Pitfalls of Quantitative Easing Effect on the EMU Economic Growth: Searching for Turning Points[1]

Veronika ŠULIKOVÁ – Marianna SINIČÁKOVÁ* – Ľubica ŠTIBLÁROVÁ** – Jana BUDOVÁ**

Abstract

This study aims to fill the gap in recent research on the effect of quantitative easing proxied by the broad money growth on economic growth in Economic and Monetary Union (EMU) countries. Specifically, we aim to determine an optimum level of quantitative easing in specific countries that enabled the highest possible economic growth from 2010 to 2019. The results based on the system generalized method of moments (GMM) estimation suggest the inverted U-shaped curve relationship between the broad money growth and GDP per capita growth/GDP growth with the parabola peak between 6.24% and 8.08%. After exceeding this level of broad money growth, the effect on economic growth appears negative, implying that excessive usage of quantitative easing hampered EMU economic growth. Therefore, we assume that sporadic and moderate quantitative easing could be beneficial in times of recession and in the absence of inflation pressures. Otherwise, the risk of stagflation would become real.

Keywords: *broad money growth, economic growth, quantitative easing, panel data model, Generalized Method of Moments, threshold effects*

JEL Classification: E51, E52, C23, O42

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Introduction

The Economic and Monetary Union (EMU) has been experiencing a relatively long period of unconventional monetary policies as a remedy against the global financial crisis, the sovereign debt crisis, and the COVID-19 pandemic and their consequences. Unconventional measures were meant to be applied exclusively to nonstandard circumstances such as liquidity traps, enabling the supply of credit under the negative cost of borrowing. This reasoning significantly amended elementary theoretical and practical pillars of monetary policy.

Borio and Zabai (2018, p. 1) warn that, unlike the original plans of occasional and temporary use of unconventional monetary measures, "*they risk becoming standard and permanent, as the boundaries of the unconventional are stretched day after day*." Therefore, monetary authorities should carefully consider the incorporation of these actions into their standard portfolios and not deviate from their predetermined mandates and goals.

In addition to the European Central Bank's (ECB's) primary objective of price stability, this monetary authority takes into account other goals such as economic growth (Babecká-Kuharčuková et al., 2016). This is apparent from the ECB's application of the Taylor Rule and other monetary principles (Baranowski et al., 2021). Nevertheless, the weights associated with GDP variables are comparatively lower than inflation indicators. The ECB's discretionary measures in response to the Great Recession highlight its consideration of GDP implications. The ECB followed the example of the U.S. Federal Reserve System (the Fed) and implemented an unconventional monetary policy as a tool against the Great Recession (global financial and economic crisis) and its consequences. As a result, the assets of the Fed and the ECB balance sheet increased abruptly, from USD 1 trillion in 2007 to USD 4 trillion in 2018 and from EUR 1.2 trillion to EUR 3.5 trillion, respectively (Guerini et al., 2018). Initially, the ECB approach was rather prudent in terms of the volume and scope of the unconventional measures. However, the unconventional actions gradually became more intensive and frequent due to the sovereign debt crisis involving several EMU members. The implementation of non-standard measures has continued past the sovereign debt crisis, with the ECB fortifying its quantitative easing (QE) activities since 2015 via various asset purchases. While the macroeconomic performance of the United States has improved thanks to the Fed's unconventional policy, evaluation of the ECB's unconventional approach has been more cautious (Guerini et al., 2018; Orphanides, 2021).

The initial objective of broad money growth via an unconventional approach was to support and enhance the liquidity of the European banking sector. However, this first measure was not as efficient as expected (Kinateder and Wagner, 2017). The interbank market did not act according to plan and dried up in the autumn of 2008, causing mutual interbank borrowings to become hamstrung. Therefore, the ECB prepared a new non-standard measure, fixed-rate full allotment (i.e., a possibility of unlimited credits at a fixed interest rate). In response to the sovereign debt crisis in several European countries, the ECB decided to equalize the financing conditions for households and firms across EMU countries. However, unconventional monetary policy measures also affect the pricing of sovereign risk.

Eventually, the euro area faced the risk of deflation (Storm, 2019). Therefore, the ECB repeatedly decreased the interest rate, which had been already close to zero and applied a package of unconventional measures consisting of negative interest rates on deposits, targeted longer-term refinancing operations, an asset purchase program (APP), and forward guidance to increase overall monetary policy transparency and influence the expectations of short rates in the future. The ability to stimulate the economy seemed to have reached its limit after the implementation of the zero lower bound (ZLB). In March 2020, the existing APP was extended to become a pandemic emergency purchase program to mitigate risks stemming from the COVID-19 pandemic.

Therefore, based on the above-mentioned facts and phenomena, we raise two primary research questions. First, it is questionable whether such an intensive and long-term application of unconventional monetary policy primarily in the form of QE was efficient. We wonder if excessive QE might have detrimental effects on the economy and economic growth. Second, we want to determine when the positive effects of QE on GDP growth change to negative ones in EMU countries.

This paper aims to demonstrate the uneven effects of a single unconventional monetary policy on EMU countries' economic growth and determine the optimum level of QE – an optimum annual increase in broad money connected with the highest possible economic growth. Our objective is based on the assumption that excessive QE can hinder economic growth due to inflationary pressures sparked by QE. This postulation stems from the literature that identifies non-linear relations between inflation and GDP, demonstrating that too high inflation, beyond a certain threshold, inhibits economic growth (Kremer et al., 2013). Šuliková et al. (2019) show that QE has positive effects on economic growth only if inflation is low (between 1.8% and 2.2%), which is in line with theoretical expectations. However, if inflation exceeds this threshold, QE has no significant effect or even a negative effect on economic growth. According to the money neutrality theory, excessive QE leads to higher inflation (Patinkin, 1989), which can hinder economic growth. The negative impact of inflation on economic growth is supported by theory (e.g., Barro, 1991) and by integrating inflation into the model to show the expected negative impact on economic growth. This reasoning spurs new research questions and gives pertinence to the investigation of the turning point (a parabola peak) at which the positive effect of QE on economic growth turns negative (we expect an inverted U-shaped relationship).

