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The Global Financial Crisis-Induced Quantitative Easing: Transmission Mechanisms and Financial Market Impact

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Abstract

Quantitative easing (QE) is widely implemented by major central banks to stimulate the economic recovery following the 2008-09 subprime crisis. This paper critically examines the mechanism and financial impacts of QE through a comprehensive review of literature and empirical analysis. The financial impact of QE are primarily explained by three channels: the portfolio balance channel, the signaling channel, and the liquidity channel. Prior empirical studies yield several key findings. First, QE reduces bond yields, though the magnitude of its effect varies. Second, while most studies indicate a significant influence of QE on equity prices, findings on the direction of the impact, either positive or negative, remain mixed. Third, QE depreciates local currency by expanding the money supply. Finally, the initial round QE typically has a stronger impact than subsequent rounds, as diminishing signaling effects arise from market participants' expectations of prolonged low policy rates.

Keywords: Quantitative Easing, Transmission Channel, Monetary Policy, Financial Markets

Introduction

Before the Global Financial Crisis of 2008-09 (hereafter GFC), central banks typically stimulated the economy through conventional monetary policy via three primary transmission channels: the credit channel, interest-rate channel, and asset price channel (Mishkin, 1996). The interest-rate channel posits that an expansionary monetary policy lowers real interest rates, reducing the cost of capital, and subsequently boosting business investment, consumer spending, and durable goods expenditure, ultimately raising aggregate output. Taylor (1995) provides evidence that supports the significant influence of the interest-rate channel on consumer investment spending.

The asset price channel explains the impact of monetary policy on economic activity by focusing on asset prices beyond interest rates, distinguishing it from the interest-rate channel. Monetarist, including Friedman and Modigliani, integrated macroeconomic relationships into the Keynesian model, suggesting that fluctuations in asset prices can significantly influence aggregate output (Kouri, 1986; Brunner & Meltzer, 1972). Meanwhile, the credit channel

highlights how expansionary monetary policy stimulates economic activity by mitigating asymmetric information in financial markets. It operates through two mechanisms: the bank lending channel and the balance-sheet channel. Expansionary monetary policy increases the supply of loanable funds by boosting bank deposits and reserves, thereby stimulating both investment and consumer spending. Additionally, the increase in equity prices driven by expansionary monetary policy enhances firms' net worth, mitigates asymmetric information problems, and ultimately promotes higher aggregate output and investment spending through the balance-sheet channel.

All the aforementioned conventional monetary transmission channels are designed to increase both investment and consumption, ultimately fostering economic growth. Nevertheless, the GFC posed significant challenges for central banks, raising critical questions that extended beyond the conventional theories of monetary policy (Curdia & Woodford, 2011). Firstly, the GFC severely impaired the commercial banks' balance sheets, restricting the supply of credit – contrary to the intended effects of expansionary monetary policy. Secondly, the GFC substantially increased risk premia on private securities, offsetting the impact of policy rate cuts. Then, further reductions in the federal funds target were required to counter the sharp economic downturn. However, this approach became infeasible in countries where interest rates were near the zero lower bound.

Under such circumstances, these conventional transmission channels became ineffective in lowering long-term real interest rates for economic recovery following the GFC (Krugman, 2008; Loisel & Mésonnier, 2009). The economic condition could further deteriorate if temporary disinflation escalates into deflation, raising real interest rates even the central bank maintains the nominal interest rate at zero.[1] Elevated real interest rates would discourage investments, exacerbating the economic downturn. Consequently, various unconventional monetary policy measures were introduced to further lower real interest rates. These policies seek to shape expectations regarding future policy rates, expand the monetary base on the central bank's liability side (i.e., pure quantitative easing, QE), and adjust the asset composition of assets of the balance sheet (i.e., credit easing, which shares similarities with QE). The public often refers to the credit easing adopted by the Federal Reserve (Fed) in 2008 as QE. However, Bernanke (2010) differentiates credit easing from the Bank of Japan (BOJ) QE in 2001, although both policies involve balance sheet expansion. QE in Japan primarily focused on increasing bank reserves, while credit easing emphasized the types and size of purchased assets alongside increased bank reserves to enhance liquidity and credit conditions.

Generally, QE is an unconventional monetary policy employed by central banks in countries with near-zero-interest rates to promote economic recovery during financial or economic distress. It has been widely adopted by major central banks to mitigate economic challenges in the aftermath of the GFC. Although the stated objectives of QE vary across countries, the common underlying motive is to enhance liquidity and credit conditions by significantly expanding the monetary base through massive asset purchases. This, in turn, aims to lower the long-term bonds yields and other domestic currency-denominated assets, thereby supporting economic growth. However, Eggertsson and Woodford (2003) contend

[1] Real interest rate = nominal interest rate - inflation. Hence, real interest rate will exceed nominal interest rate if deflation occurs (negative inflation level).

that the effectiveness of QE in reducing long-term yields relies on the central bank's commitment to maintaining low interest rates even after economic recovery. This commitment is crucial, as QE increases long-term security prices (thereby lowering their yields) through large-scale asset purchases. However, premature interest rate hikes by the central bank could lead to losses on these securities, undermining QE's intended impact (Clouse, et al., 2000).

