capital. They suggested that the country should use favorable environment on capital markets and raise relatively cheap financing. Moreover, such logic could be applied to the real sector companies as well since there is a

strong relationship between sovereign and corporate bonds (i.e., Augustin et al. (2016)).

Additionally, this research could be of interest to investors. If the effect is significant, the yield on Ukrainian sovereign bonds could be less than under the standard conditions due to the large market players (four central banks) that buy only long-term assets and influence the right part of the yield curve. After unwinding such a large-scale program (which was already announced by the Fed and the ECB), yields could potentially return to their previous normal ranges.

The study is organized as follows. The next section contains literature overview of monetary policy effects on domestic markets and their international spillovers. The third section outlines the empirical methodology employed. The fourth section presents an overview of data used in the research. The fifth section then presents the empirical findings and related discussion. Finally, conclusions are made in the sixth section.

Chapter 2

LITERATURE REVIEW

In general, the problem of monetary policy influence on financial markets (including spillovers) is not a new one. Many papers investigate the impact of the policy used by the central bank on different components of financial markets (i.e., bonds, equity markets, capital flows, exchange rate, etc).

We could aggregate the corresponding literature to the following groups: (i) effect of monetary policy on financial markets; (ii) effect of monetary policy on foreign financial markets (spillover effect); (iii) effect of QE on international financial markets and (iv) effect of QE on bonds in foreign countries. Groups go range from more broad to narrower and more detailed, with the last group being the narrowest.

2.1 Monetary policy and financial markets

Gagnon et al. (2011) are one of the first papers that discuss impact of US QE on domestic financial market. Utilizing both time-series and event study approaches, the authors shows that the policy in 2008-2009 period led to a substantial deduction of long-term interest rates on Treasuries, agency debt and mortgage-backed security in the domestic markets. These reductions mainly reflects lower term premium rather than lower expected short-term interest rates in the future.

D'Amico and King (2010)[7] in their work decided to concentrate on the effect of US QE on Treasuries (compared to aggregate time series data used by Gagnon et al. (2011) within more or less the same period). They found that the policy on

[7] We decided to put D'Amico and King (2010) paper after Gagnon et al. (2011) since the first draft of the latter was published earlier and literature refer to it as a starting point of the discussion.

average lowered treasuries yield by 3.5 bps and the entire QE program shifted yield curve down by approximately 50 bps. Moreover, the study pointed out about small temporary effect of the flow on yields. Similar findings for the US QE program were presented by Swanson (2011), Krishnamurthy and Vissing-Jorgensen (2010), Hamilton and Wu (2012) etc.

Andrade et al. (2016) performed similar event-study for QE adopted by ECB and found that the policy persistently reduced sovereign yields on long-term bonds. Later, Gambetti and Musso (2017) utilized the VAR model and presented evidence on reduction in long-term yield, as well as upward effect on inflation and real GDP.

The main message of the discussion above is that the literature presents persuasive evidence that the US QE since the end of 2008 significantly lowered long-term interest rate on US Treasuries. It is also worth to note that the policy implemented by the Fed is much more thoroughly studied than that of other three central banks due to earlier adoption and relatively larger scale of purchases.

2.2 Monetary policy and international financial markets

International monetary policy spillovers have been the subject of economic debate for a long period now. Formal modeling of monetary policy in an open economy dates back to the pioneering analyses of Mundell (1963) and Fleming (1962). It is worth noting, that literature mainly concentrates on conventional policy actions since the unconventional tools are used by central banks only recently.

Under imperfect asset substitution (i.e. between bonds of different maturities or between domestic and foreign bonds) asset prices are sensitive to the relative supply of the assets. In such way Tobin (1969 and 1982) describe idea of portfolio rebalancing. The shortage of long-term treasuries as a result of QE "reduces the marginal benefit of short-term domestic treasuries", lowering respective prices of

long-term bonds. This motivates investors to shift (rebalance) their portfolio to other assets.

Corsetti et al. (2000) provide a more recent discussion of spillovers. Thus, work investigates the mechanism of international transmission of exchange rate shocks. The authors conclude that there is potentially a "beggar-thy-neighbor" effect of one country on another mainly through cost-competitiveness (positive effect on country that adopted monetary policy and negative on neighbor/foreign countries). The authors provide a theoretical framework for policy analysis and estimations of exchange rate devaluations of such negative spillover effect.

Clarida, Gali, and Gertler (2002) developed a dynamic New Keynesian model with open economy with two countries (home and foreign). The monetary policy problem in this case is sensitive to the strategic interactions between central banks. The main finding is that central banks that adopt coordination policy, which takes into account this monetary policy spillovers, can potentially improve domestic welfare. Moreover, the authors suggests that central banks could implement the optimal policy rule in case of coordination.

These spillovers get renewed attention after the 2008 global financial crisis. This time characterized by significant rise in interest rates difference among different global regions. As discussed earlier in the work, many central banks experimented with new (unconventional or QE) forms of monetary stimulus in that time.

Rey (2013) discusses possible actions of central banks that could help insulate spillover effect of monetary policy. However, he suggests that effective international cooperation among major central banks aimed to internalize the spillover of their monetary policies is practically impossible. In addition, Rey (2013) concludes that floating exchange rate regime cannot completely insulate domestic financial markets from external (foreign) shocks.

A more recent study performed by Ammer at el. (2016) indicates that international spillovers could be positive and negative depending on the relative strength of transmission channels. These authors find that the US monetary policy had a positive spillover effect on the global economy, which is in line with previous discussion in the literature. Moreover, they argued that there is no significant difference between conventional and unconventional monetary policy in case of effect on exchange rate and bonds yield.

Yildrim (2016) performed investigation of US monetary policy and global risk aversion shocks on asset prices, exchange rate and credit default swaps in Fragile Five countries. He conclude that results differs among countries and macroeconomic fundamentals (i.e. real GDP growth. external debt and current account) drive the difference in outcome. Countries with such low indicators are more influences by chosen exogenous shocks.