This paper fills in the gap in recent research on the responses of economic growth to QE in the EMU by estimating the turning points in the broad money – economic growth relationship using the system generalized method of moments (GMM) approach. To the best of our knowledge, this study is the first to empirically investigate the point at which the positive relationship between broad money growth and economic growth turns negative. As other papers omit this aspect, our research provides a wider point of view by integrating the possible existence of breaks in the effects of broad money growth.

Our paper focuses on the time span from 2010 to 2019, as after this period, unconventional monetary measures became a "new normal" for some researchers and are currently considered by some literature to be conventional tools (Orphanides, 2021). However, more importantly, in 2020 asset purchase programs were enacted at an unprecedented scale (e.g., Corsi and Mudde, 2022; Klose and Tillmann, 2021). To preserve favorable financing conditions, in particular following the launch of the pandemic emergency purchase program (PEPP) with an available amount of EUR 1,850 billion, of which EUR 1,581 billion had been employed by the end of 2021. As this paper aims to capture the effects of unconventional monetary policy, the years marked by an unprecedented approach in terms of quantity, structure, and purpose of the PEPP (see quantity evolution in Figure 1), were not considered. Including pandemic years accompanied by relaxed asset purchase conditions could bias our overall results.

The remainder of this paper is structured as follows. Section 1 offers theoretical background information and summarizes relevant literature sources. Section 2 discusses the methodology and data. Section 3 reports our results and offers a discussion based on the findings. Last, the concluding section summarizes the findings, offers major contributions and possible practical implications of the study, acknowledges research limitations, and suggests future avenues for research.

1. Theoretical Background and Literature Overview

The relationship between money supply and economic growth has garnered increasing attention in recent years. Monetary policy has an important role in supporting the economic growth of any country. Monetarists and classic economists believe that monetary policy affects prices but not the real GDP. However, Keynesians believe that changes in the money supply lead to changes in GDP (Blinder, 2008; Chaitip et al., 2015; Doan Van, 2020).

Classical economic theory, which is based on the neutrality of money, argues that changes in the money supply are influenced by nominal variables, not real variables. Consequently, an increase in the money supply raises prices and wages but does not affect the real GDP and unemployment. However, recent evidence suggests that in the short run, changes in the money supply affect real variables such as GDP and employment levels due to price-rigidity and imperfect information flow in markets (Hussain and Haque, 2017). These findings in favor of the non-neutrality of money support the idea that monetary policy interventions are logical, and the importance of an active monetary policy could be emphasized mainly in times of crises (Zeng, 2013).

The global financial crisis in 2007, which led to the Great Recession, represents a watershed event in monetary policy theory when the neutrality of money was reconsidered, the usual approach to monetary policy application was changed, new monetary tools were implemented, and new transmission channels were tested (Wang et al., 2022). One of the main reasons for this change was the inefficiency of conventional interest rate adjustments during a liquidity trap (Guerini et al., 2018). Therefore, unconventional balance sheet – based policy was introduced by the Fed in the United States and by the ECB in the euro area.

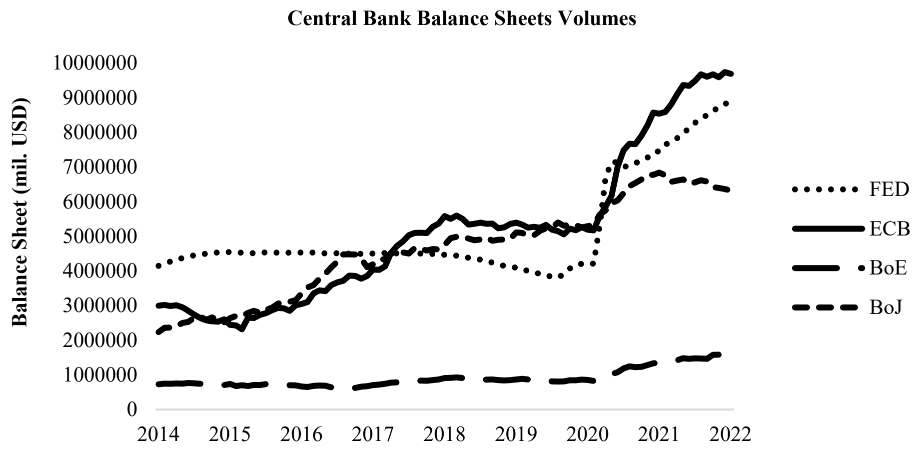
However, the first well-known experience with such unconventional measures took place much sooner in Japan. In 2001, the Bank of Japan announced the first round of QE, aimed at coping with deflationary pressures (Bowman et al., 2015). The Bank of Japan was rather exceptional in using this instrument until 2008; however, since the global financial crisis, virtually all central banks in developed countries – including the United States and the euro area – have benefited from QE. QE practiced by the Bank of Japan does not differ much from the techniques later implemented by other central banks. In 2020, in response to the crisis resulting from the COVID-19 pandemic, the Fed announced open purchases of assets, including corporate bonds in an unprecedented measure. The ECB began purchasing assets in response to the global financial crisis and later sovereign debt crisis in 2008 – 2012. Between 2014 and 2019, it continued to purchase a range of assets in support of monetary policy objectives and to provide further incentives. In 2020, in response to the COVID-19 pandemic, it also launched a pandemic emergency purchase program, which similar to the Fed, relaxed the criteria for asset purchases.

Consequently, the balance sheet volumes of central banks applying unconventional monetary policy via quantitative and qualitative easing have increased significantly (Figure 1).

According to Putnam (2013), to encourage a rapid return to economic growth, it is appropriate for the central bank to purchase securities held by the failing banking system, as this form of QE is the most efficient. QE mainly leads to credit growth and household consumption, capital inflows, stock market price increases, and exchange rate appreciation (Barroso et al., 2016). The efficacy of unconventional monetary policy and its QE depends on the functionality of three primary transmission channels: the signaling channel, the portfolio-balancing channel, and the liquidity channel. Via these channels, monetary authorities promote economic growth.

F i g u r e 1

Central Bank Balance Sheets Volumes



Note: FED – Federal Reserve System; ECB – European Central Bank; BoE – Bank of England, BoJ – Bank of Japan.

Source: Created by authors based on data from the Atlantic Council Global QE Tracker (2022).