The QE implemented in the United Kingdom (U.K.), Japan, and United States (U.S.) fundamentally differ from those in Europe. The former primarily focus on large-scale bond purchases, reflecting the greater significance of bond markets in their financial systems. In contrast, the European Central Bank (ECB)'s QE emphasize direct lending to banks, aligning with the more prominent role of banks in continental European economies. Meanwhile, the Swiss QE mechanism is distinct from both approaches, as it expands central bank reserves without acquiring long-term securities. Despite these differences, all QE share the common objective of providing liquidity and stabilizing the financial system.

Hence, this study contributes to the existing literature by synthesizing current studies to elucidate the financial impact of QE through a comprehensive understanding of its transmission mechanism. The research objectives are as follows,

1. The study aims to explore the transmission channels of QE that highlights its effects on both financial markets and economic activities.
2. Review empirical evidence on the domestic and global financial market responses to QE, offering a holistic perspective on its broader investment implications.

Transmission Channels of QE

Signaling Channel

The term structure of interest rate decomposes bond yield into two elements: a residual term premium and a risk-neutral component, as shown below:[2]

$$y_t(T) = \frac{1}{T}\int_t^{t+T} E_t^P\,[r_s]ds + TP_t(T) \quad (1)$$

where T denotes time to maturity. $\frac{1}{T}\int_t^{t+T} E_t^P\,[r_s]ds$ denotes the risk neutral component of the yield, which is identical for all bonds of the same maturity, regardless of the issuer. $TP_t(T)$ represents the term premium, which reflects issuer-specific risks and macroeconomic risks. Additionally, it accounts for a premium arising from demand and supply dynamics in the bond market, particularly in the presence of market imperfections. Massive asset purchases by the central bank can influence both components. The risk-neutral component of the yield is affecting though the signaling channel, while the term premium is influenced by the portfolio balance channel.

The signaling channel captures information about expected future policy rates. It implies that the new information in relation to QE will signal the current or future credit condition of a country. Through the signaling channel, market participants alter their anticipations regarding the future trajectory of the policy rate, suggesting that the signaling channel may explain the impact of massive purchases on bond yields by altering the risk-neutral component of interest rates, via expectation hypothesis.

[2] The equation of bond yield is extracted from Christensen and Krogstrup (2019).

QE reflects the prediction that the central bank is pushing for loosening credit condition in the future by expanding the balance sheet of a country and hence increasing the money supply in the economy. This would lower the expectations components of long-term yields. Subsequently, the increase in funds available in the market for lending would, ceteris paribus, lower the loan rates, resulting in more borrowers to access cheaper capital for greater investments. Christensen and Rudebusch (2012) reveal that the decline in the U.S. Treasury yields during QE period primarily reflects lower policy rate expectations, suggesting that QE effectively influences market perceptions of future monetary policy. Bauer and Neely (2014) highlight that the signaling channel plays a crucial role to explain the effect of the Fed QE on international bond yields.

The application of the signaling channel assumes that all assets are perfect substitutes. However, the concept of imperfect asset substitutability suggests that assets possess unique characteristics, making their prices difficult to justify solely through common-state-contingent contracts. Individual-specific risk in a portfolio may remain undiversified, and the supply of a given asset generally influences its price (Tobin, 1958; Tobin, 1969; Andrés, López-Salido, & Nelson, 2004). Hence, if investors who exhibit 'preferred habitats' for specific assets or maturities, asset substitutability becomes imperfect, resulting in downward sloping demand curves.

In a model with financial friction or imperfect asset substitutability across different risk levels, the signaling channel becomes negligible to affect asset prices. To assess the signaling effect, "path" and "target" monetary policy surprise measures, as defined by Gürkaynak, Sack and Swanson (2005), can be used to evaluate asset price responses to unconventional monetary policy shocks. Dedola et al. (2021) reveal that the ECB's QE significantly depreciates exchange rates through the signaling channel, as it alters anticipations about the future trajectory of monetary policy, thereby influencing currency valuation.

Portfolio Balance Channel

The portfolio balance channel, commonly used to explain the impact of QE, is referred to as the supply-induced portfolio balance channel. It posits that a reduction in bond supply, resulting from central bank purchases, influences the risk premium investors demand for holding these securities. As described by Gagnon et al. (2011), massive asset purchases by a central bank reduces the supply available to the private sector, displacing some investors and decreasing others' holdings. Simultaneously, it increases the private sector's bank reserves. The purchased security's expected return must decline for investors to accommodate these adjustments.