Ammer et al. (2016) also suggest that the majority of central banks that adopted flexible exchange rate regime could respond to the spillovers by their own independent monetary policies (which confronts the findings of Rey (2013) as discussed above). However, they also emphasize that if a central bank has other goals than output growth and low inflation (i.e. increase export or financial stability), the response could be limited.

2.3 Spillover effect of QE

This and next subsections overlap, since one part of the literature aims at more broad studies (on different parts of financial markets including bonds) and another one is dedicated specifically to bonds. We decided to do a more detailed review on the latter due to it being the closest to our study and therefore dedicate a separate subsection to it.

Papers in the literature on the spillover effects of monetary policy differ in various dimensions. One of them is geographical. Several authors investigates spillovers of QE adopted by four major central banks on other advanced economies (i.e. Glick and Leduc (2012 and 2013) or Chen at al. (2011)). However, the main stream of literature concentrated on QE spillover to emerging economies. Since they have higher interest rate differential and growth rate, potentially the effect on such regions should be higher.

Fratzscher et al. (2013) performed panel regression analysis of the US QE program on 65 foreign financial markets. Specifically, they look at capital flows, exchange rates and asset prices. Using daily data from January 2007 to December 2010, they found that unconventional monetary policy provided by the Fed (both announcements and actual purchases of assets) had large effect on emerging countries financial markets. However, during the first stage of implementation QE had procyclical effect on capital flows, and then reversed its direction during the second stage.

Ahmed and Zlate (2014) investigated the main driver of net private capital flows to emerging markets. Their study looked at 12 emerging countries in Asia and Latin America from first quarter 2002 to second quarter 2012. The QE effect was captured in two ways: the first one takes the value of one in the quarters in QE was announced or extended by the Fed; the second takes the value of one during the period when QE active. The main explanatory variables included were risk aversion indicator, the growth and interest rate differential between advanced and emerging economies. Their panel regression findings indicate that last two variables are the major determinants of capital flows.

Interesting findings are presented by Hausman and Wongsman (2011). Employing event study methodology on 49 countries they arguing that majority of cross-country variation in the effect of shocks from US QE could be explained by the

exchange rate regime. Country with less flexible exchange rate regime more exposed to the policy shocks. They also pointed out that difference among countries also could be explained by the share of US investors in equity markets of particular country.

Bowman et al. (2015) contribute to the literature by developing comprehensive study of the US QE spillover effect on sovereign yields, exchange rates and stock prices in emerging countries and simultaneously allowing for dependency on country-specific characteristics. The authors found that the US monetary policy shocks lower US sovereign yields as well as yields in the majority of emerging economies. Moreover, they concluded that several country-specific variable like high interest rates, inflation, CDS spreads and current-account deficit are the main drivers of country vulnerability to the US monetary policy shocks.

However, more recent work of Bhattarai et al. (2018)[8] found that QE spillover is much stronger on financial variables rather on macroeconomic. Using a panel VAR framework, authors found significant effect of the policy on appreciation of exchange rate, rise in stock market indexes, reduction of bonds yields and increase in capital inflows to emerging countries. They also pointed about, that Fragile Five countries have stronger influenced by the policy.

Rogers et al. (2014) were among the first that examine the effects of QE implemented by four major central banks simultaneously on stock prices, exchange rates and bond yields. Using event study methodology on daily and intradaily data, the authors provide evidence of decreased long-term bond yields in emerging economies particularly due to reduced term premia.

[8] First draft of the paper refers back to November 2015.

2.4 QE and sovereign bonds of foreign countries

This subsection present overview of the literature that is the closest to the research question of our study. The authors mainly use two methodologies. Firstly, it is an event-study approach, which is aimed at capturing QE announcement effects. Based on market efficiency theory, asset prices tend to rapidly incorporate information from the news (in the very short time window). Secondly, it is a regression analysis that is aimed at empirically estimating the effect of actual purchases of the assets by central bank rather than announcements. We will first overview the event studies and then turn to regression analysis studies, to which our study is closely related.

Event study approach aimed to capture the effect of QE around narrowly chosen event windows. Most of them seek to determine the effect of the unexpected component of event related to QE on prices. Worth noting that event studies make implied assumption that other news during particular event window are negligible.

One of the pioneering work dedicated to the QE spillover on bonds was performed by Neely (2010). This author found that the US QE reduced long-term yield on domestic and foreign bonds (issued by Australia, Canada, Germany etc.) based on data from December 2008 to February 2010. He adopts event-study methodology to evaluate the joint effect of QE on nominal longer-term foreign bond yields and the corresponding exchange rates.

Bauer and Neely (2014) developed dynamic term structure models to investigate transmission channels of international spillovers of key US QE announcements on bonds. They found strong evidence of yield reduction in foreign bonds and shown results of substantial signaling effect on US (domestic market) and Canada. However, effect of portfolio rebalancing channel found only with Germany.

Another approach, adopted by Cahill et al. (2013) and Joyce et al. (2011) is to analyses the effects of the surprise component of QE announcements based on survey expectations. However, there are limitation about surveys data due to its availability in terms of sample period and number of questions asked. Moreover, it is for sure not a perfect indicator of investors' beliefs.

Gilchrist et al. (2016) extended literature by performing comparison analysis of US conventional and unconventional monetary policies on foreign bond yields. Employing event study approach authors arguing that two policies are comparable. However, they indicate that there is a significant difference among advanced and emerging economies in degree of spillover effect.

One part of the literature investigating QE spillover on bonds concentrate on term premium, which is specific part of yield and corresponds to premium that investors would require in long-term over short-term bonds. Leading work of Li and Wei, (2013[9]) indicates that US QE decrease term premium over 10-years US treasuries by 1%. Pericoli (2014) indicate that spillover of QE adopted by the Fed and BOE significantly reduced term premium in emerging markets.

