



UDC: 336.763.3(100)

DOI: 10.2478/jcbtp-2025-0009

*Journal of Central Banking Theory and Practice, 2025, 1, pp. 163-181**Received: 25 February 2024; accepted: 18 November 2024***Hedvig Gal ***, **Attila Juhasz ****

Quantitative Tightening: Theory, Research, and Impact on Selected Emerging Market Economies

** Department of Economics,
Corvinus University of Budapest,
Budapest, Hungary**E-mail:
hedvig.gal@uni-corvinus.hu**** Treasury, World Bank,
Washington, USA**E-mail:
ajuhasz@worldbank.org*

Abstract: This paper reflects on the experience of the Federal Reserve Bank (Fed) related to its policy of Quantitative Tightening (QT) and spillover effect on BRICS (Brazil, Russia, India, China, South-Africa) and other selected emerging market economies. We have chosen a sample of countries to examine the impact of the Fed's QT on 10-year government bond yields, between the period of 2012-2022. The result proves that the highest correlation between the long-end yields of the United States and the selected EM has materialized during the first QT (QT1) operation by the Fed between 2017 and 2019 for Peru, Brazil, India and Hungary. We expect the same behaviour of long-end yields during the second QT (QT2) policy for the selected emerging market countries.

Key words: Monetary Policy, International transmission mechanism, Emerging Markets.

JEL Classification: E37, E52, E 61, G15.

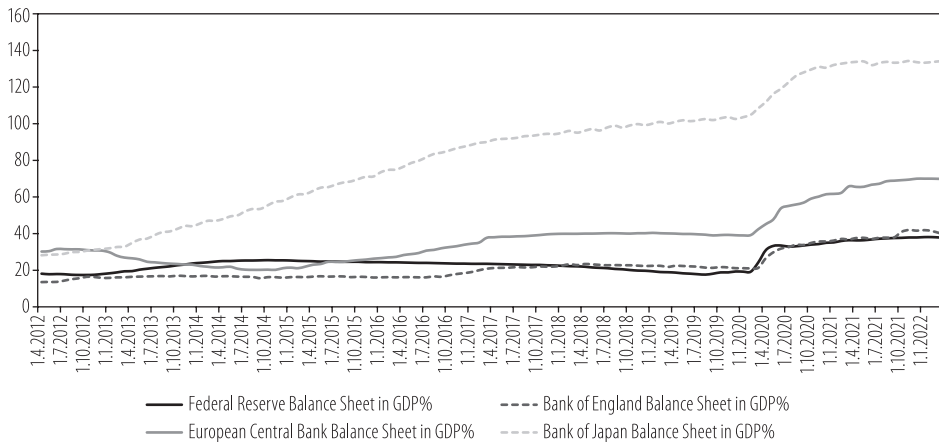
1. Introduction

The world economies are in the process of recovering and inflation exceeded its target level, most of the central banks used a tightening policy by reducing the central bank balance sheet size, i.e. Quantitative Tightening (QT). The Federal Reserve (Fed) faced again with a question: How to manage its balance sheet? Beside the process of Fed's balance sheet shrinkage, we follow the long-end yield change and their spillover effect from a hegemon country (USA) towards the emerging market countries. The balance sheet shrinkage policy became relevant

as it supports conventional monetary policy of avoiding further inflationary pressures. The World Bank authors (Lim, Mohapatra, and Stocker, 2014) evidenced that the unconventional monetary policy in the form of Quantitative Easing affects gross financial inflow from the United States to the other advanced and developing countries, where the government bond flow channel tends to be even more sensitive than other foreign direct investments. We saw that these effects of quantitative tightening are visible in the changes of interest rates and asset prices.

A number of economies in the world have raised their sovereign debt level during the Covid-19 pandemic. In order to cover their accelerated budget deficit, the governments issued more securities, where not only the traditional public or the private sector came up as investors, but also the central banks. The Federal Reserve (Fed) without any obligation or government forces has the autonomy to purchase securities, this occurred during the Covid-19, where the Fed consistently by the fourth round of Quantitative Easing prevented nominal yields from turning negative (Allen and Hein, 2023). Figure 1 shows that it initiated the asset purchase program, which led to a significant expansion of the Fed's Balance Sheet:

Figure 1: Balance sheet comparison of the major central banks (in percentage)



Note: Figure 1 shows the balance sheet comparison of the four major central banks for nearly a decade period. Actually, it starts from a moderate level and then increases gradually. It is visible that the liquidity excess is much higher in 2022 than in 2012. The balance sheet level of the Fed and the Bank of England in GDP % slowly follows each other. However, the Bank of Japan's acceleration was outstanding compared to its peers! The European Central Bank with higher volume follows similar periodical jumps as the Fed and the Bank of England. The Fed and the Bank of Japan has conducted unconventional monetary policy since 2008. (Oxford Analytica, 2019).