The portfolio balance channel relies on the preferred habitat theory and market segmentation concept, which inhibit perfect arbitrage between expected short-term and long-term interest rates, allowing alters in the maturity composition of nominal government debt to influence asset prices (Joyce et al., 2010; Thornton, 2012; Fawley & Neely, 2013). The essential idea of this channel is that bonds with different maturities are imperfect substitutes. When a central bank implements massive purchases of a specific asset type, the term premium on those assets decline, as investors demand less compensation to hold the remaining supply. Thus, the portfolio balance channel provides a framework for assessing the effect of QE by addressing the issue of imperfect asset substitutability.

A key question is whether this concept should be applied to a particular asset class or broadly across fixed income instruments. Greenword and Vayanos (2014) apply this concept to the Treasury market, demonstrating that the spread between short-term and long-term Treasury bonds is significantly influenced significantly by changes in their relative supply. D'Amico and King (2013) support the imperfect substitutability theory and preferred habitat theory by providing evidence on the importance of the local supply channel through estimating the flow and stock effects of U.S. QE1.[3] Their findings indicate that stock effects have a significant and positive impact on cumulative holding returns for both Treasury purchases and near-substitute purchases, with Treasury purchases exerting greater effects, suggesting imperfect substitution within the same sector. Meanwhile, flow effects show that only eligible securities with remaining maturities of less than 15 years experience positive and statistically significant price changes. Alternatively, Gagnon et al. (2011) advocate the implementation of QE by the Fed leads to reductions in long-term interest rates on broad fixed income securities.

Empirical literature show that the portfolio balance channel is the most effective mechanism for influencing financial asset prices (see Bernanke & Reinhart, 2004; Bernanke, 2010; Christensen, Lopez, & Rudebusch, 2014). QE measures affect the demand and supply dynamics of a given asset, thereby affecting its yield and price. Vayanos and Vila (2021) suggest that when the Fed conducts massive asset purchases, the publicly available supply of these securities decreases. For market participants to be willing to sell and hold fewer long-term securities, their prices must rise relative to other assets, leading to a decline in long-term yields.

The portfolio balance channel explains that QE declines long-term yields and trigger portfolio reallocation as investors seek for greater returns. Hence, investors shift funds from Treasuries to riskier assets such as equities and commodities, which pushes up the prices for these assets. This channel highlights how QE not only affects bond markets but also stimulates broader financial markets by altering investors' risk preferences and asset allocations. Priftis and Vogel (2016) reveal that the ECB QE declines long-term bond yields, prompting investors to reallocate their portfolios toward alternative assets such as physical capital and foreign assets. Alpanda and Kabaca (2020) provide evidence of a stronger portfolio balance effect of QE, demonstrating that it not only impacts domestic asset prices but also generates significant international spillover effects. Yip, Lau, and Brooks (2024) also find that total return spillovers intensify during the initiation of QE1 but diminish when QE tapering begins.

Christensen and Krogstrup (2019) distinguish the reserved-induced portfolio balance effect from the supply-induced portfolio balance effect by examining the impact of the Swiss National Bank's (SNB) QE's announcements on long-term interest rates. Their findings reveal that decline in long-term yields following QE announcements was primarily driven by the reserve-induced portfolio balance effect. This effect explains asset price and yield reactions to QE through the expansion of central bank reserves without the acquisition of long-term securities.

[3] Local supply channel explains that the relative quantities outstanding of long-term assets that are available for public purchases will affect the long-term yields. Two types of investors are included in this assumption, which are preferred-habitat investors and arbitrageurs. Similar study was carried out by D'Amico et al. (2012).

The reserve-induced portfolio balance channel serves as the primary mechanism underlying SNB's QE, proposing that long-term yields respond to reserve expansion independently of the assets purchased by the SNB. To simplify the transmission mechanism, the financial system is categorized into three groups: non-bank financial institutions (NBFIs), banks, and the central bank. When the central bank implements QE by purchasing short-term assets (e.g., short-term bills) from banks with newly issued reserves, banks' portfolio composition remains unchanged, as reserves and short-term assets are considered near-perfect substitutes. Therefore, banks are not required to adjust their portfolios.

Alternatively, if the central bank acquires short-term assets from NBFIs with newly issued reserves, banks' portfolio composition will be affected. As NBFIs cannot directly hold reserves, the central bank transfers these reserves to their respective banks, which subsequently record them as deposits for the NBFIs. Consequently, banks' portfolios depend heavily on safe, liquid, and low-yielding reserves. In response, banks may try to diversify their portfolio by purchasing other riskier securities with their excess reserves. Consequently, the prices of these securities increase.

Liquidity Channel

Under normal market conditions, the liquidity channel may have a negligible impact, as markets tend to be sufficiently liquid and deep. Hence, it is easy for the investors to buy and sell the assets within a short period with no loss in value. However, liquidity of the market can be one of the important concerns when the market is in stressed conditions. In such circumstances, the liquidity channel serves as a framework for evaluating the financial impact of QE.