Since investor dedicate some probability to execution of central bank announcements, effect measured by event studies could deviate from effect of actual purchases of assets by central bank under QE program. Therefore, some recent studies employed regression analysis to estimate overall effect and our work mainly relates to this part of the literature.

Worth noting that mainly, authors performed combined regression analysis on different asset prices, exchange rate, capital flow etc and only few authors performed study that concentrate specifically on bond yields. For example, Meaning and Zhu (2011) indicate that actual purchases significantly reduce long-

[9] Similar finding presented by Joyce et al. (2011) for UK and Gagnon et al. (2011) for US.

term yield on sovereign bonds in UK and US. In more recent study, Ghysels et al. (2017) employed VAR framework and shows that QE program implemented by ECB significantly reduce yield on government bonds.

To sum, literature provide strong evidence of QE spillovers on international financial markets (including yield on foreign bonds). Majority of authors concentrate on spillovers of one central bank (mainly the Fed), but this could potentially lead to omitted variable bias since three other central banks have adopted QE as well. In terms of geographic, most of the papers concentrate on emerging countries. However, effect on Eastern Europe (including Ukraine) countries remains to be undiscovered. Finally, majority of researches concentrate on announcement effect rather than on actual purchases. All this points indicate the difference between our study and existing literature.

Chapter 3

METHODOLOGY

The section organize as follows. The first part made a review of the theoretical analysis of the relationship between yields on Ukrainian and US (or members of EU) sovereign bonds and aimed to guide through the logic of the dependency. This important, since one of the primary driver of international spillover is rebalancing effect. In addition, it is discussed a motivation of international investors to buy bonds of emerging countries (including Ukraine). Second part provides information about empirical specifications of the theoretical model that used in the study.

3.1 Theoretical model

Since spillover effect of QE mainly goes through portfolio rebalancing effect, investors observe a relationship between interest rates in domestic and foreign markets. It could be expressed in the following form:

$$i^{foreign} = i^{domestic} + i^{spread} \quad (1)$$

where $i^{foreign}$ – yield on sovereign bonds of foreign countries in reference to the country that adopted QE;

$i^{domestic}$ – yield on bonds of domestic sovereign bonds where QE was adopted;

i^{spread} – represents risk premium over domestic yield.

Central banks under QE buys long-term domestic bonds and those lower domestic yield (first part in the equation above). The second part includes a risk premium for macroeconomic conditions of the foreign country (in other words – default

risk). Moreover, it includes other risk factors that are affected by global financial shocks.

In theory, the spread could have positive and negative value. Since Ukraine could be classified as a country in transition and historical it was much more volatile than US and country-members of EU, and we expect that this spread would have a positive value. This says that investor requires some premium for the additional risk.

3.2 Empirical specifications

In this thesis, we will be following OLS approach employed by Hausman and Wongsman (2011), Bowman et al. (2015) and Yildirim (2016) in terms of general empirical methodology. Main empirical model is:

$$\Delta Y_t = \gamma + (\alpha_1 + \alpha_2 * X_{t-1}) * \Delta Y_{vix,t}$$

$$+ (\beta_1 + \beta_2 * X_{t-1}) * \Delta Y_{qe,t} + H_t + \varepsilon_t \quad (2)$$

where ΔY_t represents changes in Ukraine's sovereign Eurobonds yields,

X_{t-1} – includes lagged macroeconomics country-specific variables for Ukraine

$\Delta Y_{vix,t}$ – a measure of global risk aversion;

$\Delta Y_{qe,t}$ – a measure of QE policy actions;

H_t – includes additional control variable.

Recent studies describe the theoretical link between global risk aversion, prices of assets in emerging economies and capital inflows. Bruno and Shin (2015) developed a model that assumed that a risk-taking channel of CB's policy explained this. They suggest that changes in the Fed monetary policy be transferred to the international markets through "shifts in global risk aversion".

CBOE Volatility Index (VIX), which is designed to show global financial risks and it is included to capture shifts in global risk aversion.

Besides global risk aversion, the general movement of international capital markets, which indicates capital inflows to the financial markets, influence the bond prices (as well as yield). We used log first difference in S&P 500 index as a proxy.

Country-specific macroeconomic factors are the key factors that influence bond's yield[10]. Investors used them to identify the default rate and associated risk with investments into the bonds. The most critical factors that indicate macroeconomic stability are real GDP growth, gross debt, international reserves, exchange rate and the key policy rate.

Worth noting that we used a lagged values of Ukrainian macroeconomics variables following the approach used in the literature. Market players observe such variables only on the announcement by public authorities (NBU or State Statistics Service of Ukraine) and then adjust their expectations accordingly. So lags used further in the research determined by the lags in the announcement (excluding key policy rate and exchange rate that observed immediately).

However, several studies (Wachtel and Young 1987, Elmendorf 1996, Luabach 2009) provide evidence that sovereign yields more depends on expected values of macroeconomic indicators rather than on current. Since expected values could not be observed explicitly, in this study we (as a vast majority of the literature) would rely on historical values of these factors.

The impact of the QE adoption will be measured by the change in the amount of securities held by the Fed and ECB separately. This securities portfolio mainly

[10] This statement supported by Gale and Orszag (2002), Brook (2003), Haugh et al. (2009).

consists of bonds and notes issued by US Treasuries and mortgage-backed securities issued by federal agencies.

β_1 represents the coefficient of interest and captures the effect of the QE on the Ukrainian bond's yield. It is expected that it will have a negative sign and the policy decrease yields on sovereign bonds. If the coefficient is found to be statistically insignificant, this may lead us to the conclusion that Ukraine's macroeconomics and global financial conditions are the main drivers of the dependent variable of interest.