Data source: Bloomberg

During the COVID-19, the Fed announced \$700 billion purchase of assets on March 15, 2020¹: \$500 billion of Treasury Securities and \$200 billion of Mortgage-Backed Securities (MBS) to support liquidity needs of financial market in response to the pandemic². The accumulation of securities more than doubled on the Fed's balance sheet compared to the period before pandemic. It increased from \$4 trillion to \$9 trillion of Treasuries and MBS. That time, it was not possible to predict how much the Fed's balance sheet would increase. By the end of 2020, the Fed's balance sheet was standing at 34% of GDP in the U.S., while, the ECB's at 59% in Europe, the Bank of England's 40%, and the Bank of Japan's 127%. The Fed's policymakers observed that the balance sheet is higher than the average level, and further shrinkage was necessary to happen in 2022! The Fed's asset purchase program ended in March 2022³. The list of same open market purchase transaction according to the International Monetary Fund was utilized by the large number of other countries from the advanced and emerging market economies⁴. The Fed's first intention was to increase its primary policy rate⁵ in order to fighting against the inflation, which was increasing.⁶ The authors Lim et al., (2014) from the World Bank found that 62% of the increase in financial inflows was during 2009–2013 from the US to other advanced and developing countries, where at least 13% of this was attributed to QE in high-income countries and 5% for the average developing countries. We estimated that the monetary policy shock from

¹ Federal Reserve's (Federal Open Market Committee) issued a statement on March 15, 2020 related to the asset purchase program. Source: Board of Governors of the Federal Reserve System.

² The FOMC purchased Treasury securities and agency Mortgage-Backed Securities in the optimal amounts needed to support smooth market functioning and effective monetary policy transmission. Source: Federal Reserve announces extensive new measures to support the economy Board of Governors of the Federal Reserve System

³ The same situation occurred in Europe so the European Central Bank (ECB) announced the discontinuation of its Pandemic Emergency Purchase Program (PEPP) at the end of March 2022.

⁴ List of Asset Purchase Programs for Advanced economies: Australia, Canada, Iceland, Israel, South Korea, New Zealand, Norway, Sweden, the United Kingdom. Developed and Emerging Market Economies: Angola, Bolivia, Cabo Verde, Chile, China, Colombia, Costa Rica, Croatia, Egypt, Hungary, India, Indonesia, Jamaica, Mauritius, Mexico, Philippines, Poland, Romania, South Africa, Thailand, Turkey, Ethiopia, Ghana, Papua New Guinea, Rwanda, Uganda (Fratto, Vannier, Mircheva, de Padua and Poirson, 2021).

⁵ FOMC Communications Related to Policy Normalization of plans and principles for reducing the size of the Federal Reserve's Balance Sheet. Source: Board of Governors of the Federal Reserve System.

⁶ Ha, Kose, and Ohnsorge (2022) compared similarities and differences between the Great Inflation in the 1970s and the Inflation of 2022. Similarities appeared in supply disruptions driven by the pandemic, supply shocks of energy prices resemble the oil shocks in 1973 and 1979–1980 and heightened geopolitical tensions.

the U.S. raises long-term yields by 42.70 basis points related to the top five major emerging market and 85.32 basis points for other selected emerging markets.

2. Balance Sheet Shrinkage Policy

Quantitative Tightening or Quantitative Tapering is a process of decreasing the *fixed-income assets* held by the Fed. This paper differentiates *the active and passive approach*. First is a shrinkage of the balance sheet by actively selling securities. The passive approach means that the securities on the balance sheet expire automatically without any financial transaction. In the last phase, when treasury securities reach their maturity date, they are paid off by the government and Mortgage-backed securities are paid off by government-sponsored enterprises, such as the Federal National Mortgage Association or the Federal Home Loan Mortgage Corporation. The QT1 lasted for less than two years, between 2017 and 2019. Essentially, this tightening policy had never been done before on a massive scale in the United States. Engemann (2019) defines it as redeeming or reducing of the Fed's balance sheet size. However, Hopper (2018) reflects on it as the normalization of monetary policy through "unwinding", where the term "unwinding" means the slow and gradual nature of reduction of Fed's balance sheet, which was expanded after the global financial crisis. Hopper (2018), interpreted "unwinding" as simply stopping the replacement of securities, which mature. Berentsen and Waller (2011), pointed out that it is a process of increasing the supply of Treasuries in the financial market, where the Fed explicitly lets the supply of Treasuries in the hands of the private sector grow. The tightening process of selling securities causes increase in supply, which pushes the prices low, and the yields are adjusted upwards. The selling of treasury security on the asset side of the balance sheet is decreasing, while the liability side of the balance sheet exactly matches the decrease in assets (Hollenhorst, Mehta, Williams and Munir, 2022). The Fed's balance sheet represents equilibrium on both the assets and *liabilities side* (Table 1.):

Table 1: Federal Reserve Balance Sheet (billion\$)

Assets		Liabilities	
U.S. Treasury securities	5,700	Reserves (depository institutions)	3,271
MBS	2,726	Repurchase agreements	2,494
Other	425	Currency	2,276
		Treasury general account	530
		Other	280
Total	8,851	Total	8,851

Note: Balance sheet composition of total assets and liabilities.

Data source: Federal Reserve statistical release (H.4.1.), August 25, 2022

Allen, Chadha and Turner (2021) have reflected on quantitative tightening as a process of balance sheet contraction, where the private sector absorbs these assets and results an upward movement in the yield curve (see Figure 4). The main reasons behind the voting for quantitative tightening program were:

1. the inflation was much higher than the average level and this complementary tightening operation could help to fight inflation. The price increased in all sectors, in the supply chain, energy, fuel and non-durable goods.
2. over-accumulation of assets on the Fed's balance sheet also urged the quantitative tightening operation.