The liquidity channel plays an important role as it affect the banks' ability to expand credit and stimulate economic activity. Yip, Lau, and Brooks (2023) demonstrate that the U.S. QE effectively reduced the liquidity premium, thereby narrowing sovereign yield spreads in most commodity-exporters. This suggests that QE fostered higher real economic activity and increased credit expansion. QE involves large-scale purchase of long-term securities by the central bank, which pays for these assets by expanding reserve balances. Since reserve balances are more liquid than long-term securities, market functioning may improve with the central bank's presence as a significant buyer, thereby enhancing overall market liquidity (Joyce & Tong, 2012). Fic (2013) finds that QE significantly impact both developed and developing economies by enhancing global liquidity.

Consistently, Krishnamurthy and Vissing-Jorgensen (2011) demonstrate that QE may reduce the liquidity premium and raise yields of the most liquid assets (i.e. Treasuries) through the liquidity channel. Christensen and Gillan (2022) also show that the U.S. QE2 significantly improve financial market functioning through the liquidity channel. Balcilar et al. (2024) document that QE reduces the liquidity premium, allowing those banks that experienced liquidity constraints due to the GFC to extend credit to investors. Similarly. Caldentey (2017) suggests that QE positively impacts the international bond market by enhancing global liquidity and altering the relative profitability of investing in different assets.

Nonetheless, the liquidity channel might become negligible during economic recovery when a "liquidity trap" exists. The concept of the liquidity trap, first introduced by Keynes (1936) and Hicks (1937), suggests that market participants prefer to hold cash rather than

purchasing securities, rendering additional liquidity injection ineffective as the surplus money is merely stored by the market. Consequently, when central banks inject money into economy through massive purchases, the excess saving surpassing investment remain unabsorbed, hindering economic recovery from recession (Yellen, 2009). Herrenbrueck (2014) contends that QE may crowd out private capital flows, leading to higher real yields and disinflation. This effect arises from the "limited" supply of Treasuries, potentially resulting in a liquidity trap.

Default Risk Channel

Beyond the three main transmission channels, QE can also influence asset prices through the default risk channel. Different financial assets carry different degree of default risks. For instance, a junk bond such as a BB-rated bond is more likely to default than an AA-rated bond. The default risk channel predicts that the default risk of institutions will decline if QE successfully stimulates economic recovery. Furthermore, the Capital Asset Pricing Model (CAPM) suggests that the default risk premium declines alongside economic recovery as investors' risk aversion declines.

Krishnamurthy and Vissing-Jorgensen (2011) propose examining the role of the default risk channel in affecting interest rates during the QE period using credit-default swaps (CDS).[4] Moreover, Albu et al. (2014a) analyse the effect of the ECB QE on the dynamics of a series of five-year sovereign CDS by using event study analysis in the spirit of Albu *et al*. (2014b).[5] The findings suggest the ECB's QE has a substantial influence on the dynamics of the CDS, within a range from 73.17% to 92.68%.

Confidence Level Channel

The confidence level channel implies that QE might cause the fall of asset prices if the market participants perceive the announcement of QE will deteriorate the economic outlook compared to pre-QE period. In this case, riskless investments such as Treasury securities are more desirable to hold. This could lead the demand for riskier assets to decline, leading to shrinkage of prices.

In contrast, if the market participants view the announcement of QE will reduce concerns about risk, then asset prices may hike (Glick & Leduc, 2012; Roache & Rousset, 2013). Hence, asset prices are affected greatly by the perception of the market participants to the underlying economic outlook at the time of the QE's announcements.

Inventory Demand Channel

QE may influence the volatility of asset prices through the inventory demand channel. Yet, this channel might have greater impact on the commodity market especially storable commodities. If QE causes lower yields, it may stimulate inventory demand for storable commodities as lower cost of carrying inventories. As a result, the price of storable commodities might increase (Glick & Leduc, 2012). This, in turn, would increase demand for storable commodities, thereby raising their prices. Perhaps, the countries that depend heavily

[4] CDS is a hedging tool to insure against default on a certain bond by paying a percentage of face-value as an annual insurance premium.

[5] They estimate based on an ARMA (1,1) –GARCH (1,1) model to test on the eight events announcement dates of the ECB QE. The expected returns are predicted by ARMA-GARCH model. They focus on both abnormal returns and squared abnormal returns.

on the performance of the commodities will be influenced substantially through their equity markets and currencies (Kozicki, Santor, & Suchanek, 2015).

Exchange Rate Channel

The exchange rate may exert an indirect effect on asset prices, particularly for assets denominated in the domestic currency where QE happens. Generally, monetary policy easing is generally linked to domestic currency depreciation due to expansion of domestic currency in the market. For instance, The Fed's QE tend to weaken the USD. Consequently, those assets that are priced in the USD, such as commodities, become more affordable for holders of other currencies, leading to higher demand and, subsequently, rising prices (Kozicki *et al.*, 2015).

