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How Many Rate Hikes Does Quantitative Tightening Equal?

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Summary:

In this article, I examine the question of how to quantify the equivalence between interest rate hikes and quantitative tightening (QT). Using a simple "preferred habit" model I estimate that a $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 at normal times, but 74 basis points during turbulent periods.

Key findings:

1. The author quantifies how many interest rate hikes quantitative tightening (QT) equals.

2. He estimates that a $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 at normal times, but 74 basis points during crisis periods.

Center Affiliation: Center for Quantitative Economic Research

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Key words: monetary policy, quantitative tightening, QT, quantitative easing, QE, rate hikes, preferred-habitat

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Comments to the author are welcome at bin.wei@atl.frb.org.

1 Introduction

When the COVID-19 pandemic hit, the Federal Reserve lowered interest rates to near zero and launched a suite of emergency lending programs, including an open-ended quantitative easing (QE) program, to support the economy and stabilize financial markets. As a result of this program, the Fed's holdings of Treasury securities and mortgage-backed securities increased from $4.4 trillion in March 2020 to $8.5 trillion in March 2022. However, in response to elevated inflation risks, the Federal Open Market Committee (FOMC) raised the benchmark federal funds rate by 25, 50, and 75 basis points at its March, May and June 2022 meetings, respectively, to a range between 1.50 percent and 1.75 percent. Additionally, at its May meeting, the Committee announced that it would start the process of shrinking its nearly $9 trillion balance sheet starting on June 1, 2022. This process of balance sheet reduction is often referred to as "quantitative tightening"(QT).

To assess the overall stance of monetary policy, we need to take into consideration the effects of both the interest rate policy and the balance sheet policy. A natural question then arises: what is the equivalence between interest rate hikes and QT? Answering this question is challenging for several reasons. For instance, the interest rate policy and the balance sheet policy act upon securities of different maturity, with the former influencing primarily short-term interest rates, whereas the latter works to influence primarily longer-term rates. This means a specific definition of "equivalence" between these policy tools is required. Given the specifics of QT (e.g., size and pace), I define a certain sized rate hike as equivalent to QT if both the rate hike and QT have the *same* expected effect on the 10-year yield. Another challenge is that experience with QT is limited: historically, there was only one round of QT, which was initiated in October 2017 and ended in September 2019. In addition, distinguishing the effects of QT on interest rates from those of other policy actions such as forward guidance is difficult. Moreover, empirical estimates of the effects of QT vary with market conditions.

In Wei (2022), I address these various challenges by examining the question of the equivalence between rate hikes and QT in the context of the preferred-habitat model used in the seminal work by Vayanos and Vila (2021). This model is useful for examining the effects of QT because of the central role that both supply and demand changes play in determining bond yields. The Vayanos-Vila model has two types of agents: arbitrageurs and preferred-habitat investors. If, as a result of QT, arbitrageurs need to hold more debt previously held by investors, they would be more exposed to interest rate risks and thus require a larger risk premium in exchange for bearing the extra risk, driving up long-term yields through the so-called "portfolio rebalance" channel.

In this article, I focus on QT in the context of FOMC's announced plan to shrink its holdings of Treasury securities.[1] I calibrate the Vayanos-Vila model to fit nominal Treasury data

[1] According to a press release issued in conjunction with the May FOMC statement, the monthly cap for Treasury securities (agency debt and agency mortgage-backed securities) will initially be set at $30

between January 1999 and March 2022 and then use the calibrated model to quantify the size of the interest rate hike that a given amount of QT in the Treasury market is equivalent to. I consider a baseline scenario in which the Fed's holdings of Treasury securities are run off passively for three years for a total of $2.2 trillion. For simplicity, I focus on passive roll-off of Treasury securities only and drop the monthly cap in estimation which binds only occasionally. I find that this is equivalent to an increase of 29 basis points in the current federal funds rate under normal or average market conditions, and 74 basis points during a turbulent period when the 10-year Treasury yield volatility increases by 40 percent. Interestingly, my estimate of QT-equivalent rate hikes under normal market conditions is a similar magnitude to the one presented in Crawley et al. (2022) Their estimate is based on the Fed's "FRB/US model," and they estimate that reducing the size of the balance sheet by about $2.5 trillion over the next few years using that model would be roughly equivalent to raising the policy rate by about 50 basis points.

Finally, the size of QT-equivalent rate hikes partly depends on how the Treasury refinances its debt as the Fed's balance sheet runs down. In my baseline scenario I have the Treasury issuing new securities with the same initial maturity as the maturing bonds. As an alternative, I also consider a case where the Treasury issues only short-dated bills to replace maturing securities. In that case, the resulting QT-equivalent rate hike is substantially lower.