Afonso et al. (2018) underline the importance of the bank risk channel, which enables ECB policy interventions to affect the relationship between sovereign bond yield spreads and fundamentals in the euro area. According to Alou (2021), another important transmission channel of unconventional monetary policies is the exchange rate. If QE is effective, the currency should weaken. A weak exchange rate has a positive impact on investment, production, and export competitiveness.

Altavilla and Giannone (2017) suggest that QE should be applied together with forward guidance to increase a central bank's transparency and stabilize the confidence of investors. Joyce et al. (2011) find that the dominance of a transmission channel under QE depends on factors such as companies' willingness to invest and employ, individual consumption, and banks' lending activities. According to Stefański (2022), QE is transmitted to the economy via a decrease in stock market volatility and an increase in stock prices.

Evaluating the efficiency of an unconventional policy and consequent broad money growth, including possible spillover effects to other countries and markets, has garnered the attention of various researchers and policymakers. Gagnon et al.

(2011) and Duca (2013) employ the event studies approach and confirm the positive effects of large asset purchase programs on financial markets. Duca et al. (2016) conclude that QE in the United States has a significant impact on bond issuance in emerging markets. Issuance in these markets without QE would have been only half of the actual issuance since 2009. MacDonald and Popiel (2020) investigate unconventional monetary policies in small open economies such as Canada and related spillovers from foreign unconventional monetary measures via the Bayesian structural vector autoregressive model. Georgiadis and Gräb (2016) identify the impact of the announcements of the ECB´s asset purchase programs on global financial markets and the euro exchange rate. Grabowski and Stawasz-Grabowska (2021) confirm the spillover effects of the ECB's unconventional monetary measures on exchange rates as well as equity and sovereign bond markets in other European countries beyond the eurozone (i.e., the Czech Republic, Hungary, and Poland). Horvath and Voslarova (2016) corroborate the impact of the ECB's unconventional monetary procedure on mainly output growth but also on inflation in the Czech Republic, Hungary, and Poland via shadow policy rates.

Swanson (2021) distinguishes the time aspect of unconventional procedures in the United States from 2009 to 2015, concluding that forward guidance was more favorable in the short term while large-scale asset purchases were more beneficial in the mid and long run. Overall, Swanson concludes that an unconventional monetary policy was equally efficient as a conventional one under normal circumstances. Wei and Han (2021) argue that an unconventional monetary policy is more effective than a conventional one during a pandemic because it can affect the stock and exchange rate markets, and a more interventive monetary policy is needed in the post-pandemic period.

Several pertinent studies have focused on the effect of unconventional monetary policy on sovereign bond yield spreads in the euro area, as those became exceptionally high in the aftermath of the global financial crisis. Falagiarda and Reitz (2015) and De Santis (2020) underscore the importance of the ECB's transparent communication strategy, as its announcements about unconventional monetary policies significantly decreased long-term government bond yield spreads in comparison to German ones in all countries except Greece. Afonso et al. (2018) agree that unconventional monetary policies substantially supported euro area sovereign bonds toward the reduction of their spreads. However, in the future, this experience can contribute to a potential moral hazard in certain eurozone countries.

In line with the main objective of our paper, we focus our literature overview on the efficacy of unconventional monetary policies from the aspect of their effect on GDP and inflation. Snyder and Vale (2022) conclude that aggregate M3 increased GDP across the euro area between 1Q 2000 and 4Q 2019. Their results show that the loss of effectiveness of this unconventional monetary policy occurred as the impact of M3 on GDP decreased after 2008, but after the crisis, the impact of the monetary policy on credit became more pronounced.

In contrast, Rogoff (2017) argues that unconventional monetary policies could have negative impacts and therefore should not replace traditional approaches. The unconventional approach does not allow us to influence significantly private demand for credit and is thus weak in impacting output and inflation. Martin and Milas (2012) confirm only a mild positive effect of unconventional monetary policies on macroeconomic fundamentals. Lavoie (2017) claims that unconventional monetary policies proved that central bank independence had been just an illusion. In times of crisis and non-standard policies, coordination between central banks and fiscal authorities is essential. However, unlike political central bank independence, operational central bank independence can be maintained. According to a recent study by Zhang et al. (2020), unconventional monetary policy in the form of QE in the United States creates uncertainty and may cause long-term problems. Chen et al. (2016) analyze the impact of QE in the United States on developing and advanced economies and their results show that spillovers of this unconventional monetary policy caused overheating in Brazil and China in 2010 and 2011. However, QE in the United States supported the recovery of these economies in 2009 and 2012.

Matousek et al. (2019) examine the QE conducted by the Bank of Japan between 2000 and 2015 and find that there was a significant positive effect of QE on inflation and gross domestic product for small regional banks. Schenkelberg and Watzka (2013) argue that QE in Japan stimulated real activity but did not lead to an increase in inflation. Ryou et al. (2019) use two models in their analysis: a qualitative vector autoregression (Qual VAR) and a time-varying parameter vector autoregression (TVP-VAR). The results of the Qual VAR model suggest that QE had a statistically insignificant effect on the Japanese GDP. The results of the TVP-VAR model point to a positive short-term impact of unconventional monetary policy on the Japanese GDP after 2006. According to these authors, unconventional monetary policy increased the Japanese consumer price index in the short and long runs. However, their results also show that QE had a negative impact on South Korea's GDP.

Hohberger et al. (2019) also point to the positive impact of QE on annual GDP growth and inflation in the eurozone. Cova et al. (2019) examine the domestic and international effects of the Eurosystem's expanded asset purchase program (APP). The authors find that APP increases economic activity and domestic inflation. According to their results, GDP and domestic inflation are rising due to the stimulation of consumption and investment by higher liquidity and lower long-term interest rates. Mouabbi and Sacha (2019) show that without an unconventional monetary policy, the eurozone would have suffered deflation in 1Q 2009 and 1Q 2016. Their results highlight that unconventional central bank measures were reflected in year-on-year GDP growth in the period from 1Q 2014 to 1Q 2016.

Some studies (Hába, 2019) analyze QE in several countries as it was originally planned as just a temporary policy. However, the COVID-19 pandemic crisis reintroduced it very quickly in both the literature and practice (Orphanides, 2021) despite more frequent warnings of its negative consequences on inflation (Churm et al., 2021).