Financial Impact of QE

Impact of QE on bond market

The empirical literature on the financial impact of QE dated back to Kimura and Small (2006), suggesting that the implied volatility and historical volatility are statistically significant and positive to credit spreads during QE in Japan. This implies that an increase in the volatility leads to the increase in the credit spreads, that is, QE increases the low-grade corporate bonds' volatility. The effect is adverse for high-grade corporate bonds. Moreover, they discover that the impact of QE on volatility differ across the grades of the corporate bonds. Volatilities tend to be negative and statistically significant to credit spreads; indicating QE reduces the high-grade corporate bonds' volatility. During QE, investors tend to increase their holdings of counter-cyclical bonds (e.g., government bonds and high-grade corporate bonds) and shrink their holdings of pro-cyclical bonds (low-grade corporate bonds). As a result, the risk premium in counter-cyclical bonds decrease, but those of pro-cyclical bonds increase.

Subsequently, extensive empirical research has investigated the effect of QE on the bond market in the aftermath of the GFC (see Bayoumi & Bui, 2011; Krishnamurthy & Vissing-Jorgensen, 2011; Breedon, Chadha, & Waters, 2012). Most studies indicate that QE significantly reduces bond yields, though the effect of QE2 is considerably smaller than that of QE1. Bauer and Rudebusch (2013) suggest that the smaller impact of QE2 steams from weaker signaling effects, as market participants had already anticipated persistently low policy rates over an extended period at the time of the QE2 announcements. Szczerbowicz (2011) finds a reduction of 22 basis points from government bond purchases and 17bps from purchases of agency debt and mortgage-based securities (MBS) during the Fed QE1. Krishnamurthy and Vissing-Jorgensen (2011) investigate the response of both long-term and short-term Treasury yields to U.S. QEs. The results show longer term Treasury yields show statistically significant decline more substantially than short term Treasury yields around U.S. QE1 announcements.[6]

Moore et al. (2013) focus on the impact of U.S. QE announcements on the change in emerging markets yields by using intraday data. Their findings reveal that a contraction in U.S. Treasury yields leads to an increase in foreign holdings of emerging markets government bonds, subsequently reducing their yields. However, the magnitude of this pass through differs across countries, with the U.S. long-term rates influencing emerging market long-term rates by approximately 7 to 55%. Yet, pass through is commonly greater in countries whose

[6] Their findings consistent with Gagnon et al. (2011), suggesting that the larger decline in longer term rates is principally due to the greater decline in the term premium for longer term Treasuries yields.

currency is fixed to the USD. Specifically, greater impact is observed for those countries with flexible foreign exchange regime, greater financial openness, or higher exposure to the U.S. economy.[7]

Joyce et al. (2010) show that the U.K. QE gives an immediate negative impact on excess returns on gilts and corporate bonds by 85bps and 81bps respectively. Consistently, Steeley and Matyushkin (2015) suggest that the BOE QE decline volatility of the gilt-edged market significantly by adopting a GARCH framework event study. Their findings also show that bonds with higher coupons and longer maturities exhibit greater volatility in response to QE compared to the pre-crisis period. Meier (2009) finds a larger effect to gilt yields, estimating a reduction of 40 to 100bps. The author argue that U.K. QE affects gilt yields by at least 35 to 60bps. Similarly, Kapetanios et al. (2012) document that the Bank of England (BOE) QE reduces Treasury yields and yields on MBS by roughly 90bps and 110 bps respectively.

Of note, Christensen and Rudebusch (2012) examine the impact of the Fed QE1 and the BOE QE1 on both Treasury yields and corporate bond yields. They suggest that the decline in the U.K. Treasury yields mainly reflect reduced term premium (i.e. portfolio balance effects) whereas a contraction in the U.S. Treasury yields appeared to reflect lower policy expectations (signaling effects). For corporate bond yields, the longer the maturity, the greater the yields declined. Similarly, Meaning and Zhu (2011) measure the announcement effects of the Fed and BOE QE on cumulative changes in bond yields. Their findings contribute to several aspects. First, they conclude that the relevant announcements of QE1 in U.S. and U.K. had stronger and more significant effect to government bond yields in comparison to QE2 in U.S. and U.K. Additionally, their findings support the portfolio balance effect, suggesting the relevant announcements led to a substantial reduction in corporate bond yields. Consistently, Breedon et al. (2012) find the BOE QE1 related announcements lowered government bond yields and the corporate bonds especially ten-year AAA bonds through the portfolio balance channel. Girardin and Moussa (2011) present evidence of the negative impact of QE on Japan Government Bond (JGB) yields, transmitted through the portfolio balance channel, the signaling channel, and the policy-duration channel. Their findings support the expectations hypothesis of the term structure of interest rates during Japan QE.

Particularly, Neely (2015) to measures the impact of the U.S. QE to U.S., Canada, German, and Japanese bond yields by differentiating the effects of “buy event” from “sell event” to bond yields.[8] All the bond yields were declined cumulatively on a “buy event” while the adverse effect applied to a “sell event”, but the effect is weaker. Similarly, Glick and Leduc (2012) examine the impact of the Fed and BOE QE positive surprise and negative surprise on the long-term interest rates.[9] Not surprisingly, positive monetary surprises decline the ten-year Treasury yields, while negative monetary surprises increase it for both QE. Driffill (2016) focuses on the impact of the ECB QE on ten-year government bond yields. Indeed, one of the notable findings should be highlighted is that the Portuguese financial market gets more

[7] Their study also tests on the direct impact of U.S. interest rates on emerging markets interest rates, the result shows positive relationship and marginally significant at the 10% level.