The rest of the article is structured as follows. Our main estimation results are reported in Section 2. We then provide further discussion in Section 3 and conclude in Section 4.

2 Main Findings

In this section, I report the main estimation results. In the companion paper Wei (2022), I provide further details about the methodology and estimation results for alternative scenarios. In this article, I focus only on nominal Treasury securities, which account for more than 60 percent of securities held by the Fed. (That is, a $2.2-trillion QT of nominal Treasury securities is part of a $3.5-trillion operation of nominal and real Treasury securities plus mortgage-backed securities.) In addition, I focus primarily on passive roll-off, meaning no reinvestment for maturing bonds. I also briefly discuss an alternative implementation of QT through active sales.

Estimation Results under "Normal" Market Conditions

I consider the following baseline scenario for estimating QT-equivalent rate hikes in which the Fed's balance sheet rolls off passively for three years. Based on data on the Federal Reserve System Open Market Account (SOMA) portfolio,[2] a roll-off over three years amounts to a $2.2

($17.5) billion per month and after three months will increase to $60 ($35) billion per month. For details, see Board of Governors of the Federal Reserve System, "Plans for Reducing the Size of the Federal Reserve's Balance Sheet," press release, May 4, 2022, https://www.federalreserve.gov/newsevents/pressreleases/monetary20220504b.htm.

[2] The data on SOMA holdings can be found at Federal Reserve Bank of New York, "System Open Market Account Holdings of Domestic Securities," April 28, 2022, https://www.newyorkfed.org/markets/soma-holdings.

trillion reduction in the Fed's balance sheet.

Table 1: QT-Equivalent Rate Hikes under Passive Roll-Off

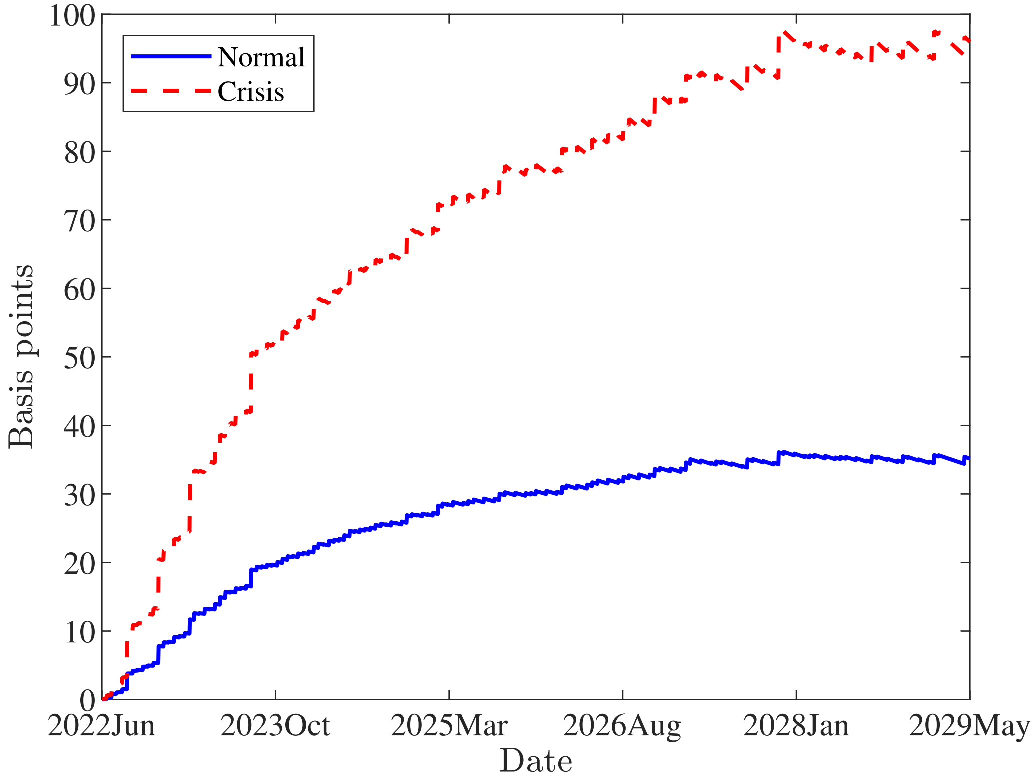
	Scenario 1		Scenario 2		Scenario 3	
Equiv. Impact	normal	crisis	normal	crisis	normal	crisis
10-year yield (basis points)	6.0	9.1	7.2	11.3	7.3	12.0
Current FF rate (basis points)	29.2	74.2	34.7	92.2	35.2	97.6
QT size (trillion)	2.2		2.8		3.3	
QT duration (years)	3		5		7	