Starting the QT2 was subject to being over the zero lower bound. Therefore, the Federal Funds Target Rate was increased from 0.08% (range 0.00-0.25) to 0.33% (range 0.25-0.50) in mid-March, 2022; then from 0.33% (range 0.25-0.50) to 0.83% (range 0.75-1.00) at the beginning of May, 2022. After the base rate further increased from 0.83% (range 0.75-1.00) to 1.58% (range 1.50-1.75) in mid-June, 2022. Peña (2023) stated in his research that raising interest rates mainly affected middle income households in Europe during the Covid-19, and caused asymmetric repercussions in the level of income.

3. Literature review

Monetary policy has gone through various changes over the last decades, which witnessed the end of the “reserve position doctrine” and the turn to a clear focus on short-term and long-term interest rates. The reserve position doctrine was supported by Keynes and later by the monetarist school, developed mainly by the U.S. central bankers during the early 1920s. It became the unchallenged principle for over sixty years. Bindseil (2003) reflects in his book on monetary policy history and explains the three supporting instruments of monetary policy: open market operations, standing facilities, and reserve requirements, where open market operations are the subject of QE and QT.

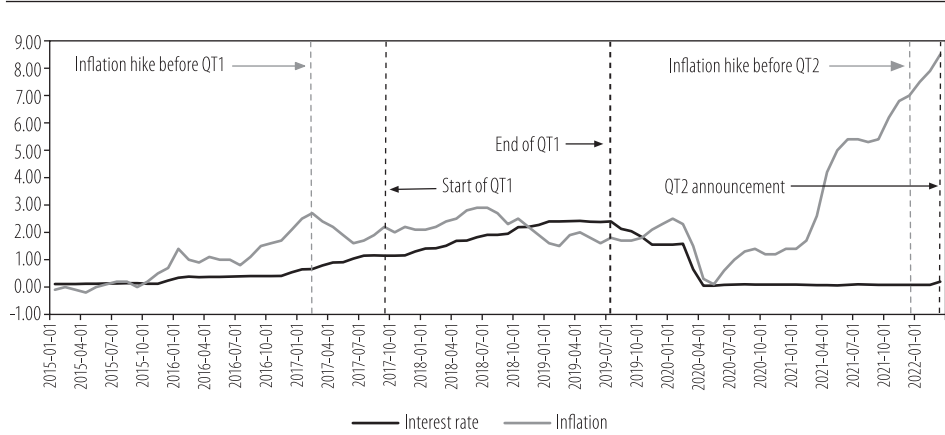
Five years ago, the incumbents thought that the balance sheet was a poorly understood tool according to Hollenhorst, Mehta, Williams and Munir (2022), however, any further effect on the markets should be slowly and quietly unwound. D'Amico and Seida (2020) performed a quantitative analysis, and they found that the yield sensitivities of QT are more prominent, on average, than yield sensitivities of QE. However, Goodhart (2010) emphasizes that the role of the central bank through its balance sheet operations is important. These financial instruments serve to reach targets, where the Fed has a dual mandate: price stability

and reaching maximum employment! Over the past three decades, central banks of advanced economies have established a credible track record of achieving inflation targets (Bordo, Erceg, Levin and Michaels, 2007; Eichengreen, 2022). Other authors (Tucker and Cecchetti, 2021) pointed out that official declarations of aiming for price stability and financial stability are unsatisfactory if there is a jump to end goals without attending to the specific operations and facilities. The authors alternatively provide a categorization of operations: (1) stimulating or dampening aggregate demand by monetary policy to achieve price stability with full use of the economy's productive resources; (2) lending funds to firms whose financial needs cannot be met via private markets – central bank as a lender of last resort; (3) addressing liquidity problems in specific markets – central bank as a market maker of last resort; (4) ensure the flow of credit to specific sectors, regions, or firms – central bank as a selective credit supporter; (5) providing needed funds directly to the government – central bank in an emergency government finance role, where we add (6) operation of balance sheet policy and its international transmission mechanism channel.

According to a numerical estimation of Wei (2022), a \$2.2 trillion passive roll-off of nominal treasury securities from the Federal Reserve's balance is equivalent to an increase of 29 basis points in the current federal effective funds rate at ordinary times, over the three years of observations, and 74 basis points increase during the crisis periods. Crawley, Gagnon, Hebden and Trevino (2022) predict reducing the size of the balance sheet by about \$2 trillion over the next few years, which would be roughly equivalent to raising the policy rate by a little more than 50 basis points. Besides treasury and MBS securities, there are other assets on the Fed's balance sheet in a much smaller amount, such as FX swap lines and the Fed's discount window. FX swap lines provide U.S. dollars to the five major central banks. However, given the stability in U.S. dollar funding markets its usage is minimal (Cabana and Craig, 2022).

4. Macroeconomic Outcomes: Prior vs. Current Cycle of QT

The prior cycle could serve as a reference point for the current one, where the policy rate remains the primary and active tool of the monetary policy, and the quantitative tightening program secondary and complementary tool in the background. In comparison with QT1 program, the QT2 is expected to gear up faster, related to a more rapid runoff of short-maturity Treasuries. Figure 2. provides an overview of inflation behaviour through quantitative tightening programs by the Fed:

Figure 2: Quantitative Tightening and Inflation Hikes (in Percentage)

Note: Quantitative tightening program serves as a response to the inflation hike. Similarly, there was a high inflation during the 1970s. Blinder (1982) compared a double-digits inflation in 1974 (12.2%) and in 1979 (13.3%) for the United States, where the crucial factors accounted for the price level acceleration was the energy and the food price. Concerns about the inflation appeared almost in all economic decisions (DeLong, 1997).