[8] “Buy event” is the relevant announcements or suggestions of future purchases while “sell event” is the announcements related to limited or reduced purchases.

[9] Positive surprise indicates a loosening of monetary policy whereas negative surprise reflects a tightening of monetary policy.

advantage from the additional liquidity provided by Euro QE by showing that its yields fell the most (around 58bps). In contrast, the Greek bond yields decline less in response to QE (around 5bps) as its economy is mainly influenced by the Greek crisis and political changes in 2015. Christensen and Krogstrup (2019) support that the SNB QE declines long-term yields, with longer-maturity bond experiencing greater declines than shorter-maturity bonds.[10]

Schenkelberg and Watzka (2013) employ low-frequency data to measure the real effects of QE when the short-term rate is constrained by the zero lower bound, applying a Structural Vector Autoregression (SVAR) through Bayesian estimation. They propose a new sign restriction in the SVAR framework, derived from Eggertsson's (2011) New Keynesian dynamic stochastic general equilibrium (DSGE) model via Bayesian estimation methods. The model restricts the response of reserves to amplify the impact of QE shocks on long-term yields. Their results reveal that the 10-year government bond yield experiences a significant initial decline in response to the BOJ QE, with the negative effect persisting for approximately two years. The forecast error variance decomposition demonstrates that QE shocks significantly influence long-term government bond yield, explaining up to 59% of their variations.

Interestingly, Hancock and Passmore (2011) estimate the impact of the U.S. QE1 on mortgage rates by dividing QE into four distinct periods.[11] During the announcement period, mortgage rates declined by 97 bps through portfolio balance effects, indicating that the Fed's actions significantly reduced overall interest rates and improved market functioning. However, the effect diminished during the market transition period, likely due to uncertainty surrounding the QE's objectives. Notably, mortgage rates increased by 15 bps during the normal market pricing period, attributed to the clear communication of QE's objectives, which contributed to the stabilization of market functioning.

A more recent study by Eser and Schwaab (2016) aligns with previous empirical studies, demonstrating that bond yields in all five euro countries decline in response to the ECB's QE. Specifically, Greek bond yields experience the most substantial reduction, while Italian bond yields exhibit the smallest decline compared to other euro area countries. Similarly, Priftis and Vogel (2016) explore the ECB's QE effect through the portfolio balance channel by developing a DSGE model with Bayesian estimation techniques.[12] Their findings indicate that the ECB's QE reduces long-term bond yields, decreases savings, and stimulates consumption.

Likewise, Honda, Kuroki and Tachibana (2013) identify the QE-shock in Japan on long-term interest rates. However, their identification setup is more restrictive than Schenkelberg and Watzka (2013) due to small number of observations they used. Their findings are contradicted to empirical findings, where QE-shock gives positive responses to long-term interest rates. Larger positive responses are observed for the longer maturity. Bayoumi and Bui (2011) find that U.S. QE1 and QE2 have statistically significant and positive effects on emerging market bond yields, whereas only Australian and Canadian bond yields declined significantly over U.S. QE1 and QE2 for advanced countries. Wright (2012) employs a SVAR to

[10] Joyce and Tong (2012) applied the similar event window as Christensen and Krogstrup (2019) to assess the reaction of nominal gilt yields to QE announcements. Additionally, they tested on intraday announcement reactions. Their findings consistent with Christensen and Krogstrup (2019) that gilt yields decline around the U.K. QE announcements.
[11] The four periods are namely announcement period, market transition period (i.e. some uncertainty about government actions), normal market pricing (i.e. elimination of the uncertainty concerning the Fed's objective), and post-Fed intervention.
[12] See Ratto, Roeger, and in't Veld (2009) and Vogel (2017) for the details of the DSGE estimation.

assess the effects of QE shocks on various long-term yields.[13] The findings show U.S. QEs decline U.S. Treasury yields and corporate bond yields significantly, but the effects are reversed over the subsequent months for two reasons. First, the economy is recovering due to the economic stimulus provided by a series of QEs actions. Second, market participants initially overreacted to the QE related announcements.