Note: This table reports estimates of QT-equivalent rate hikes under passive roll-off during both "normal" (column "normal") and "crisis" market conditions (column "crisis"). I consider three scenarios: QT—beginning on June 1, 2022—lasts for 3 years in scenario 1 (dolumn "Scenario 1"), five years in scenario 2 (column "Scenario 2"), and seven years in scenario 3 (column "Scenario 3"). I report the equivalent effects of QT in basis points on the 10-year yield (row "10-year yield"), the current federal funds rate (row "Current FF rate"), as well as the size and duration of QT in the scenario considered (rows "QT size" and "QT duration").

Table 1 reports the main estimation results. I find that in the baseline scenario (column "Scenario 1") under normal market conditions (column "normal"), a $2.2 trillion passive roll-off over 3 years is estimated to be equivalent to an immediate increase of 29 basis points in the federal funds rate. That is, both the roll-off and the 29-basis-point rate hikes have the same estimated impact on the 10-year yield: an increase of 6 basis points.

I also consider other scenarios with QT of different sizes or duration. In scenario 2 (or scenario 3), if passive roll-off were to last for five (seven) years, the Fed's balance sheet would be reduced by $2.8 ($3.3) trillion. Under normal market conditions, the equivalent increase in the current federal funds rate is estimated to be about 35 basis points in these two alternative scenarios.

Figure 1: Federal Funds Rate Hikes Equivalent to Passive Roll-Off



Note: This figure plots the estimates of QT-equivalent rate hikes in the current federal funds rate under normal market conditions (blue solid line) or during crisis periods (red dashed line) for passive roll-off. The start date of QT is fixed as June 1, 2022, and the end date varies from June 2, 2022, through June 1, 2029.
Source: Author's calculations.

The results are summarized in the figure 1, which maps out the estimated impact of a passive roll-off by letting the duration of roll-off vary from June 1, 2022, to May 31, 2029. (The solid blue line indicates the estimates under normal market conditions, and where a three-year duration would correspond to June 2025).

Estimation Results Under "Crisis" Market Conditions

Because the estimates of the equivalence between interest rate hikes and QT depends on financial market conditions, I also recast the baseline scenario in a crisis period. I model a crisis period as one in which risk aversion of arbitrageurs increases sharply, implying a reduced risk-bearing capacity. Specifically, I assume that risk aversion increases twofold. In this case, the market is more volatile: the 10-year yield volatility increases from 1.3 percent to 1.7 percent—an almost 40 percent increase. At the same time, I find that a passive roll-off of $2.2 trillion QT over three years (scenario 1) during a crisis period leads to a much larger effect compared to that under normal market conditions: it is equivalent to an estimated immediate increase of 74 basis points in the current federal funds rate, as opposed to an increase of 29 basis points. Similarly, the equivalent rate hikes in the current federal funds rate increase to 92 (98) basis points in scenario 2 (scenario 3) during crisis periods. The red dashed line in the previous chart plots estimates of the QT-equivalent increases in the current federal funds rate during crisis periods for varying duration.

The larger impact of QT during a crisis period results from the "local-supply" channel in the Vayanos-Vila model. This is because, with heightened risk aversion, arbitrageurs refrain from engaging in active transactions, and the market becomes segmented to such an extent that changes in Treasury net supply arising from QT have the largest effects on the yields of Treasury securities in the maturity sector in which bonds are being rolled off as a result of QT.[3]

The sharp difference in the estimated impact of QT when market conditions change suggests that continual monitoring of financial conditions will be an important part of the management of the QT program going forward.[4]

Alternative QT Implementation: Active Sales

In this section, I briefly describe the case of active sales prior to maturity as an alternative to passive roll-off. (More details on this alternative are contained in Wei (2022).) Passive roll-off and active sales have at least two potentially important differences. First, they have different effects on the duration risk borne by the private sector. Under active sales, it is the *remaining* maturity of bonds bought by the private sector that adds to investors' duration risk, whereas under passive roll-off, it is the *initial* maturity at issuance that matters, assuming the Treasury issues new bonds with the same initial maturity to offset maturing bonds. Second, the timing of impact is also different: the impact of active sales is front-loaded, whereas the impact of passive roll-off is back-loaded and takes place when bonds mature.