Data source: St. Louis Fed, U.S. Bureau of Labor Statistics

The Fed was more conservative with its balance sheet reduction in QT1. The only \$10 billion/month was followed by a reduction of \$50 billion/month with a split of \$30 billion in Treasuries and \$20 billion in Morgaged-Backed Securities (MBS). During the time, when it initiated its QT1, in 2017, the total balance sheet was around \$4.5 trillion, and it managed to bring it down to \$3.8 trillion. In comparison, the maturity structure of the treasury portfolio for QT2 is longer than in QT1. The second tapering has started with a \$47.5 billion/month decrease in September of 2022 and followed by a \$95 billion/month reduction of \$60 billion in Treasuries and \$35 billion in MBS. Some of the features of balance sheet tightening program, which can be observed:

1. The tightening of the Fed's balance sheet affect long-term yields.
2. Money supply in the system decreases as it induces less money in the market circulation.
3. Small and recursive active sales occurs when passive runoff of Treasuries and MBS reach below the monthly target. Small amount of sales is less likely to involve market concerns.

4. Inflation, debt, and income inequality could endanger recovery in emerging economies, according to the World Bank's Global Economic Prospects report.⁷
5. The Fed may choose to reinvest in shorter maturities, for instance, by purchasing several 3-months T-bills.
6. The trade-off between balance sheet reduction and effective funds rate hike – some market participants use the "3 to 1" rule of thumb, such that the 3-basis point (bp) move in policy rates is worth 1 bp on 10-year treasury yield change. The \$50 billion per month of balance sheet reduction is a substitution for 2% additional rate hikes per year. The Kansas City Fed President, Ester George, mentioned that policy rate hikes might slow once the balance sheet reduction starts (Hollenhorst, Mehta, Williams and Munir (2022).

Table 2: The remaining maturity distribution of selected assets (billion \$)

Maturity	Within 15d	16d-90d	91d-1y	1y-5y	5y-10y	Over 10y	All
U.S. Treasury security holdings	78,233	324,425	819,487	2,017,728	1,009,321	1,451,434	5,700,628
Weekly changes	-44	+615	-505	+565	+22,583	-21,761	+1,453
MBS holdings	0	2	57	2,412	57,525	2,665,909	2,725,906
Weekly changes	0	0	0	-1	-2	-1,565	-1,567

Note: "d" stands for "days", "y" stands for "years".

Data source: Federal Reserve statistical release (H.4.1.), August 25, 2022

Ben Bernanke: Taper Tantrum

Ben Bernanke, then-chairman of the Fed, recommended *tapering asset purchases* in 2013. The outcome was that the yield on 10-year U.S. Treasuries rose from around 2% in May 2013 to around 3% in December 2013. This sharp climb in yields is often referred to as the "taper tantrum". In July 2021, Fed officials signalled that the Federal Reserve would need to reduce the volume of its bond purchases. This signal made some investors worry (Bernanke, 2022) about another "taper tantrum", due to its negative connotation and shock to the market. Despite these fears, most investors remained placid when the Fed hinted at tapering in July 2021. Essentially, the announcement was in line with market

⁷ Global Economic Prospects Report, Stagflation Risk Rises Amid Sharp Slowdown in Growth World Bank, 2022.

expectations in 2021, while the announcement in 2013 came much earlier than expected! Ben Bernanke indicated that a balance sheet reduction should follow the effective policy funds rate increase as a first phase of tightening process, but he was taking no position on the appropriate pace of monetary tightening. The policy communication is easier, and the risk of market disruption is minimized if the shrinkage of the balance sheet is predictable. It is prudent not to begin that process until short-term interest rates are comfortably away from their effective lower bound. For instance, the first quantitative tightening program did not begin until rates had reached 1.00-1.25. Bernanke, Kiley, and Roberts (2019) used the Fed's large-scale macroeconomic model in order to study interest rate policies, and found that the market participants are forward looking, but other agents not.

Table 3: Comparison of the prior and the current cycle

Period	Quantitative Tightening (QT)
	Prior cycle (QT1)
June 2017	Plan for balance sheet reduction announced
September 2017	The balance sheet reduction started at \$10 billion/month in October
October 2018	Speed of \$50 billion/month (\$30 billion/month treasury bills and 20\$ billion/month Mortgage-Backed Securities – MBS) reached.
January 2019	The committee announced that it would implement a policy in an “ample reserves” regime.
March 2019	Announced that balance sheet reduction will be fully phased out in September 2019
July 2019	Balance sheet reduction ended two months earlier than planned, along with a 25bp cut in the policy rate.
Current cycle (QT2)	
June 2022	Balance sheet reduction from June 1. Declining split between \$30 billion/month Treasuries and \$17.5 billion/month Agency debt and Agency MBS.
September 2022	Rise at monthly intervals to \$95 billion/month (split of \$60 billion/month Treasuries and 35\$ billion/month MBS).
Mid-2024	Sufficient liquidity has been drained, so the reserve repo facility (RRF) is no longer used. As a result, bank deposits may move sideways as the depletion of the RRF means reserves shrink faster.
Mid-2025	The balance sheet approaches \$6 trillion in assets (\$4 trillion in treasury holdings, \$2 trillion in MBS holdings) and \$2.5 trillion in reserves. At this point, balance sheet reduction might be slowed or stopped as Fed officials seek to maintain a comfortable level of aggregate reserves. According to estimation, the \$2.2 trillion passive roll-off of nominal treasury securities from the Federal Reserve's balance sheet over three years is equivalent to an increase of 29 basis points in the current federal funds rate.