Impact of QE on Equity and Foreign Exchange Markets

Despite a growing literature on the impact of QE on both equity and foreign exchange rates, the evidence remains inconclusive. Some studies suggests that QE positively affects foreign or local equity prices, while exerting a positive (negative) impact on foreign (local) currencies. Examples include Morgan (2011), Wright (2012), Rosa (2012), Rogers, Scotti, and Wright (2014), Neely (2015), Kenourgios, Papadamou, and Dimitriou (2015). Generally, massive purchases raise the prices of the acquired assets, while also driving up the prices of other financial assets through the portfolio balance channel. Under market segmentation theory, investors rebalance their portfolios as the assets purchased by the central bank are imperfect substitutes for money. As government bond yields decline, investors reduce the risk premium and shift their portfolio allocation from government bonds to riskier assets such as equities and foreign currencies. This portfolio rebalancing increases demand for other financial assets, exerting additional upward pressure on their prices. Benford et al. (2009) reveal that QE enhances the liquidity of private sector balance sheets by injecting money into the economy. Consequently, financial asset prices are driven up as the massive purchases by central bank facilitate the acquisition of these assets.

Kimura and Small (2006) show that the BOJ QE has a positive and statistically significant impact on implied volatility that led to the increase in risk premia on stocks. Following by Honda et al. (2013), their findings highlight that the BOJ QE-shock gives significant positive response to stock prices persistently, however, insignificant negative responses are observed for the JPY throughout QE period. This finding is in line with Svensson (2003); implying that the BOJ did not implement QE effective enough to depreciate the JPY thereby promoting economic activities.

Morgan (2011) empirically investigates the response of foreign exchange rates in Emerging Asia to the U.S. QE announcements. The findings indicate significant cumulative appreciations of 10&, 3.3%, and 2.1% in the Korean Won, Singapore dollar and Indian Rupee, respectively, with the Korean Won's greater appreciation reflecting the openness and large size of Korean financial markets. Rosa (2012) provides evidence of significant QE effects on both exchange rates and stock prices, with all currencies appreciating during the U.S. and U.K. QE periods. Likewise, Rogers et al. (2014) indicate that QE depreciates the local currency in countries implementing the policy, while most stock returns respond positively to the QE announcements.

Kenourgios et al. (2015) examine the impact of the BOJ, BOE, and ECB QE on exchange rate co-movements and volatility, showing that QE significantly devalues the GBP and JPY, with a delayed depreciation of the Euro. Additionally, their findings reveal that only Euro

[13] Carrera, Forero, and Ramírez-Rondán (2014) apply the similar statistical technique to assess the impact of QE on macroeconomic and financial variables for Peru. They observe the real exchange rate appreciates in line with the massive entrance of capital to the Peruvian economy due to U.S. QE.

volatility increases around the ECB QE announcements. Consistently, Kurcharčuková, Claeys and Vašíček (2016) find strong and significant Euro depreciation in response to the ECB QE, using a block-restricted SVAR model. Specifically, Neely (2015) finds that the USD cumulatively depreciated significantly, ranging from 3.54% to 7.76% across foreign currencies for the sum of buy and sell events. The buy-event triggers slightly larger 2-day responses compared to 1-day responses.

Another strand of studies presents mixed findings on the financial impact of QE (see, among others, Bayoumi & Bui, 2011; Glick & Leduc, 2012; Neely, 2015). Empirical evidence suggests that the financial impact of QE varies across countries and phases of implementation, reflecting differences in the design, implementation, and economic conditions of each QE programme. Glick and Leduc (2012) estimate the effect of the BOE and Fed QE on financial assets in developed countries.[14] Their results demonstrate that the Fed QE has a statistically significant negative effect on the USD against all sampled foreign currencies, primarily driven by positive monetary surprises rather than negative ones. Conversely, U.K. QE exerts a negative but statistically insignificant effect on the GBP against all sampled currencies, except for the JPY. Regarding equity prices, the findings are mixed. U.S. QE1 and QE2 announcements significantly lowered most equity indices. Ranging from 0.5% to 5.5%, except for the S&P500 and XetraDax. Similarly, U.K. QE announcements caused declines in most equity indices between 1% and 6.5%, apart from the All Ordinaries. Specifically, the results show that positive monetary surprise announcements of U.S. QEs reduced most equity indices, while negative surprises increased all equity indices. Likewise, U.K. QE surprises lowered most equity indices, except for the All Ordinaries.

Meaning and Zhu (2011) measure the cumulative changes in several key financial indicators during the U.S. and U.K. QE programmes. They find that the nominal effective exchange rates of the USD and Pound depreciated by 7% and 3.7%, respectively, with QE1 in both countries exerting a greater impact than subsequent programmes. Moreover, their results show that equity prices surged during U.S. QE1 and U.K. QE2 but declined during U.K. QE1, attributed to a fall in the implied volatility of equity prices.[15] Similarly, Joyce et al. (2010) document that the FTSE all-Share index exhibited a non-uniform response to U.K. QE announcements, while QE-related news consistently triggered a depreciation of the Pound.

Bayoumi and Bui (2011) found inconsistent results over U.S. QE1 and QE2. Most foreign currencies depreciate significantly against the USD over U.S. QE1 announcements except for the JPY and Renminbi. Meanwhile, U.S. QE2 announcements led to insignificant impact on most foreign currencies. Both QE1 and QE2 news show weak and insignificant effects to most of the foreign equity returns.