Our paper determines the limits of QE not only in terms of inflation risk but in economic growth as well.

2. Methodology and Data

To examine the effect of QE on the economic growth in EMU countries, we estimate the following dynamic panel data model:

$$GDP\_PC\_G_{it} = \beta_1 GDP\_PC\_G_{it-1} + \beta_2 M3_{it} + \beta_3 M3_{it-1} + \beta_4 \left(M3_{it-1}\right)^2 + \\ + \sum_{c=1}^{C} \gamma_c CV_{cit} + \nu_t + \varepsilon_{it} \tag{1}$$

where $GDP\_PC\_G_{it}$ represents economic growth measured as GDP per capita growth (annual percentage) for the particular EMU country i in year t. We also employ GDP growth (annual percentage) as the dependent variable in the robustness check. Our main independent variable of interest, *M3,* represents the M3 national contribution to EMU aggregate growth (annual percentage) which acts as a proxy for QE. Using a broad money indicator (M3) as a proxy variable for QE has been previously employed by other authors (see, e.g., Bukowski and Gowers, 2018; Černohorská and Klejzar, 2018; Rosenberg, 2019).[2] Here, we include linear terms $M3_{it}$ and $M3_{it-1}$ and a quadratic term ($M3_{it-1}$) to verify a possible inverted U-shaped relationship between QE and economic growth.[3] We primarily focus on the lagged terms, as the impact of QE on economic growth is generally observed with a lag, similar to findings in other studies (Bhattarai, Chatterjee and Park, 2021).

[2] By using M3 as the proxy for QE, we aim to capture broader financial conditions, which was the objective of the APP implemented by the ECB. Due to multiple channels, the effects of QE can also be observed for assets not directly involved in the APP (see, e.g., ECB, 2022). The validity of the proxy has also been verified using the Pearson correlation coefficient between broad money (M3) growth and QE in the form of the APP in EMU countries during the examined period. The coefficient value of 0.65 indicates a medium to strong association, supporting the suitability of the proxy variable.

[3] There is no significant correlation between $M3_{it}$ and $M3_{it-1}$ (see the correlation matrix in Table A1 in the Appendix); therefore, we can use both independent variables in our estimation.

To avoid possible omitted variables bias, we consider several control variables (CV_{cit}).[4] These include inflation in consumer prices ($INFL\_CP_{it}$) (annual percentage), which is expected to have a negative effect on economic growth, as suggested by Barro (1991). This is because high inflation diminishes purchasing power and creates economic uncertainty, leading to increased costs and a decline in investment and consumption.

Another important control variable is the age dependency ratio (AGE_{it},) (percentage of working-age population). An increase in this ratio is expected to correlate with lower economic growth, as a higher age dependency ratio indicates a larger proportion of the population that is not contributing to economic productivity. This relationship has been highlighted in studies such as Cruz and Ahmed (2018).

Gross fixed capital formation ($GFCF\_G_{it}$) (annual percentage growth) is also considered, as it is expected to boost economic growth through the creation of jobs, increased productivity, and technical progress. This positive relationship between capital formation and economic growth is supported by Dritsakis, Varelas and Adamopoulos (2006).

Trade openness ($OPEN_{it}$) (percentage of GDP) is likely to promote economic growth. Open economies can benefit from access to larger markets, technology transfer, and induced foreign investment. Leitao (2010) provides evidence for the positive effect of trade openness on economic growth.

Following the extant growth literature, we also include the lagged dependent variable, $GDP\_PC\_G_{it\text{-}1}$, on the right side of Eq. (1). This inclusion accounts for the persistence of economic growth, meaning that current economic growth is often similar to its previous value. However, the inclusion of a lagged dependent variable is correlated with unobserved individual panel effects, which could result in inconsistency in standard estimators. To overcome this issue, we apply the system dynamic panel estimator of the GMM developed by Blundell and Bond (1998). We choose the Blundell-Bond system GMM estimator over the Arellano-Bond difference estimator due to its ability to address weak instruments and improve efficiency by incorporating additional moment conditions (Blundell and Bond, 1998). This estimator also allows us to solve endogeneity problems of the regressors (Leitao, 2010). v_t denotes year-specific effects, and ε_{it} represents the error term.

The analysis includes 15 EMU countries (excluding Estonia, Latvia, Lithuania, and Cyprus). Since our research focuses on the effects of unconventional monetary policies following the Great Recession, we exclude the COVID-19 pandemic period due to the distinct purpose, structure, and scale of APP post-2019. The model is estimated using annual data from 2010 to 2019.

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[4] Overall, there is no significant correlation between the independent variables in our model (see the correlation matrix in Table A1 in the Appendix).

T a b l e 1

Descriptive Statistics

	GDP_PC_G	GDP_G	M3	INFL_CP	OPEN	GFCF_G	AGE
Min	–8.998	–9.133	–21.608	–1.736	52.340	–23.458	38.480
1st Quartile	0.242	0.666	0.613	0.508	67.190	–2.259	48.420
Median	1.417	1.816	4.023	1.366	104.220	2.180	52.060
Mean	1.417	1.935	3.325	1.312	140.920	2.689	51.310
3rd Quartile	2.451	2.888	6.493	1.992	178.310	4.891	54.410
Max	23.986	25.163	23.723	4.713	416.390	100.691	62.280

Note: Number of observations: N = 150, 15 countries, 10 years (2010 – 2019).

Source: Created by authors based on data from the IMF, Eurosystem NCBs, and the World Bank.

Data are retrieved from several databases, including the International Monetary Fund, Eurosystem NCBs, and the World Bank. The descriptive statistics for all considered variables are reported in Table 1.

3. Results and Discussion

Before estimating the model, we check the stationarity of the input data. This step is crucial before proceeding with the subsequent GMM estimation, as it prevents erroneous interpretations arising from spurious regression. Several panel unit root tests are employed: the Levin-Lin-Chu, Im-Pesaran-Shin, and Maddala-Wu unit root tests. The results are reported in Table 2.