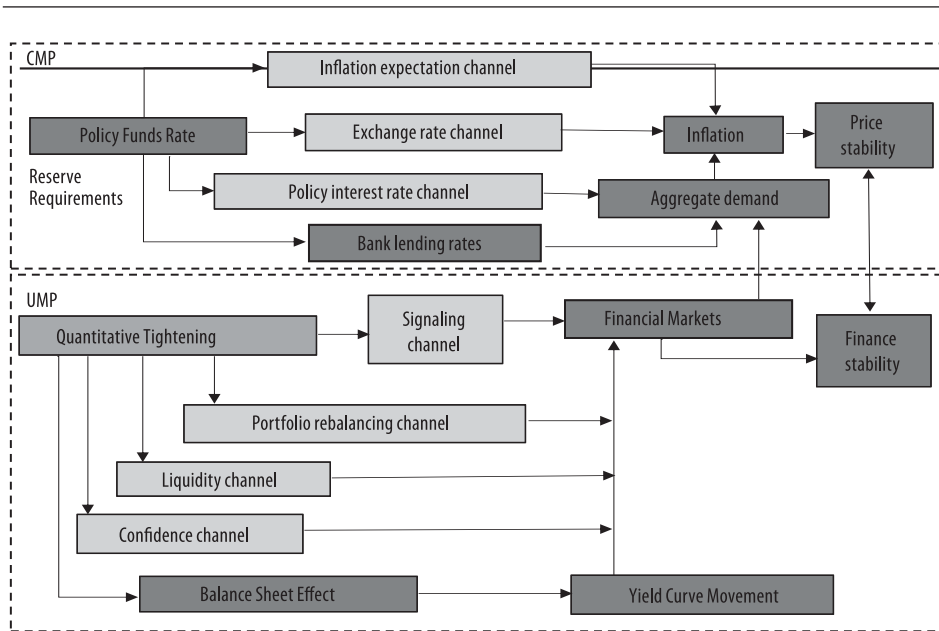
Note: Projections shown are based on Rajdeep Sengupta and A. Lee Smith: Assessing Market Conditions ahead of Quantitative Tightening, Economic Bulletin, Federal Reserve of Kansas City, 2022. and Wei, B. 2022. “How Many Rate Hikes Does Quantitative Tightening Equal?”, Federal Reserve of Atlanta’s Policy Hub, Center for Quantitative Economic Research, No. 11–2022 July 2022. The Fed’s prior versus current QT cycle, where the projections usually refer to three year period (Sengupta and Smith, 2022; Wei, 2022)

Source: Fed of Kansas City, Fed of Atlanta, Fed of New York

5. The general transmission mechanism of QT

Through the transmission mechanism channel of quantitative tightening program, the asset sales affect even cross-border capital flows and market yields (Gagnon, Raskin, Remache and Sack, 2011; Hamilton and Wu, 2012; de Haan, Schoenmaker, Wierts, 2020). Market participants adjust their investment portfolios according to the operations of the Fed through portfolio rebalancing channel. These market transactions, in turn, increase the available stock of privately held assets by buying securities. The second channel is the *signalling channel* (de Haan et al., 2020), where the central bank communicates its expectations according to the base rate and the quantitative tightening program. It improves the perception of financial institutions, businesses, and households by diminishing their concerns. The third is the *liquidity channel* (Gagnon et al., 2011; Joyce, Lasaoa, Stevens and Tong, 2011; Krishnamurthy and Vissing-Jørgensen, 2013), where its effects are moderate with less money in the financial circulation but the expansion of yields on securities.

Figure 3: Transmission mechanism of CMP and UMP



Note: The Conventional Monetary Policy (CMP) and Unconventional Monetary Policy (UMP). QT should not have any material effect through signalling channels and the portfolio balance channel has small and temporary effects on yields.

Source: Authors’ analysis

The amount of money in circulation decreases in order to slow down inflation. Through *confidence channel* affect other countries by increasing yields of securities. The unconventional monetary policy transmission channels directly affect the yield curve and the price stability (Figure 3.). Armas, Castillo, and Vega (2014) reflected on the strong interconnection between the reserve requirement and the quantitative tightening of balance sheet assessment process for the Central Bank of Peru. In the Economic outlook, we also included the Peruvian economy.