An interesting study by Haitsma, Unalmis and De Haan (2016) analyzes the impact of the ECB QE on the EURO STOXX 50 index and sector indices.[16] Following Rogers et al. (2014), they measure the QE surprise by calculating the changes in the spread between German and Italian

[14] The sample countries included are U.S. (S&P500), U.K. (FT All Shares), Canada (S&P/TSX), Australia (All Ordinaries), Japan (Nikkei225), and Euro area (XetraDax).
[15] Implied volatility of equity prices used as a proxy of overall uncertainty in financial markets; implied volatility fell indicates uncertainty is lowered.
[16] EURO STOXX 50 index includes stocks from twelve euro-area countries whereas sector indices consist of nineteen 'supersectors' as defined by the International Classification Benchmark.

ten-year bond yields. They observed that EURO STOXX 50 respond negatively and significantly to QE surprises. Similarly, sixteen sectors exhibit significant negative responses to QE surprises, with the banking, insurance, and oil and gas sectors being the most affected, showing coefficients of -0.146, -0.103, and -0.102, respectively.

Impact of QE on Commodity Market

There is relatively limited empirical research on the impact of QE on the commodity market. In one of the earliest attempts to address this issue, Glick and Leduc (2011) refute the theory that declining interest rates drive higher commodity prices. Their findings suggest that the cumulative effect on the GSCI drops approximately 11.5% and 1.5% during U.S. QE1 and QE2, respectively. A plausible explanation is that market participants anticipated a worsen economic outlook during the QE announcements, which jointly lowered long-term interest rates, the USD value, and commodity prices.

However, Kozicki et al. (2015) present mixed evidence. They assess the effect of U.S. QE on commodity prices and commodity-exporter currencies. While QE1 exhibits no measurable impact on commodity prices, individual commodity returns display no consistent pattern in response to QE2 and QE3 announcements. For instances, during QE2, coal prices declined following the first announcement but showed statistically positive returns on the third and the last announcement. In contrast, commodity-exporter currencies appear to be statistically significant consistent and predicted responses to QE1 announcements. Most importantly, this implies the existence of spillover effects as markets are not perfectly substituted. These effects are weaker during QE2, suggesting diminished spillovers into commodity currencies.

Moreover, Roache and Rousset (2013) investigate the impact of QE on commodity prices by testing the implied volatility of both commodity subgroups and individual commodities. Their results indicate that the implied volatility of commodity prices declined significant during QE1, QE2, and QE3. In contrast, Saghaian and Reed (2014) show heterogeneous effects across different QE phases, with QE1 exhibiting a weaker positive impact on commodity prices than QE2, possibly due to heightened economic uncertainty amid the financial crisis.

By assessing the transmission mechanism between commodity currencies and commodities, Yip, Brooks, and Do (2017) demonstrate that total spillovers surged during the initiation of U.S. QE1 and slumped when QE tapered. Among commodities, the Energy and Metals components emerged as the largest net transmitters of spillovers during QE periods, likely reflecting increased demand for energy and metals spurred heightened economic activity induced by QE.

Conclusion

Understanding the transmission channels of QE holds significant implications for policymakers and investors. This study aims to contribute to the existing literature by synthesizing current studies to elucidate the financial impact of QE through a comprehensive understanding of its transmission mechanism. Specifically, the study explores the transmission channels of QE, highlights its effects on financial markets. Subsequently, empirical evidence on the domestic and global financial market responses to QE is reviewed, offering a holistic perspective on its broader investment implications.

Empirical research provides evidence that QE reduces bond yields, although estimates of the size of the effect vary. The impact of QE1 on bond yields is greater than QE2; indicating smaller signaling effects, as market participants had already anticipated persistently low policy rates at the time of the QE2 announcements.. Although most prior studies suggest a significant relationship between QE and equity prices, the results are mixed in terms of sign, either positive or negative. Nevertheless, the majority of studies show that QE positively impacts stock prices. Investors tend to adjust their portfolio by transferring their portfolio weight from government bonds to more risky assets, such as equities, when government bond yields fall. This occurs as investors reduce their required extra compensation for taking additional risk beyond risk-free assets, thereby increasing demand for equity exerting upward pressure on equity prices.

Empirical studies also offer insights into the reaction of currency values to QE. Not surprisingly, the implementation of QE leads to the depreciation of the local currency where QE is implemented. Additionally, QE tends to appreciate foreign currencies, as indicated by Morgan (2011). Despite the heightened rhetoric regarding the spillovers of QE on commodity prices, empirical evidence supporting these claims is surprisingly limited. While theoretical literature suggests that QE should have a positive impact on commodity prices, empirical evidence remains weak.

This study delivers crucial information to policymakers for designing monetary policy frameworks during financial crises and understanding their effects on financial markets as well as its cross-border impacts. It also offers valuable evidence to fund managers and investors in their investment decision-making processes by clarifying the transmission effect of QE on financial markets. Future research on the financial impact of QE could focus on analyzing the transmission channels and financial impact of COVID-19-induced QE, which is expected to differ from GFC-induced QE.

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