We allow for the response of Ukrainian bonds yield to changes in the QE adopted by the Fed and ECB to depend on country's macroeconomic characteristics by including interaction terms with (i) global risk aversion and (ii) amount of securities purchased by each CB.

Chapter 4

DATA DESCRIPTION

The data used in this work can be divided into four groups. The first one is the yield data on Ukrainian Eurobonds. The second group is the quantity of assets purchased by CB's that adopted quantitative easing programs. The third group corresponds to control variables for global financial market conditions. The fourth group contains control variables that reflects Ukraine's macroeconomic conditions.

Based on the data availability, the sample period for estimation is January 2008 - December 2017. It is worth noting that the period covers an active phase of CB's assets accumulation under the QEs programs.

4.1 Bonds yields

In the literature, the yield on 10-years bonds is typically used for such kind of research. However, the data for Ukraine are available only from October 2013, which doesn't fully cover the period of QE adoption by major CBs and significantly eliminate the number of observations. In our analysis, we decided to take 7-years Ukrainian sovereign Eurobonds (nominated in USD) due to data availability. The data provided by Bloomberg Terminal on a weekly basis.

However, there a lot of missing values in a yield on 7-years bonds as well. We substitute missing data with a yield on bonds with a lower maturity that was available for that time. Since the difference between bonds yield with different duration is majorly attributed to term premium, we add a dummy variable that equal to one when the data used from lower maturity as a control in our further OLS estimations.

Firstly, the plotted yield in the graph on the next page shows that there are two breaks where the data were unavailable (circled) from October 2010 to January 2012 and October 2013 to July 2014. Possibly, in those periods there were no 8-years bond or bonds that had lower and higher maturity to approximate the yield on such bond. The Literature suggests constituting such periods with bonds with the closest maturity (i.e., Moore et. al. (2013) or Yildrim (2016)). Potentially we can also divide our data into tree corresponding subsamples and run estimates over each period separately or create dummy variables that indicate each period.

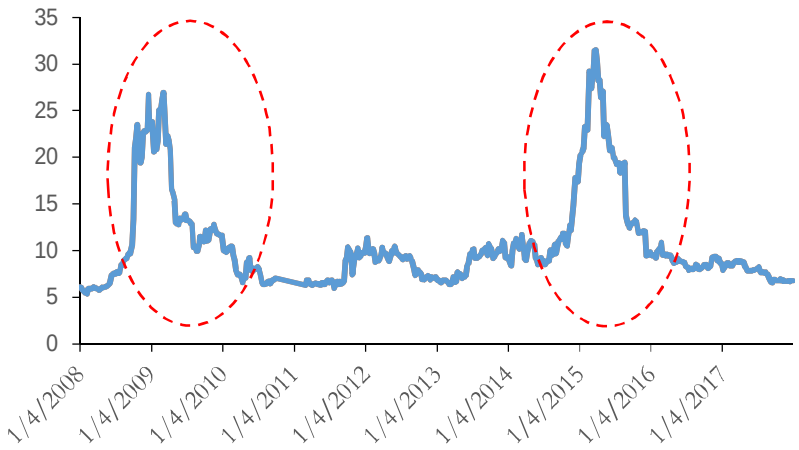

Figure 1. Ukrainian bond yields dynamics

Secondly, we can observe patterns in the yield. A sharp rise in 2008 (circled) indicates drop in assets prices during the global financial crisis and increase at the end of 2014 indicates the political crisis and the military conflict in Ukraine. This leads to the conclusion that apparently bonds yield is determined by global financial market conditions and Ukraine's macroeconomic indicators. So in further estimates, we should control for such variables.

Table 1. Ukrainian bond's yield descriptive statistics

Indicator	Value
Number of observations	501.0
Min	5.4
Max	31.5
Median	9.2
Mean	10.7
Variance	26.7
Standard deviation	5.2
Variation coefficient	0.5

Summary statistics in the Table 1 shows that the Ukrainian yield is highly volatile. Maximum value amounted to 31.5%, which for sure indicates some structural brakes (crisis) in the observed country.

4.2 Assets bought under QE

The System Open Market Account, managed by the Federal Reserve Bank of New York, provides the data on securities holdings of the US Federal Reserve System[11]. The graph above (Figure 2) shows that active adoption of QE by the Federal Reserve System starts at the end of 2008. CB mainly purchased notes and bonds issued by the US treasury as well as mortgage-backed securities. Interesting that before the QE adoption the Fed's portfolio was relatively stable and central bank does not actively use it as a monetary policy tool. The period from 2003 was chosen only for illustrative purposes.

[11] https://www.newyorkfed.org/markets/soma/sysopen_accholdings.html#export-builder

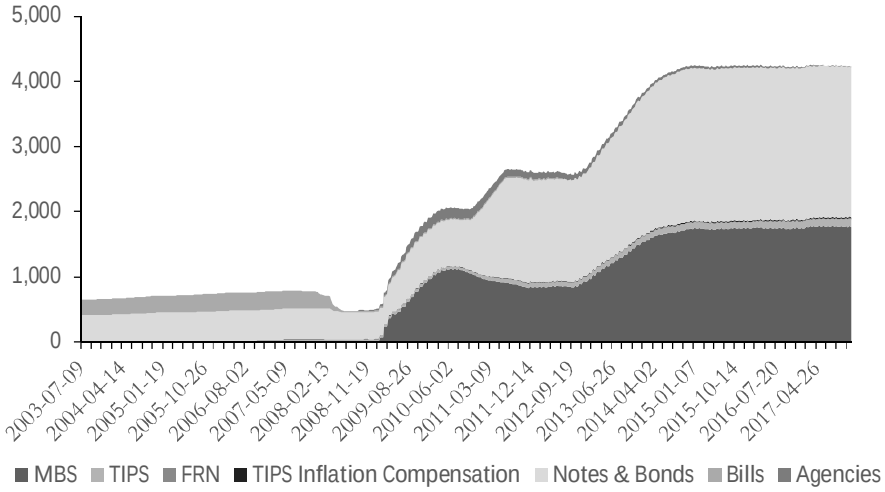

Figure 2. Amount of assets bought by the Fed, USD bn

A maximum amount of the QE program (see Table 2) came to approximately 4.2 trillion USD (during 2014-2017), which is a little bit less than 10 times amount of CB's asset portfolio in 2008. In 2014, the Federal Reserve System reaches its target of the portfolio size. Worth noting, that at the end of 2017 it announced that in 2018 the "unwinding" procedure would start.