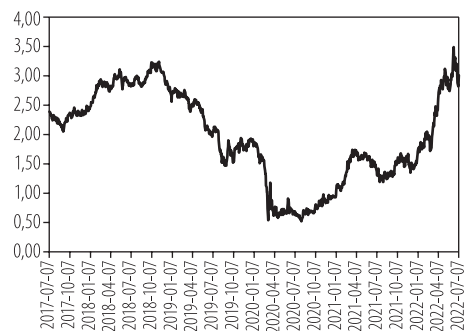
6. Economic outlook

The paper reflects on the 10-year U.S. treasury yield spillover effect towards the selected emerging market. An insightful analysis was performed by Mulaahmetović (2022) related to unconventional monetary policy and macroeconomic performance in the United States.

The BRICS are known for their significant influence on their respective regional affairs to other neighbouring countries in their region. The second group of analysis refers to an arbitrary sampling of the countries: Mexico, Peru, Hungary, Greece, and Turkey. The result shows that the yields moved upward during the QT1 operation between 2017 and 2019. The empirical result reflects on that there is significant increase in yields and a strong correlation between the rates moving across the world.

Engstrom, E.C., Sharpe, S.A. (2022) stated that a difference in maturity between the long-term and the short-term yield spread can be served as an indicator for predicting a recession. Regulatory framework of a central bank keeps financial risk under control with two instruments: balance sheet and interest rate policy in order to reach its traditional macroeconomic objective of financial stability (Turner, 2021). The following statistical overview serves as a comparative analysis between the U.S. and the selected EM economies. The World Bank Global Economic Prospect report for June 2022 (World Bank, 2022) provides a

Figure 4: The yield on U.S. treasury securities at 10-year constant maturity (in percentage)



Note: Daily yields on 10-year U.S. Treasuries between July 2017 and July 2022.

Data source: FRED (St. Louis Fed)

detailed economic outlook about geopolitical factors related to high commodity prices and monetary tightening and indicates the need for a price control.

Table 4: Key Statistics of the USA and BRICS (in %)

	April 2022		Policy interest rate	2021-2022	
	Inflation	10-year Yields		GDP 2021Q4	Unemployment rate 2022Q1
Brazil	12.1	12.29	11.75	1.60	11.1
India	7.8	7.14	4.25	5.40	7.6
China	2.1	2.84	1.50	4.0	5.80
Russia	17.8	10.17	17.00	5.0	4.20
South Africa	11.9	10.36	4.25	1.7	35.3
USA	8.3	2.93	0.50	5.5	3.80
Mean	10.34	8.56	7.75	3.54	12.80

Note: Mean only refers to the BRICS.

Data source: World Bank, Bloomberg (World Economic Statistics)

The table indicates, that the USA as a hegemon country, fulfils the (a.) high GDP, (b.) low unemployment, (c.) policy interest rate hike preliminary conditions of the implementation of the QT program.

The monthly data in local currency for each country was decomposed into five cohorts:

1. May 2012 – May 2022: *a full decade overview;*
2. May 2012 – June 2017: *a period from 2012 till the announcement of QT1;*
3. June 2017 – October 2017: *a period from QT1 announcement till the QT1 program starts;*
4. October 2017 – July 2019: *a full period of the QT1;*
5. July 2019 – May 2022: *a period from the end of QT1 until the current period of QT2 announcement.*

Table 5: Correlation of the USA and BRICS

Time frame/ Selected Countries	(1)	(2)	(3)	(4)	(5)
Brazil	0.46	0.23	0.09	0.72	0.60
India	0.61	0.29	0.57	0.90	0.85
China	0.59	0.70	0.34	0.27	0.04
Russia	0.39	0.07	0.58	0.29	0.62
South Africa	0.16	0.23	0.59	0.24	0.30
Mean	0.44	0.30	0.43	0.48	0.48

Note: The correlation of 10-year Yields between the USA and India was the highest during QT1 (Column 4).

Data source: Bloomberg (GGR - Generic Government Rates)

Column (4) indicates that during QT1, the highest correlation was between the USA and India (0.90) and Brazil (0.72).

Table 6: Key Statistics of the Other Emerging Markets (in %)

	Inflation	April 2022		2021-2022	
		10-year Yields	Policy interest rate	GDP 2021Q4	Unemployment rate 2022Q1
Hungary	9.5	6.9	5.40	7.1	3.57
Mexico	7.7	8.32	6.50	1.1	3.47
Greece	10.13	3.33	0.00	7.4	12.9
Turkey	69.97	8.65	14.00	9.1	11.40
Peru	7.96	7.85	4.50	3.2	8.97
Mean	21.05	7.01	6.08	5.58	8.06

Note: Selected Other Emerging Markets, where the population is lower than in BRICS.

Data source: Bloomberg (World Economic Statistics)

Table 7: Correlation of the USA and Other Selected Emerging Markets

Time frame/ Selected Countries	(1)	(2)	(3)	(4)	(5)
Hungary	0.26	0.01	0.46	0.57	0.72
Mexico	0.44	0.52	0.52	0.37	0.86
Greece	0.11	0.53	0.06	0.50	0.67
Turkey	0.01	0.64	0.90	0.01	0.40
Peru	0.43	0.15	0.13	0.63	0.66
Mean	0.26	0.39	0.41	0.41	0.65

Note: The mean is the highest in the fifth time frame (Column 5).

Data source: Bloomberg (GGR - Generic Government Rates)

Column (4) indicates that during QT1, the highest correlation was between the USA and Peru (0.63).