T a b l e 2

Panel Unit Root Testing

Variable	Levin-Lin-Chu Unit-Root Test		Im-Pesaran-Shin Unit-Root Test		Maddala-Wu Unit-Root Test	
	No trend	*Trend*	*No trend*	*Trend*	*No trend*	*Trend*
GDP_PC_G	–12.130***	–16.566***	–7.554***	–10.43***	265.820***	430.780***
GDP_G	–7.689***	–14.295***	–5.594***	–9.743***	145.850***	335.800***
M3	–9.563***	–8.821***	–7.282***	–7.501***	204.510***	207.630***
INFL_CP	–14.543***	–8.321***	–9.540***	–4.459***	259.380***	147.700***
OPEN	–8.470***	–8.104***	–4.904***	–5.224***	129.620***	155.660***
GFCF_G	–8.207***	–11.199***	–6.791***	–8.351***	172.810***	275.830***
AGE	–4.019***	–0.090	0.845	5.471	94.675***	77.713***

Note: We provide values of test statistics for the Levin-Lin-Chu, Im-Pesaran-Shin, and Maddala-Wu unit root tests. In all the tests, the null hypothesis assumes the non-stationarity of time series. ***, **, and * denote statistical significance at the 0.1%, 1%, and 5% levels, respectively.

Source: Calculated by authors based on data from the IMF, Eurosystem NCBs, and the World Bank.

Based on the results of stationarity testing, we reject the null hypothesis that the time series are I(1) (i.e., integrated of order one), and thus, assume their stationarity. Since each individual variable is stationary, we proceed with the system GMM estimation of the baseline model to investigate the effect of lagged broad money growth ($M3_{t-1}$) on GDP per capita growth. The results are reported in Table 3.

T a b l e 3

Effect of Lagged Broad Money Growth on GDP per Capita Growth: System GMM Estimation

	Dependent variable: GDP per capita growth (%)	
	Estimated coefficient	**Statistics: z-value**
$GDP\_PC\_G_{t-1}$	0.225	2.491*
$M3_t$	0.091	4.525***
$M3_{t-1}$	0.063	3.634***
$(M3_{t-1})^2$	–0.005	–4.563***
INFL_CP	–0.649	–3.235**
OPEN	0.003	1.018
GFCF_G	0.060	9.492***
AGE	0.018	2.143*
Sargan test	15.000 (1)	
AR (1) test	–	
AR (2) test	–0.536 (0.592)	
Wald test	5890.077 (<0.001)	

Note: We estimate the model using the system generalized methods of moments (GMM). ***, **, and * denote statistical significance at the 0.1%, 1%, and 5% levels, respectively. For the diagnostic tests, we report the values of test statistics (with p-values in parentheses). For the Sargan test of over-identifying restrictions, the null hypothesis is that the over-identifying restrictions are valid. For the Arellano-Bond autocorrelation test of the first order, the null hypothesis is that there is no first-order serial correlation in the first-differenced errors. For the Arellano-Bond autocorrelation test of the second order, the null hypothesis is that there is no second-order serial correlation in the first-differenced errors. For the Wald test for coefficients, the null hypothesis is that all coefficients are zero.

Source: Calculated by authors based on data from the IMF, Eurosystem NCBs, and the World Bank.

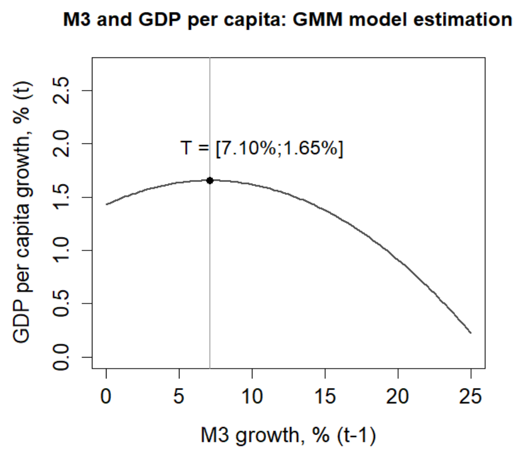
First, we find the coefficient related to the lagged dependent variable $GDP\_PC\_G_{it-1}$ to be statistically significant, which confirms the persistence of GDP per capita growth. This further highlights the appropriate decision to use the dynamic panel model estimation with the GMM technique.

Regarding the primary variable of interest, our findings confirm the significant relationship between economic growth and QE, as proxied by the broad money aggregate. In particular, we find a statistically significant positive relationship between broad money growth and economic growth in the EMU countries during 2010 – 2019 (see coefficients related to $M3_t$ and $M3_{t-1}$). This suggests that the unconventional monetary policy tool contributed to boosting economic growth in the EMU countries examined in this study. These findings are consistent with those of Snyder and Vale (2022). We also observe a statistically significant relationship between economic growth and the quadratic term of $(M3_{t-1})^2$, indicating that the estimated relationship is parabolic rather than linear.

Given that the regression coefficient for the linear term $M3_{t-1}$ is positive and the coefficient for the quadratic term $(M3_{t-1})^2$ is negative, we confirm an inverted U-shaped relationship between broad money growth and GDP per capita growth (see Figure 2). The estimated parabola allows us to determine a peak, or turning point, beyond which the positive relationship between broad money growth and GDP per capita growth becomes negative.

F i g u r e 2

Effect of Lagged Broad Money Growth on GDP per Capita Growth: System GMM Estimation



Note: The estimated parabola is given by the equation: $y = 1.429 + 0.063x - 0.004x^2$. The corresponding coefficients for (x) and (x^2) are the estimated coefficients from the GMM model (specifically, ($M3_{t-1}$) and $(M3_{t-1})^2$; see Table 3). We calculate the mean intercept of 1.429 for all 15 countries in our sample. Individual country-specific intercepts are reported in Table 4.

Source: Created by authors based on data from the IMF, Eurosystem NCBs, and the World Bank.

According to the estimated coefficients of the model (Table 3), a positive relationship exists between broad money growth and GDP per capita growth when broad money growth is less than 7.10%. However, if the ECB increases broad money by more than 7.10%, this relationship becomes negative (see Figure 2). These findings suggest that persistent and unlimited QE may not be beneficial for economic growth in the EMU. The estimated parabola indicates that an increase in broad money growth beyond approximately 7% has undesirable consequences and can hinder economic growth in the EMU.