These two differences pose an interesting trade-off between passive roll-off and active sales. Based on the composition of the SOMA portfolio, I show that in the short run (for example, three years or less), the effects from the duration difference dominate, and thus passive roll-off has a stronger impact. The impact is greater is because the Treasury assets in the SOMA portfolio maturing in the near future had a long initial maturity on average, ranging from four to six years. On the other hand, the effects from the timing difference start to dominate in the medium and long run so that QT implemented through active sales has a stronger impact. Here, the impact is greater because earlier sales of long-dated bonds have a front-loaded impact, as opposed to the back-loaded impact under passive roll-off.

The estimation results reported in Wei (2022) suggest that under normal market conditions, QT with active sales is equivalent to an increase of 22 basis points in the current federal funds rate in the baseline scenario (scenario 1) in which QT lasts for three years, but 47 basis points in the alternative scenario in which ($3.3 trillion) QT lasts for seven years (scenario 3).

The smaller impact of active sales in scenario 1 reflects the dominant effect due to the

[3] see, for example, Gilchrist et al. (2020) for evidence for the local-supply effect and their analysis of the role of risk aversion around Secondary Market Corporate Credit Facility (SMCCF) announcements).

[4] One gauge of strains in the financial markets is the so-called "excess bond premium" (EBP) proposed in Gilchrist and Zakrajšek (2012). See also Gilchrist et al. (2021) for short-, medium-, and long-term EBP measures.

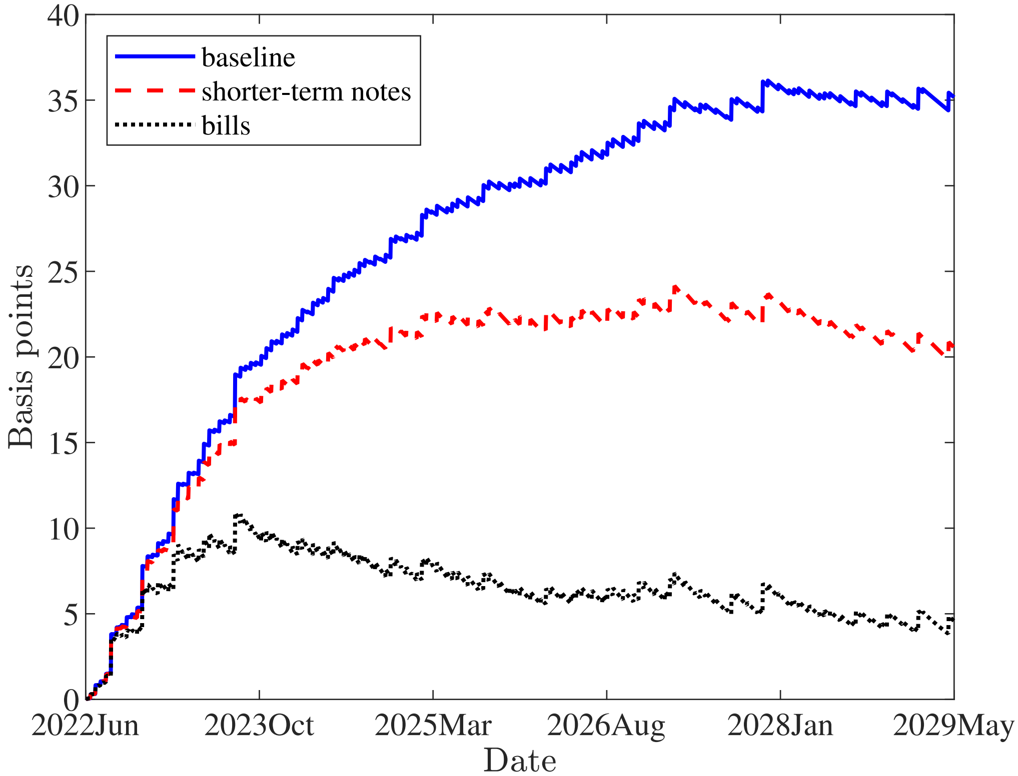
duration difference: the Treasury assets maturing within three years in the SOMA portfolio are primarily notes with longer maturities at issuance, and, under passive roll-off, those bonds will be replaced by new issues with the same initial maturity. By contrast, the larger impact of active sales in the medium to long run (scenario 3) reflects the timing difference: the earlier sales of long-dated bonds under active sales have a front-loaded impact, as opposed to the back-loaded impact under passive roll-off.

3 Further Discussion

Wei (2022) also considers other factors important to the implementation and impact of QT, such as the final size of the Fed's balance sheet and the interaction with the demand for liquidity in the financial system. How much can roll off the Fed's balance sheet before pressure in the reserves market emerges remains a highly debated question. The answer to this question is closely related to the impact of QT on the liability side of the Fed's balance sheet as well as the responses from market players, including the US Treasury Department, as discussed in Wei (2022) .