Table 8: Data panel regression

Dependent variable: 10-year government yields (EM country)					
	Independent variable (10-year U.S. government yield)	t-statistics	R ²	F-statistic	Intercept
Brazil	2.21*** (0.19)	11.61***	0.77 (1.10)	128.61***	30.31*** (5.88)
India	0.50*** (0.08)	6.68***	0.77 (0.42)	127.67***	12.03*** (1.71)
China	0.37*** (0.05)	7.39***	0.55 (0.31)	47.45***	-0.54 (0.15)
Russia	0.97*** (0.21)	4.53***	0.15 (1.46)	20.52***	6.14*** (0.46)
South Africa	0.19* (0.10)	1.95*	0.66 (0.48)	78.37***	7.98*** (2.70)
Hungary	0.67*** (0.23)	2.94***	0.07 (1.55)	8.64***	2.45*** (0.48)
Mexico	0.54*** (0.15)	3.68***	0.35 (0.76)	20.39***	6.80 (4.63)
Greece	2.39** (0.96)	2.48**	0.18 (4.94)	8.21***	2.71 (43.0)
Turkey	1.08*** (0.11)	9.47***	0.78 (0.61)	137.08***	45.09 (5.33)
Peru	0.67*** (0.13)	5.15***	0.19 (0.87)	26.56***	4.07 (0.27)

Note: Robust standard errors are reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Data source: Bloomberg (Generic Government Rates)

The panel regressions indicates (Table 8) 10- year government bond yields with the intention to validate the hypothesis, which is that the 10- year U.S. government bond yield has significant impact on the selected emerging market.

The change in yields in the U.S. (Table 9) was an increase of 0.85%, then the change in yields in India increased by 0.99%, in Russia with a 1% annual increase in 10-year government yields. Related to the results, the variation in yields in Brazil

increased by 0.22% and in South Africa by 0.29%. Only in China was a decrease in the 10-year government yields for the selected period with -0.36%.

Table 9: Change of 10-year Government Yields for over a year (2017-2018) for BRICS and the U.S. during QT1

	October 2017	October 2018	Change in bps	Change in %
USA	2.29	3.14	84.93	0.85
Brazil	9.99	10.21	21.98	0.22
India	6.86	7.85	99.00	0.99
China	3.88	3.52	-35.50	-0.36
Russia	7.60	8.60	99.50	1.00
South Africa	9.09	9.38	28.50	0.29
Mean	7.48	7.91	42.70	0.43

Data source: Bloomberg (Generic Government Rates)

Table 10 describes a change of 10-year government yields in Turkey, which was an increase of 2.19%, then the change in yields in Mexico increased by 1.61%, and a similar occurred in Hungary with a 1.17% annual increase in 10-year government bond yields.

Table 10: Change of 10-year Government Yields for over a year (2017-2018) for the Selected EM

	October 2017	October 2018	Change in bps	Change in %
Hungary	2.47	3.64	116.90	1.17
Mexico	7.27	8.88	161.00	1.61
Greece	5.43	4.21	-121.50	-1.22
Turkey	5.28	7.47	219.20	2.19
Peru	5.38	5.89	51.00	0.51
Mean	5.17	6.02	85.32	0.85

Data source: Bloomberg (Generic Government Rates)

Conclusion

The empirical approach presented that the U.S. long-term government bond yields have a spillover effect to the Emerging Market economies. This international transmission mechanism came with financial globalization of capital flows and we can observe it in monetary policy decision making as well. We present the spillover effect among chosen countries through the long-end yields co-movement. The result indicates that the strongest correlation was related to the BRICS countries for India (0.90) and Brazil (0.72) during QT1. While related to the other selected countries, the co-movement was significant for Peru (0.63) and Hungary (0.57) during QT1. We assume the same market behaviour of yields for QT2 (2022-2025). We also showed that the USA has fulfilled the three preliminary conditions of QT implementation such as (a) high GDP% (5.5%), (b) low unemployment (3.80%), and (c) policy interest rate hike or over the zero-lower bound (0.50 bp).

References

1. Allen, D. K. and Hein, E. S. (2023). "Unusual Changes in the U.S. Treasury Security Market During the Fourth Round of Quantitative Easing", *Journal of Central Banking Theory and Practice*, Vol. 12(3), pages 5-22.
2. Allen, W., Chadha, J. and Turner, P. (2021). "Commentary: Quantitative Tightening: Protecting Monetary Policy from Fiscal Encroachment." National Institute Economic Review, Cambridge University Press, 257, 1-8. August 31, 2021.
3. Armas, A., Castillo, P. and Vega, M. (2014). "Inflation Targeting and Quantitative Tightening: Effects of Reserve Requirements in Peru." *Economía* Vol. 15, No. 1, Special Issue on Inflation Targeting in Latin America, pp. 133-175, Brookings Institution Press.
4. Bernanke, B. S., Kiley, M. T., and Roberts, J. M.. (2019). "Monetary Policy Strategies for a Low-Rate Environment." AEA Papers and Proceedings, 109: 421-26.
5. Bernanke, B. (2022). "21st Century Monetary Policy: The Federal Reserve from the Great Inflation to COVID-19.", W. W. Norton and Co.
6. Berentsen, A., Waller Ch. (2011), "Price-Level Targeting and Stabilization Policy," *Journal of Money, Credit and Banking*, vol. 43, Supplement 2 (October), pp. 559–80.
7. Bindseil, U. (2003). "Monetary Policy Implementation: Theory, Past, and Present." Oxford: Oxford University Press.
8. Blinder, A. S. (1982). "Chapter 12: The Anatomy of Double-Digit Inflation in the 1970s.", in R E Hall(ed.), *Inflation: Causes and Effects*, University of Chicago Press, p. 261–282
9. Bordo, M. D., Erceg, C ., Levin, A . and Michaels, R. (2007). "Three Great American Disinflations." NBER Working Paper 12982.
10. Cabana, M. and Craig K. 2022. *Fed policy plumbing*, BofA Securities, Rates Strategy, 16 June 2022.
11. Crawley, E., Gagnon, E., Hebden, J., Trevino, J. (2022). "Substitutability between Balance Sheet Reductions and Policy Rate Hikes: Some Illustrations and a Discussion." FEDS Notes. Washington: Board of Governors of the Federal Reserve System, June 03, 2022.
12. D'Amico, S. and Seida, T. (2020). "Unexpected Supply Effects of Quantitative Easing and Tightening." FRB of Chicago Working Paper No. 2020-17.
13. De Haan, J., D. Schoenmaker, P. Wiert. (2020). "Financial markets and institutional: A European perspective.", 4. ed. Cambridge University Press, 2020.