To substantiate these claims economically, it is important to consider that an excessive increase in broad money can hinder economic growth due to potential inflationary pressures caused by QE. This aligns with the money neutrality theory, which posits that an increase in money supply leads to higher inflation (see, e.g., Patinkin, 1989). The negative impact of inflation on economic growth is supported by both theoretical and empirical research (Barro, 1991; Kremer et al., 2013). Our GMM estimation results also support this, as the regression coefficient corresponding to inflation in Table 3 is significantly negative.

Our evidence partially corroborates the findings of Rogoff (2017), who argues that unconventional monetary policy instruments should be used cautiously and not replace the traditional approach. This point is also confirmed by the situation in the EMU. Excessive persistence in an unconventional monetary approach such as QE appears to have become a stumbling block for the ECB, which has faced an inflationary crisis. In comparison to the rigidity of the ECB, the more flexible approach of the Fed, implementing QE when needed and then abandoning it in line with economic fundamentals, along with its readiness to increase base rates faster, appears to be more efficient.

However, the issue is more complex, and as stated by Schröder and Storm (2020) and Storm (2022), monetary policymakers must consider social costs stemming from monetary policy changes, global supply chain crisis, de-globalization, "greenflation" due to green structural economic transition, and many other current challenges. Consequently, the ECB's prudence in applying restrictive monetary measures is somewhat understandable, as higher inflation can help to reduce the value of public debt of highly indebted EMU members. Nevertheless, this approach does not seem to be appropriate for more disciplined EMU members in terms of public indebtedness.

Table 4

Individual (Country-Specific) Intercepts: Lagged M3 and GDP per Capita Growth

	Austria	**Belgium**	**Finland**	**France**
Intercept Parabola peak	0.749 [7.10%, 0.97%]	0.698 [7.10%, 0.92%]	0.521 [7.10%, 0.75%]	0.817 [7.10%, 1.04%]
	Germany	**Greece**	**Ireland**	**Italy**
Intercept Parabola peak	1.366 [7.10%, 1.59%]	–0.377 [7.10%, –0.15%]	6.272 [7.10%, 6.50%]	0.015 [7.10%, 0.24%]
	Luxemburg	**Malta**	**Netherlands**	**Portugal**
Intercept Parabola peak	0.484 [7.10%, 0.71%]	3.634 [7.10%, 3.86%]	1.014 [7.10%, 1.24%]	0.935 [7.10%, 1.16%]
	Slovakia	**Slovenia**	**Spain**	**All 15 countries**
Intercept Parabola peak	2.573 [7.10%, 2.80%]	1.693 [7.10%, 1.92%]	1.045 [7.10%, 1.27%]	1.429 [7.10%, 1.65%]

Note: The intercepts are calculated for the parabolic equation (y = INTERCEPT + 0.063x – 0.004x2), representing the estimated relationship between M3 growth (t – 1) and GDP per capita growth. Country-specific intercepts adjust the estimated parabola vertically for each country, meaning the estimated M3 growth threshold (7.10%, as shown in Figure 2) remains constant across countries, while the corresponding GDP per capita growth varies.

Source: Calculated by authors based on data from the IMF, Eurosystem NCBs, and the World Bank.

The turning point of broad money growth at 7.10% is associated with the highest GDP per capita growth, averaging 1.65% across all 15 countries included in the panel model. This turning point can be considered the optimal annual increase in broad money, corresponding to the peak economic growth (see Figure 2). We also calculate individual country-specific intercepts and values of GDP per capita growth at the peaks of their respective parabolas. These results are reported in Table 4.

Overall, the GDP per capita growth corresponding to the parabola peaks remains at a similar level of approximately 1% across the EMU countries examined in this study, with the exception of several countries. In particular, Greece (−0.15%)

and Italy (0.24%) exhibit minor economic growth at the turning point of 7.10% broad money growth, while Ireland experiences substantial economic growth of 6.50%. This result can be explained by the historical data used for the analysis; in 2015, Ireland's GDP per capita grew by almost 24% as several foreign companies moved their bases to Ireland which, in turn, increased the value of Ireland's balance sheet.

Regarding the control variables, our results confirm the negative relationship between inflation and economic growth, validating the models of economic growth (see, e.g., Barro, 1991; Orphanides and Solow, 1990).[5] We also find a positive and statistically significant relationship between gross capital formation and economic growth, consistent with other empirical studies (see, e.g., Dritsakis, Varelas and Adamopoulos, 2006) and theoretical claims regarding the support of economic growth through technology transfer or the increase in physical capital stock (Levine and Renelt, 1992). Although we do not find a statistically significant positive relationship between trade openness and economic growth, we find one between the age dependency ratio and economic growth.

T a b l e 5

Robustness Check (I): Alternating GDP per Capita Growth, Adding/Removing $M3_t$

	Dependent variable			
	GDP per capita growth		*GDP growth*	
	Model 1	**Model 2**	**Model 3**	**Model 4**
$GDP\_PC\_G_{t-1}$	0.225*	0.279**		
$GDP\_ G_{t-1}$			0.228*	0.283**
$M3_t$	0.091***		0.097***	
$M3_{t-1}$	0.063***	0.062***	0.075***	0.073***
$(M3_{t-1})^2$	–0.005***	–0.005***	–0.005***	–0.005***
INFL_CP	–0.649**	–0.694***	–0.633**	–0.683***
OPEN	0.003	0.005	0.008*	0.009*
GFCF_G	0.060***	0.059***	0.063***	0.062***
AGE	0.018*	0.021**	0.011	0.015
Parabola peak: $[M3_{t-1}; GDPG_t]$	[7.10, 1.65]	[6.24, 1.65]	[8.08, 2.23]	[7.10, 2.22]
Sargan test	15.000 (1)	15.000 (1)	15.000 (1)	15.000 (1)
AR (1) test	–	–	–1.351 (0.177)	–1.235 (0.217)
AR (2) test	–0.536 (0.592)	–0.478 (0.633)	–0.745 (0.456)	–0.708 (0.479)
Wald test	5890.077 (<0.001)	1835.473 (<0.001)	10967.460 (<0.001)	2402.749 (<0.001)

Notes: We estimate the models using the system generalized methods of moments (GMM). Model 1 corresponds to the model presented in Table 3 and Figure 2. Models 2 and 4 exclude the independent variable $M3_t$ and only incorporate lagged values of M3. ***, **, and * denote statistical significance at the 0.1%, 1%, and 5% levels, respectively. For the corresponding diagnostic tests, we report the values of test statistics (with p-values in parentheses).