Table 2. The Fed securities portfolio summary statistics

Indicator	Value
Number of observations	501
Min	473.3
Max	4240.9
Median	2893.7
Mean	2909.8
Standard deviation	1303.6
Variation coefficient	0.45

ECB's QE starts only on 2015 and has a smaller scale than a respective program in the US, but also incorporated into the analysis. We decided to do not include QE performed by BOE and BOJ to our analysis due to its relatively small scale and geographical location relative to Ukraine.

4.3 Global financial markets

The data for the CBOE Volatility Index (VIX) is provided by The Chicago Board Options Exchange and available via its website. The graph (see Figure 3) shows that VIX (which is used in our work as a proxy for global risk aversion) picked during 2008 global financial crisis, and after that significantly decreased. This movement potentially could influence assets prices in emerging markets due to decrease risk aversion and should be included in our estimations as the control variable. Higher index indicates higher risk aversion and respective depreciation of risky assets and respectively lower index indicates an appreciation of assets and lower risk aversion. Worth noting that we intentionally pick more earlier periods for illustrational purposes.

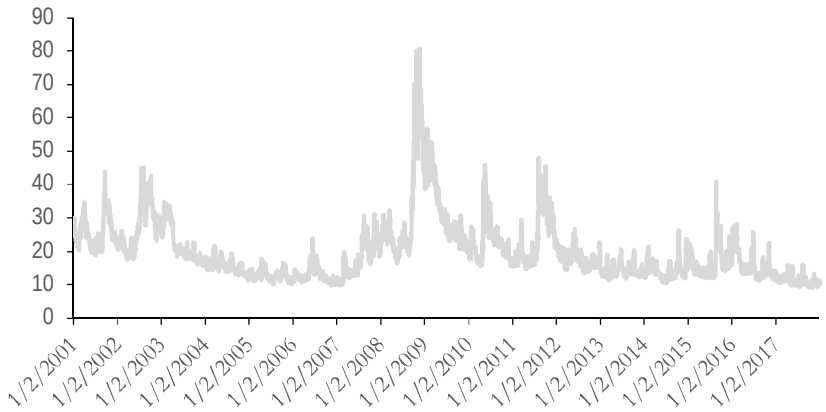

Figure 3. VIX dynamics

The data on S&P 500 index is provided by S&P Capital IQ platform via S&P Global Market Intelligence. The movement of the indicator (see Figure 4 below) have opposite dynamic with VIX in the most of the period. Indicator widely used in the literature as a proxy for capital flows into the global financial markets. We expect that sharp increase in the S&P 500 index starting from the end of 2008 could lower.

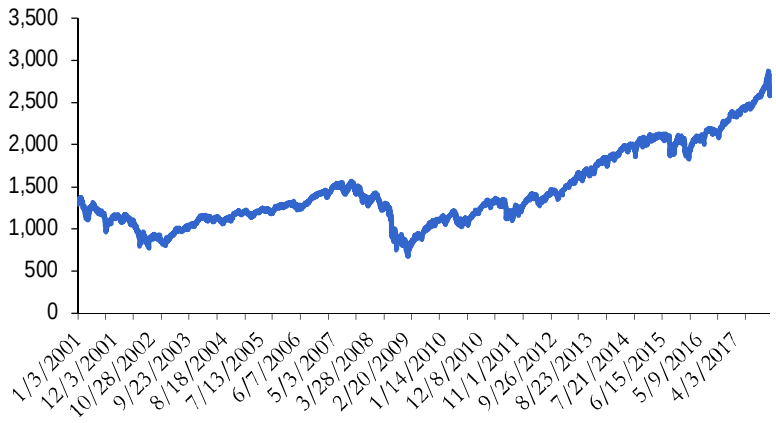

Figure 4. S&P 500 dynamics

4.4 Ukraine macroeconomic indicators

The data on macroeconomic indicators (see Table 3 on the next page) are obtained from NBU and SSCU (for real GDP growth). The main problem is that most of the indicators are not available on a weekly basis, so linear interpolation was performed as for example in Yildirim (2016) or Bowman et al. (2015).

Mean value of Ukrainian debt level is very close to its maximum value. This dynamics could be explained by currency depreciation after the start of political crisis and cancelation of fixed exchange regime (from 2014) as well as further IMF support.

Table 3. Summary statistics on Ukrainian macroeconomic indicators

Indicator	Debt	Policy rate	Reserves	Real GDP growth	Exchange rate
Number of observations	501	501	501	501	501
Min	80,860.0	6.5%	5,625.3	-1.33%	4.8
Max	142,079.0	30.0%	38,351.7	0.65%	28.1
Median	119,219.6	11.0%	24,666.4	0.12%	8.0
Mean	118,491.8	12.2%	23,227.0	-0.09%	13.3
Standard deviation	14,059.8	5.7%	8,721.1	0.52%	8.0
Variation coefficient	0.12	0.47	0.38	-5.97	0.60

The key policy rate (PR variable) approximate monetary policy of National Bank of Ukraine and has a vast range over the sample period (23.5% from minimum to maximum value). Worth noting a substantial difference between minimum and maximum values of NBU's international reserves due to the fixed foreign exchange rate regime. Moreover, a negative mean of real GDP growth supports our idea about significant structural brakes that significantly influence economic relationships between agents.