14. DeLong, J. B. (1997). "America's Peacetime Inflation: The 1970s." in C. D. Romer and D. H. Romer (eds), *Reducing Inflation: Motivation and Strategy*, University of Chicago Press, pp. 247-80..
15. Eichengreen, B. (2022). "America's Not-so-Great Inflation." Project Syndicate, February 10.
16. Engemann, K. (2019). "What is Quantitative Tightening?" Federal Reserve Bank of St. Louis.
17. Engstrom, E.C., Sharpe, S.A. (2022). "(Don't Fear) The Yield Curve, Reprise." FEDS Notes. Washington: Board of Governors of the Federal Reserve System, March 25, 2022. /Where are these authors referenced in the paper? Page 9.
18. Fratto, C., Vannier, B. H., Mircheva, B., de Padua, D. and Poirson, H.. (2021). "Unconventional Monetary Policies in Emerging Markets and Frontier Countries." IMF Working Paper, IMF, January 2021.
19. Gagnon, J. E., Raskin, M. D., Remache, J. A. and Sack, B. P. (2011). "The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases." *International Journal of Central Banking* 7(1) (March): 3-44.
20. Goodhart, C. (2010). "Changing Role of Central Banks.", FMG Special Paper number 197, Financial Markets Group.
21. Ha, J., Kose, M. A and Ohnsorge, F. (2022). "From low to high inflation: Implications for emerging market and developing economies." Centre for Economic Policy Research, Policy Insight No 115.
22. Hamilton, J. D. and Wu, J. C. (2012). "The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment." *Journal of Money, Credit and Banking* 44(S1) (February): pp. 3-46.
23. Hollenhorst A., A. Mehta, J. Williams, I. Munir. (2022). „US Multi-Asset and Economics. Balance sheet reduction – Same tool, different goals, new path." Citi Research., 9. March, 2022.
24. Hopper, L. J. (2018). "How the Fed Is Reducing Its Balance Sheet—and Why." Federal Reserve Bank of St. Louis.
25. Joyce, M. A. S., Lasaosa, A., Stevens, I., Tong, M. R.. (2011). "The Financial Market Impact of Quantitative Easing in the United Kingdom," *International Journal of Central Banking* 7(3) (September):113-162.
26. Kim, D. H., and Ochoa, M. (2021). *International Yield Spillovers*, *Finance and Economics Discussion Series* 2021-001. Washington: Board of Governors of the Federal Reserve System.
27. Krishnamurthy, A. and Vissing-Jørgensen, A. (2013). "The Ins and Outs of LSAPs." In Economic Symposium Conference Proceedings. Jackson Hole, WY: Federal Reserve Bank of Kansas City.

28. Lim, J. J., Mohapatra, S. and Stocker, M. (2014). "Tinker, Taper, QE, Bye? The Effect of Quantitative Easing on Financial Flows to Developing Countries." Policy Research Working Paper; No. 6820. World Bank, Washington, DC. World Bank.
29. Mulaahmetović, I. (2022). "Quantitative Easing and Macroeconomic Performance in the United States", *Journal of Central Banking Theory and Practice*, Vol. 11(3), pages 79-98.
30. Oxford Analytica. (2019). "Even gradual quantitative tightening raises GDP risks." Expert Briefings.
31. Peña, G. (2023). "Raising Interest Rates for Improving Income", *Journal of Central Banking Theory and Practice*, Vol. 12(3), pages 199-217.
32. Tucker, P. and Cecchetti, S. (2021). "Understanding how central banks use their balance sheets: A critical categorization." CERP Policy Research.
33. Turner, P. (2021). "A new monetary policy revolution." NIESR Occasional Paper no. 60
34. Wei, B. (2022). "How Many Rate Hikes Does Quantitative Tightening Equal?", Federal Reserve of Atlanta's Policy Hub. (2022). Center for Quantitative Economic Research, No. 11-2022, July 2022.
35. World Bank. (2022). "Global Economic Prospects — June 2022" Washington D.C.: World Bank. World Bank. "Various years. World Development Indicators Database." Washington, D.C