Another factor that influences how QT affects interest rates is the maturity structure of Treasury debt. In my preceding analysis, I assumed that the Treasury issues new securities with the *same* initial maturity as the maturing bonds. Figure 2 plots QT-equivalent rate hikes in the current federal funds rate when the Treasury issues shorter-term securities to offset maturing securities. The blue line represents the baseline scenario where the newly issued securities have the same initial maturity as the maturing ones. The dashed red line and the dotted black line represent the alternative scenarios in which the Treasury issues shorter-term notes and bills, respectively. As expected, QT has a much smaller impact when the Treasury issues shorter-term securities because the resulting supply effects are shorter-lived. Quantitatively, in the baseline scenario (scenario 1), the equivalent rate hikes in the current federal funds rate decrease from 29 basis points to 22.5 if the Treasury issues shorter-term notes (red dashed line), and only 7.4 basis points if the Treasury issues bills only (black dotted line). I also find that the equivalent rate hikes during a crisis period in the baseline scenario are 12.6 basis points if the Treasury issues bills only.

Figure 2: Federal Funds Rate Hike Equivalent to Passive Roll-Off (Counterfactual Analysis Regarding the Treasury's Response)



Note: This figure plots real-time estimates of QT-equivalent rate hikes in the current federal funds rate in three scenarios depending on how the Treasury finances the Fed's balance sheet roll-off. I consider passive-rolloffs in the following three scenarios: the baseline scenario (blue solid line), alternative scenarios with shorter-term notes (red dashed line) or bills (black dotted line) issued by the Treasury. The start date of QT is fixed as June 1, 2022 and the end date varies from June 2, 2022 through June 1, 2029.
Source: Author's calculations.

Finally, it is noteworthy that while the estimated effects of $600 billion QE in the literature are in the range of 15 to 20 basis points (Williams, 2011),[5] by contrast, our estimated effects of QT on the 10-year bond yield, renormalized to the size of $600 billion, is much smaller—about 2.7 basis points.[6] The differences between my estimates for QT and the consensus estimates for QE may be due to the fact that QE typically involved active purchases and was implemented during crisis periods when the federal funds rate had been lowered to its

[5] Using either event studies around the Fed's QE announcements or regression-based analyses, Gagnon et al. (2011), Krishnamurthy and Vissing-Jorgensen (2011), Hancock and Passmore (2011), Hamilton and Wu (2012), D'Amico and King (2013) find empirical evidence for significant effects of QE on a variety of asset prices. See Swanson (2011) for the effects of "Operation Twists," Neely (2010) for the effects of QE on foreign bond yields, Gilchrist and Zakrajšek (2013) on corporate bond spreads, and D'Amico and Seida (2020) for the evolution of the effects of QE or QT over time and across market conditions.

[6] My estimate of 2.7 basis points is obtained as follows $(0.6/15)/(2.2/24.4) * 6$. In our calculation, we take into account changes in GDP; that is, a $600 billion QE operation back then was 4 percent of $15 trillion GDP, whereas a $2.2 trillion QT operation now is 9 percent of $24.4 trillion GDP.

effective lower bound (the 2008–09 financial crisis and the COVID-19 pandemic).

4 Conclusion

In this article, I examine the question of quantifying the interest rate hike equivalence of "quantitative tightening" (QT). My model-based estimates are built on the preferred-habitat model in Vayanos and Vila (2021). I define the equivalence between rate hikes and QT such that they both have the same expected impact on the 10-year yield.

In the baseline scenario of a $2.2 trillion passive roll-off over three years, I estimate that it is equivalent to an increase of 29 basis points in the current federal funds rate during a period of low financial market volatility. The amount of equivalent rate hikes increases to 74 basis points during a volatile market period. I also quantify the effect of QT implemented by active sales and estimate QT-equivalent rate hikes in terms of their effects on the future path of the federal funds rate. Lastly, I discuss the impact of QT on the composition of liabilities on the Fed's balance sheet. Based on our model-based estimates, I show that if the Treasury were to issue bills to offset maturing securities, the resulting equivalent rate hikes in the current federal funds rate would decrease dramatically to 7.4 (12.6) basis points under normal (crisis) market conditions.

Clearly these estimates contain considerable uncertainty, and the sensitivity of the estimates to various assumptions about financial market conditions, the maturity structure of Treasury debt issuance, and program implementation suggest that much more will be learned about the program over time that can be used to refine estimates of its impact on interest rates and the potential trade-off between interest rate and balance sheet policy.

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