Chapter 5

ESTIMATION RESULTS

The section organized as follows. Firstly, we would carefully discuss our main findings of baseline regression. Secondly, we would overview results of robustness checks applied to the model. Thirdly, we would indicate some limitations of our research and discuss ideas for further development of the study. Then, we would suggest policy recommendations and make a short summary of findings.

5.1 Baseline regression

In the third section, we described a methodology that is employed in the study. As the first step, we estimate OLS on data from January 2008 to December 2017 (whole period under review) and Table 4 presents a short version of regression output (full version of the table placed in Appendix A). We found that effect of QE adopted by both the Fed and QE is statistically significant.

However, the signs on those estimates are counter-intuitive. Results suggest that the higher Ukrainian debt level, the greater (more negative) the effect of the ECB's QE on Ukrainian bond yield. On other hand, debt level increase lead to higher default probability and should respectively increase yield. Results also indicate that the greater real GDP growth, the higher (more negative) the effect of the Fed's QE on Ukrainian bond yield, which is also illogical (higher economic growth decrease default probability).

Worth noting that results indicate that growth in S&P 500 index lowers yield on Ukrainian bonds and the global financial crisis in 2008 increased it. Interesting that

commodity prices proxied by IMF Commodity Price Index as well as a dummy on Ukrainian crisis are not statistically significant.

Counter-intuitive results on our coefficients of interest could potentially indicate an omitted variable bias. This means that our controls (includes Ukrainian macroeconomic and global financial indicators, as well as new dummies on global financial crises and Ukrainian crises described before) used in the regression analysis are not enough to capture the whole variation. Probably two primary structural brakes in this period distort economic relationships in the economy and something unobservable (i.e., political shocks) influence Ukrainian bonds yield.

Table 4. Shorted results of OLS regression on 2008-2017 period

Term	Estimate	Std. error
Constant	-1.02	2.10
S&P 500	-2.26	1.30
Global financial crisis	0.34***	0.14
Commodity Index	1.37	2.00
Ukrainian crisis	0.15	0.14
Fed's QE	29.59	40.04
Real GDP growth	-29.23***	14.23
Fed's QE*Real GDP growth	1074.32***	508.89
ECB's QE*Debt	-3512.33*	2100.92
VIX*Debt	8.49*	4.91
Observations	461	
R-squared	0.3365	
Adjusted R-squared	0.2935	

Significance codes: 0.01 '***' 0.05 '**' 0.1 '*'

What about more stable periods of Ukrainian economy? Let us look on a period from the end of the global financial crisis (approximately from July 2009) to the start of first demonstrations on Maidan that lead to revolution and change of the

Ukrainian government (October 2013). Worth noting, that only the Fed adopted QE in this period (ECB's QE started only in 2015). Results of the regression analysis are presented in Table 5 on the next page and include only statistically significant coefficients and those used in the discussion (full version of the table placed in Appendix B).

Table 5. Shorted results of OLS regression on 2009-2013 data sample

Term	Estimate	Std. error
Constant	14.90	11.42
S&P 500	0.79	1.22
Commodity Index	0.48	1.34
Fed's QE	-484.20	365.36
Debt	-36.63*	20.26
VIX	2.56	5.61
Fed's QE*Debt	4,184.93***	1,977.14
Fed's QE*Real GDP growth	155.04	756.35
Fed's QE*Policy rate	144.04	408.09
Fed's QE*Exchange rate	66.49	44.80
Fed's QE*Reserves	0.00*	0.00
Observations	200	
R-squared	0.218	
Adjusted R-squared	0.131	

Significance codes: 0.01 '***' 0.05 '**' 0.1 '*'

The effect of the Fed's QE is statistically significant. Results suggest that the higher Ukrainian debt level, the greater (more positive) the effect of the Fed's QE on the increase in Ukrainian bond yield. Moreover, cross term with reserves is also significant with a negative sign (higher reserves levels lead to the higher effect of the Fed's QE on lowering the Ukrainian yield), which is expected as well.

However, such macroeconomics indicators as real GDP growth, policy rate and exchange rate are not statistically significant, and we cannot say anything about their influence on Ukrainian bonds yield. Probably real GDP growth was relatively weak during this period and investors do not pay so much attention to it and there does not believe in NBU independence in that time (or that monetary policy shocks could significantly influence the Ukrainian economy).

Surprisingly, log first difference in VIX has no statistically significant influence on Ukrainian bond yield. This essentially means that risk taking channel appears to play no role in yield variance during the 2009-2013. In other words, macroeconomic factors matter in the responsiveness of Ukrainian bond yields to changes in the Fed's QE more than to changes in global risk aversion proxied by VIX.

We do not find evidence as well of influence global capital markets and prices of major commodities (from estimates on S&P 500 and IMF Commodity Price Index respectively). That interesting findings, since much of Ukrainian export consist of agriculture and metallurgy output that a mainly driven by global prices.

Interesting that during the 2009-2013 period fixed exchange rate regime was set by NBU. As we already discussed in the second chapter of the study, the literature suggests that countries with fixed and semi-fixed exchange regime are more responsive to external monetary shocks. Event study by Hausman and Wongsman (2011) on 49 countries conclude that majority of cross-country variation in the effect of shocks from US QE could be explained by the exchange rate regime.

Additionally, we look at results of OLS regression on data from the end of the global financial crisis to recent days (Appendix E). However, we get the similar results that are affected by some unobservable facts as during whole 2008-2017 period.

5.2 Robustness checks

In this subsection, we provide a short overview of the robustness of our results from baseline regression on 2009-2013 data. We reach quite similar results by using a different proxy for global risk aversion as well as for commodity price indicator.

Firstly, as commonly adopted in the literature, we replicate our results with US BAA corporate spread, an alternative measure of global risk appetite (results of OLS regression are presented in Appendix D). The latter represents a US high yield corporate spread. Overall, estimation results indicate that the findings remain unchanged with a new measure of global risk aversion. Additionally new results show that Ukrainian yield was affected not only by the Fed's QE but by changes in global risk aversion as well.