Source: Calculated by authors based on data from the IMF, Eurosystem NCBs, and the World Bank.

[5] However, it should be noted that recent empirical studies point out a possible nonlinear relationship between inflation and economic growth (see, e.g., Ibarra and Trupkin, 2016).

Using an alternative model specification where we set GDP growth as the dependent variable (see Table 5), we confirm the positive and statistically significant relationship between trade openness and economic growth, validating previous evidence (e.g., Leitao, 2010). Aside from minor differences, the estimation results using GDP per capita growth and GDP growth (as well as removing regressor $M3_t$) as dependent variables appear to be very similar, thus proving the robustness of the baseline regression results. Similarly, we find a statistically significant and positive coefficient for the linear term $M3_{t\text{-}1}$ and a negative one related to the quadratic term $(M3_{t\text{-}1})^2$, which indicates the inverted U-shaped curve relationship between broad money growth and economic growth (see models 1 – 4 in Table 5). In the GDP growth models, we find the parabola peaks at thresholds of either 8.08% or 7.10% of broad money growth, corresponding to 2.23% or 2.22% of economic growth, respectively (see models 3 and 4 in Table 5). In the GDP per capita growth model without M3 at time *t*, the turning point occurs at 6.24% broad money growth and 1.65% economic growth (see model 2 in Table 5). Our findings, therefore, remain qualitatively very similar: after exceeding approximately 6% – 8% of broad money growth, the positive effect on economic growth appears to become negative. This suggests that excessive use of QE in the form of broad money growth might have negative consequences for the economic growth of EMU countries.

T a b l e 6

Robustness Check (II): Adding $M3_t^2$

	Dependent variable					
	GDP per capita growth			*GDP growth*		
	Model 1a	**Model 1b**	**Model 1c**	**Model 2a**	**Model 2b**	**Model 2c**
$GDP\_PC\_G_{t-1}$	0.225*	0.236*	0.276*			
$GDP\_ G_{t-1}$				0.228*	0.245*	0.291*
$M3_t$	0.091***	0.099***	0.108***	0.097***	0.105***	0.114***
$M3_t^2$		–0.003***	–0.005***		–0.003***	–0.005***
$M3_{t-1}$	0.063***	0.053*		0.075***	0.064**	
$(M3_{t-1})^2$	–0.005***	–0.004***		–0.005***	–0.004***	
INFL_CP	–0.649**	–0.656***	–0.678**	–0.633**	–0.642***	–0.669**
OPEN	0.003	0.004	0.004	0.008*	0.009*	0.008
GFCF_G	0.060***	0.059***	0.059***	0.063***	0.061***	0.062***
AGE	0.018*	0.019*	0.019*	0.011	0.012	0.013
Parabola peak: $[M3_{t-1}, GDPG_t]$	[7.10, 1.65]	[6.61, 1.61]		[8.08, 2.23]	[7.67, 2.18]	
Parabola peak: $[M3_t, GDPG_t]$		[15.59, 2.01]	[11.23, 1.89]		[16.49, 2.60]	[11.39, 2.45]
Sargan test	15.000 (1)	15.000 (1)	15.000 (1)	15.000 (1)	15.000 (1)	15.000 (1)
AR (1) test	–	–	–	–1.351 (0.177)	–1.124 (0.261)	–1.146 (0.252)
AR (2) test	–0.536 (0.592)	–0.612 (0.540)	–0.660 (0.509)	–0.745 (0.456)	–1.136 (0.256)	–1.171 (0.242)
Wald test	5890.077 (<0.001)	2281.717 (<0.001)	2246.975 (<0.001)	10967.460 (<0.001)	5023.060 (<0.001)	3897.635 (<0.001)

Notes: We estimate the models using the system generalized methods of moments (GMM). ***, **, and * denote statistical significance at the 0.1%, 1%, and 5% levels, respectively. For the corresponding diagnostic tests, we report the values of test statistics (with p-values in parentheses).

Source: Own calculations based on data from the IMF, Eurosystem NCBs, and the World Bank.

For further robustness checks, we modify the models of GDP per capita growth and GDP growth by adding a quadratic $M3_t$ variable and removing the lagged broad money growth regressors. The results are reported in Table 6.

The results are robust to the inclusion of M3 or lagged M3, as the parabolas are very similar (see estimated coefficients for broad money growth and parabola peaks in Table 6). The parabola peaks for the non-lagged effects of broad money (M3) on economic growth (see models 1b, 1c, 2b, and 2c in Table 6) are higher: [15.59, 2.01], [11.23, 1.89], [16.49, 2.60], [11.39, 2.45]. This suggests that the impact of non-lagged broad money growth on economic growth captures only short-term effects. Thus, a negative effect (i.e., turning point) of broad money is observed at higher values, specifically when broad money growth exceeds 11% – 16%.

Table 7

Robustness Check (III): Adding Control Variables

	Dependent variable					
	GDP per capita growth			GDP growth		
	Model 1a	**Model 1b**	**Model 1c**	**Model 2a**	**Model 2b**	**Model 2c**
$GDP\_PC\_G_{t-1}$	0.225*	0.220**	0.224**			
GDP_G_{t-1}				0.228*	0.278**	0.279**
$M3_t$	0.091***	0.092***	0.092***	0.097***	0.090***	0.090***
$M3_{t-1}$	0.063***	0.064***	0.064***	0.0756***	0.069***	0.069***
$(M3_{t-1})^2$	–0.005***	–0.005***	–0.005***	–0.005***	–0.005***	–0.005***
INFL_CP	–0.649**	–0.623**	–0.635**	–0.633**	–0.634**	–0.646**
OPEN	0.003	0.004	0.004	0.008*	0.008*	0.008*
GFCF_G	0.060***	0.062***	0.061***	0.063***	0.058***	0.058***
AGE	0.018*	0.021*	0.020*	0.011	0.013	0.012
COR		–0.197			–0.086	
GEF			–0.136			0.005
Parabola peak: $[M3_{t-1}, GDPG_t]$	[7.10, 1.65]	[6.87, 1.66]	[7.02, 1.66]	[8.08, 2.23]	[7.57, 2.20]	[7.70, 2.20]
Sargan test	15.000 (1)	15.000 (1)	15.000 (1)	15.000 (1)	15.000 (1)	15.000 (1)
AR (1) test	–	–	–	–1.351 (0.179)	–1.454 (0.283)	–1.573 (0.283)
AR (2) test	–0.536 (0.592)	–0.512 (0.609)	–0.476 (0.634)	–0.745 (0.456)	–0.705 (0.283)	–0.677 (0.277)
Wald test	5890.077 (<0.001)	7353.167 (<0.001)	6379.422 (<0.001)	10967.460 (<0.001)	13683.980 (<0.001)	14015.780 (<0.001)