Secondly, since Ukrainian export and economy overall majorly influenced by agriculture and metallurgy products, we used alternative measure for commodity prices that exclude fuel-related commodities prices. IMF Non-fuel Commodity Price Index was used and lead us to very similar results of baseline regression presented in the previous subsection.

5.3 Limitations and further development

During the study, we deal with several issues. One of the main limitations of the study is the time frame. Since sovereign debt issued by Ukraine in some periods was not enough to build yield curve (especially absence of long-term debts with a maturity of 7 and more years) makes a study of the whole period of QE adoption (from the end of 2008) impossible without substitution of yield by those with smaller duration.

Then we deal with the issue that part of the indicators is not available on a weekly basis (but on monthly or quarterly), so linear interpolation was performed to increase the frequency. We are aware that such approximation effects estimates on OLS regression, but such approach is widely used in the literature (i.e., Yildirim (2016) and Bowman et al. (2015)).

Moreover, literature emphasize that in reality investors mainly interested in the expected values of country-specific macroeconomic indicators. We used historical indicators (with lags related to announcement dates) in our empirical specification since the latter presents a good proxy for the future performance of indicators and data on expected (or forecasted) indicators for each data point is not available.

Liberalization of foreign investments regulation in Ukraine starting from 2018 opens the door to investigation of influence on Ukrainian bonds that traded on internal financial markets. Part of the literature suggests that penetration of foreign investors into internal market of emerging countries strength effect of US monetary shocks. So further research could look on local government bond (nominated in UAH and USD) effects as well.

5.4 Policy implications

Our findings suggest after the end of the 2013 effect of QE on Ukrainian Eurobonds deteriorate due to the high volatility of the economy after a political and economic crisis. In other words, results indicate that currently QE adopted by the Fed and ECB does not affect the economy of Ukraine. This leads us to the conclusion that unwinds of the QE by two CBs would not significantly influence yield on Ukrainians bonds and investors could not expect its "normalization".

However, we found evidence of the presence of the QE effect during a more stable period between the end of the global financial crisis and actions on the Maidan in

2013. Since volatility of Ukrainian economy decreasing starting from 2015, potentially Ukraine could be influenced by external monetary shocks in the future as well (assuming accelerating economic growth and lower volatility). Based on that, NBU should consider this external effect on the economy and financial system accordingly. The Fed and ECB should observe such potential spillover as an unintended outcome.

To sum up, from the discussion above we can see that during 2009-2013 QE implemented by the Fed reduced the yield on Ukrainian sovereign bonds. Debt level and amount of NBU's international reserves are among key driver in country-specific indicators. Nevertheless, we found no evidence about the influence of changes in global risk aversion. Moreover, QE's effect on bonds deteriorates after events in Maidan after November 2013.

Chapter 6

CONCLUSIONS

This study investigates whether quantitative easing influenced Ukrainian sovereign bonds. Previous studies provide strong evidence of QE spillovers on international financial markets as well as emerging economies. Since Ukraine experienced immense economic volatility due to the war in the Eastern part of the country, political crisis and external debt restructuring (technical default) the impact is not apparent. In our regression analysis controlled for main macroeconomic indicators as well as global risk aversion changes. Change in amount of assets bought under QE programs by the Fed and ECB used as an indicator of the policy.

Results of our OLS regression indicates that during 2009-2013 QE implemented by the Fed reduced the yield on Ukrainian sovereign bonds. Debt level and amount of NBU's international reserves are among key driver in country-specific indicators. Nevertheless, we found no evidence about the influence of changes in global risk aversion.

Moreover, QE's effect on bonds deteriorates after events in Maidan from November 2013. Structural break in that period brings some unobservable noise that our controls do not capture. We would suggest that investors just pulled money out of Ukrainian bonds during this period scared about further political and military development.

We could state that unwind of the QE by two CBs would not significantly influence yield on Ukrainians bonds and investors could not expect its "normalization". Since volatility of Ukrainian economy decreasing starting from 2015, potentially Ukraine could be influenced by external monetary shocks in the future as well if the economy would accelerate growth and volatility would continue to decrease.

Based on that, NBU should consider this external effect on the economy and financial system accordingly. The Fed and ECB should observe such potential spillover as an unintended outcome.

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APPENDIX A

Table 6. Data sources and definitions of variables

Name	Description	Source	Frequency
Yield	Yield on Ukrainian 7-years sovereign bonds	Bloomberg	Weekly
S&P 500	The Standard & Poor's 500 index	S&P	Weekly
Yield approximation	1 for cases where yield on 7 years bonds was substitute by yield with other available maturity	Created by author	Weekly
Global financial crisis	1 for period of global financial crisis (June 2008 – July 2009)	Created by author	Weekly
Ukrainian crisis	1 for period of Ukrainian political and economic crisis, war and debt restructuring (November 2013 – December 2015)	Created by author	Weekly
Commodity Index	IMF Commodity price index	IMF	Monthly
Non-fuel Commodity Index	IMF Non-fuel Commodity price index	IMF	Monthly
Fed's QE	Amount of assets bought by the Fed	the Fed	Weekly
ECB's QE	Amount of assets bought by the ECB	ECB	Weekly
Debt	Gross debt	NBU	Monthly
Real GDP growth	Real GDP growth	SSSU	Quarterly
Policy rate	Short-term monetary policy interest rate set by NBU	NBU	Weekly
Exchange rate	UAH/USD exchange rate	NBU	Weekly
Reserves	NBU's international reserves	NBU	Monthly
VIX	The CBOE Volatility Index	CBOE	Weekly
US BAA spread	Difference between US BAA corporate bond and 20-year Treasury bond	St. Louis Fed. Fred. FRED Database	Weekly

APPENDIX B

Table 7. Results of OLS regression on 2008-2017 period

Term	Estimate	Std. error
Constant	-1.02	2.10
S&P 500	-2.26*	1.30
Yield approximation	0.09	0.10
Global financial crisis	0.34**	0.14
Commodity Index	1.37	2.00
Ukrainian crisis	0.15	0.14
Fed's QE	29.59	40.04
Debt	4.58	14.32
Real GDP growth	-29.23**	14.23
Policy rate	-2.42	1.96
Exchange rate	0.03	0.02
Reserves	0.00	0.00
ECB's QE	28.51	55.25
VIX	-0.04	0.12
Fed's QE*Debt	-1795.20	1151.76
Fed's QE*Real GDP growth	1074.32**	508.89
Fed's QE*Policy rate	-9.12	148.35
Fed's QE*Exchange rate	-1.40	1.67
Fed's QE*Reserves	0.00	0.00
ECB's QE*Debt	-3512.33*	2100.92
ECB's QE*Exchange rate	-2.05	1.84
ECB's QE*Policy rate	41.46	112.04
ECB's QE*Reserves	0.00	0.00
ECB's QE*Real GDP growth	-1919.90	2085.39
VIX*Debt	8.49	4.91
VIX*Exchange rate	0.00	0.00
VIX*Reserves	0.00	0.00
VIX*Real GDP growth	4.19	3.66
VIX*Policy rate	0.42	0.36
Observations	461	
R-squared	0.3365	
Adjusted R-squared	0.2935	

Significance codes: 0.01 '***' 0.05 '**' 0.1 '*'

Cross terms are indicated by multiplication sign (*) in the name of the variable.

APPENDIX C

Table 8. Results of OLS regression on 2009-2013 data sample

Term	Estimate	Std. error
Constant	14.90	11.42
S&P 500	0.79	1.22
Yield approximation	0.07	0.07
Commodity Index	0.48	1.34
Fed's QE	-484.20	365.36
Debt	-36.63*	20.26
Real GDP growth	-10.29	12.19
Policy rate	-1.67	5.11
Exchange rate	-1.89	1.38
Reserves	0.00	0.00
VIX	2.56	5.61
Fed's QE*Debt	4,184.93**	1,977.14
Fed's QE*Real GDP growth	155.04	756.35
Fed's QE*Policy rate	144.04	408.09
Fed's QE*Exchange rate	66.49	44.80
Fed's QE*Reserves	0.00*	0.00
VIX*Debt	-2.99	9.56
VIX*Exchange rate	-0.32	0.69
VIX*Reserves	0.00	0.00
VIX*Real GDP growth	-0.10	3.82
VIX*Policy rate	0.04	1.67
Observations	200	
R-squared	0.218	
Adjusted R-squared	0.131	

Significance codes: 0.01 '***' 0.05 '**' 0.1 '*'
Cross terms are indicated by multiplication sign (*) in the name of the variable.

APPENDIX D

Table 9. Results of OLS regression on 2009-2013 data sample (robustness check)

Term	Estimate	Std. error
Constant	-27.49*	15.22
S&P 500	1.06	1.18
Yield approximation	0.00	0.07
Commodity Index	0.27	1.27
Fed's QE	14.04	391.73
Debt	-42.48**	16.44
Real GDP growth	-7.18	14.44
Policy rate	4.93	5.31
Exchange rate	3.28	1.87
Reserves	0.00***	0.00
US BAA spread	347.88***	87.78
Fed's QE*Debt	4628.93**	1796.85
Fed's QE*Real GDP growth	-564.17	758.13
Fed's QE*Policy rate	-133.59	394.60
Fed's QE*Exchange rate	9.59	47.85
Fed's QE*Reserves	0.00**	0.00
US BAA spread*Debt	-335.74	273.58
US BAA spread*Exchange rate	-41.68***	10.64
US BAA spread*Reserves	0.00***	0.00
US BAA spread*Real GDP growth	402.01***	137.97
US BAA spread*Policy rate	14.15	67.02
Observations	200	
R-squared	0.279	
Adjusted R-squared	0.199	

Significance codes: 0.01 '***' 0.05 '**' 0.1 '*'

Cross terms are indicated by multiplication sign (*) in the name of the variable.

APPENDIX E

Table 10. Results of OLS regression on 2009-2017 data sample

Term	Estimate	Std. error
Constant	-3.30	2.04
S&P 500	0.15	1.59
Yield approximation	0.06	0.09
Global financial crisis	-0.40	0.62
Commodity Index	3.45	1.96
Ukrainian crisis	0.14	0.13
Fed's QE	14.37	49.11
Debt	-10.94	23.06
Real GDP growth	-24.50	16.09
Policy rate	-1.58	2.09
Exchange rate	0.02	0.02
Reserves	0.00	0.00
ECB's QE	4.33	48.87
VIX	0.14	0.11
Fed's QE*Debt	1868.56	2367.65
Fed's QE*Real GDP growth	-667.12	845.55
Fed's QE*Policy rate	-467.55	293.82
Fed's QE*Exchange rate	2.47	2.89
Fed's QE*Reserves	0.00	0.00
ECB's QE*Debt	-389.98	2048.33
ECB's QE*Exchange rate	-0.89	1.65
ECB's QE*Policy rate	-13.26	103.43
ECB's QE*Reserves	0.00	0.00
ECB's QE*Real GDP growth	-2705.33	1866.38
VIX*Debt	-11.40	7.83
VIX*Exchange rate	-0.01	0.00
VIX*Reserves	0.00	0.00
VIX*Real GDP growth	5.53	3.96
VIX*Policy rate	0.26	0.43
Observations	419	
R-squared	0.228	
Adjusted R-squared	0.168	

Significance codes: 0.01 '***' 0.05 '**' 0.1 '*'
Cross terms are indicated by multiplication sign (*) in the name of the variable.