Notes: We estimate the models using the system generalized methods of moments (GMM). Additional control variables are control of corruption (COR) and government effectiveness (GEF). ***, **, and * denote statistical significance at the 0.1%, 1%, and 5% levels, respectively. For the corresponding diagnostic tests, we report the values of test statistics (with p-values in parentheses).

Source: Calculated by authors based on data from the IMF, Eurosystem NCBs, and the World Bank.

Last, we assess the robustness of our baseline results by incorporating additional control variables that explain GDP growth, specifically control of corruption and government effectiveness. Although the estimated coefficients for these control variables are not significant, the models remain robust (see Table 7).

Based on our GMM model estimations across various specifications – whether for GDP per capita growth or GDP growth, with the inclusion or exclusion of M3 at time *t*, the inclusion of quadratic M3 at time *t*, and additional control variables (see Tables 5 – 7) – excessive broad money growth should not be allowed. Beyond a threshold of approximately 6% – 8% (i.e., the calculated turning points for the estimated parabolas in different models), the positive effect of broad money growth on the economic growth of EMU countries becomes negative.

Conclusion

This paper investigated the effect of unconventional EMU monetary policies, specifically QE proxied by annual broad money growth, on economic growth. This paper fills a gap in recent research by estimating the turning point at which the positive effect of broad money growth on economic growth turns negative.

The system GMM estimation indicates that the relationship between broad money growth and economic growth follows an inverted U-shaped curve. After surpassing the turning point of approximately 6% – 8% broad money growth, the positive effect of broad money growth on economic growth turns negative. This finding suggests that excessive QE may hinder economic growth in EMU countries. Contrary to Borio and Zabai's (2018) assertion that unconventional monetary policies will gradually become standard and permanent, Guerini et al. (2018) argue that QE cannot be sustained indefinitely, as it relies on money supply growth and the accumulation of so-called bad assets in central banks' balance sheets. Thus, central bankers would eventually need to reconsider raising interest rates. The recent inflation crisis has demonstrated the validity of Guerini et al.'s perspective.

Based on our findings, we do not recommend completely abandoning the use of unconventional monetary approaches in the future, as we observe a positive effect on the economic growth of EMU countries, provided that annual broad money growth does not exceed the estimated turning points (6.24% – 8.08%). Therefore, a key policy implication from our research is that unconventional measures, such as QE, should be employed as tools to be used in exceptional cases and with moderation. Our results suggest that broad money growth (i.e., QE) can be effective, but only within a certain range. This underscores the importance for policymakers to identify this turning point, beyond which an increase in broad money has a negative effect on economic growth. Moreover, recent experiences have taught economists that adhering to a specific rule (i.e., the turning point of broad money growth that should not be exceeded) is beneficial. Excessive broad money growth can lead to inflationary pressures, consistent with the Monetarist approach, which in turn slows down economic growth. The negative effect of inflation on economic growth is further supported by our system GMM model estimations, validating other well-known models of economic growth (e.g., Barro, 1991).

Our research enriches existing theories by addressing the debate on the effect of broad money growth on economic growth. The Keynesian approach posits that "money does matter," suggesting a positive effect, while the Monetarist approach argues that "money does not matter," indicating no effect. Our findings bridge these theoretical perspectives, revealing that QE can have both positive and negative effects, depending on the level of broad money growth.

The main limitation of this research is that it concludes its estimations in 2019. The pandemic years were excluded due to the excessive QE and more relaxed asset purchase conditions during that period, which would have led to biased results. For this reason, it was not feasible to include this period in our model. Furthermore, focusing solely on 2020 – 2022 (the official end of QE) would have been too short for a comprehensive analysis. However, as monetary authorities may return to QE more frequently in the future and consider it a "new normal" of monetary policy, it may prove fruitful to test GDP growth responses to QE under more contemporary circumstances. Future research could examine other determinants associated with the positive or negative effects of QE on economic growth and explore how these determinants influence the turning points of broad money growth when its effect on economic growth becomes negative.

In the future, it would be also useful, though not easy, to determine an optimum level of broad money growth that would ideally suit all EMU members. Alternatively, estimating the turning points of broad money growth individually for each EMU member could also be beneficial, as the optimum broad money growth (i.e., the turning point of the inverted U-shaped curve) may vary across euro area countries. Proper fiscal policy measures – a more disciplined approach to public debt – and increasing harmonization within the EMU could lead to a more uniform level of optimum broad money growth, resulting in more consistent turning points of the inverted U-shaped relationship between broad money and economic growth for all member countries.

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A p p e n d i x

T a b l e A1

Correlation Matrix

	$GDP\_PC\_G_{t-1}$	**GDP_G_{t-1}**	**$M3_t$**	**$M3_{t-1}$**	**INFL_CP**	**OPEN**	**GFCF_G**	**AGE**	**COR**	**GEF**
$GDP\_PC\_G_{t-1}$										
GDP_G_{t-1}	0.965									
$M3_t$	0.382	0.424								
$M3_{t-1}$	0.342	0.398	0.171							
INFL_CP	–0.307	–0.255	–0.084	–0.052						
OPEN	0.236	0.418	0.291	0.298	0.097					
GFCF_G	0.511	0.531	0.208	0.261	–0.146	0.234				
AGE	–0.005	–0.086	–0.082	–0.078	–0.255	–0.600	–0.004			
COR	0.047	0.126	0.130	0.120	0.202	0.249	0.150	0.116		
GEF	0.060	0.129	0.149	0.159	0.202	0.204	0.118	0.083	0.953	

Source: Own calculations based on data from the IMF, Eurosystem NCBs, and the World Bank.