Article

New Empirical Evidence on Factors Influencing the Yield on High-Grade Municipal Bonds

American Business Review
Nov. 2023, Vol.26(2) 503 - 518

ISSN: 2689-8810 (Online)
ISSN: 0743-2348 (Print)

James R. Barth[a], Richard J. Cebula[b], and Nguyen T.H. Nguyen[c]

https://doi.org/10.37625/abr.26.2.503-518

ABSTRACT

We investigate the impact of federal budget deficits and other factors on the *ex-post* and *ex-ante* real yields on high-grade municipal bonds. The estimation results reveal that both yields increase with the real yield on 30-year Moody's Aaa-rated bonds and provisions in the Community Reinvestment Act but decrease with net capital inflows, the real GDP growth rate, and the average effective federal income tax rate. Most importantly, both yields are increasing functions of the federal budget deficit. These results support limiting the size of federal budget deficits to avoid the excessive crowding out of private investment spending.

KEYWORDS

Interest Rates, Municipal Government Bonds, Budget Deficits, Federal Tax Rate, Quantitative Easing

INTRODUCTION

Pursuant to the formal ratification by the states of the 16th Amendment to the U.S. Constitution on February 3, 1913, the Revenue Act of 1913 was passed by the U.S. Congress and then signed into law by President Woodrow Wilson eight months later, on October 3, 1913. This statute legally codified the formal exemption of interest on municipal bonds from federal income taxation, although the U.S. Supreme Court already had ruled/held in *Pollock v. Farmers' Loan and Trust Company*, 157 429 (1895), that the federal government lacked the legal authority to tax interest payments on municipal bonds. The U.S. Internal Revenue Code, IRC § 103(a), excludes interest on municipal bond issues from federal income taxation. As a consequence of this statutory provision, the prevailing general "rule" is that the interest income earned from bonds issued by one [level of] government is not subject to taxation by another [level of] government (Heaton, 1986; Cebula, 2018). As a result, the federal government is thereby precluded from taxing interest paid on municipal bonds.

Consequently, across the U.S., towns, cities, counties, and states have long found that tax-free status on qualified bond issues enables them to borrow at a lower interest cost in financial markets. Over the long run, this is a key consideration in financing a wide variety of capital improvement

[a] Auburn University, Alabama, U.S.A.
[b] University of Tennessee Knoxville, Tennessee, U.S.A.
[c] Minnesota State University Mankato, Minnesota, U.S.A.

Corresponding Author:
Nguyen (nguyen.nguyen.2@mnsu.edu)

Dr. Barth passed away in January 2023. The current revised version of the manuscript was made and agreed upon by Dr. Cebula and Dr. Nguyen.

[1] Interestingly, the Tax Reform Act of 1986, signed into law by then-President Ronald Reagan in October of 1986, reduced the scope of activities that could be financed using tax-exempt bonds proceeds. For example, issuing municipal bonds to finance private sector activities was prohibited under provisions of this statute.

projects, including some that are a bit controversial.[2] A multi-trillion-dollar market for tax-exempt municipal bonds has developed and evolved. The magnitude of this market demonstrates the importance of tax-exempt interest rates to city, county, and state governments and holders of such bonds, such as pension funds, private portfolios, and financial institutions. This study provides new empirical evidence identifying key factors that influence the ex-post real yield on high-grade municipal bonds, focusing on potential influences that have been largely or often overlooked in the more recently published literature. These influences include monetary policy in the form of quantitative easing, the Community Reinvestment Act of 1977, the Tax Reform Act of 1986, net international capital inflows expressed as a percent of GDP, alternative real interest rates, and the federal budget deficit. As Cotton (2021, p. 2) observes, "Many papers have been written about the relationship between deficits, debt, and interest rates, but the topic has been relatively little researched since the mid-2000s." Similar to the studies by Cotton (2021) and Choate et al. (2010), we contribute to helping fill this lacuna in the literature by explicitly focusing on real tax-exempt bond yields.

Given the magnitude of the budget deficit and the national debt's size, both relative to GDP, during recent years, the focus on the federal budget deficit should be of interest to policymakers and researchers. Focusing on high-grade municipals creates a relatively high degree of quality homogeneity among tax-free bonds with typically little prospect of default. The study uses quarterly data from 1980Q1 to 2020Q4 to perform a times series estimation examining the impact of various explanatory variables on the *ex-post* real yield on tax-free bonds and (as a *de facto* robustness test) the *ex-ante* real yield on tax-free bonds.[3]

BACKGROUND ON THE MUNICIPAL BOND MARKET

Tax-exempt/tax-free bonds can be characterized according to whether or not they are general obligation bonds (GOs), revenue bonds, insured bonds (e.g., such as MBIA or AMBAC insured), or pre-refunded bonds. The rating of tax-frees by Standard and Poor's, Moody's, Best and Company, and other bond rating services is determined mainly according to such designations. It may be noteworthy that GOs and revenue bonds are the most common form of tax-free bonds.

General obligation bonds have the characteristic that the principal and interest paid on such bonds are secured by the full faith and credit of the issuer and usually supported by either the issuer's taxing power. As for revenue bonds, their principal and interest payments are secured by (backed by) revenues derived from tolls, charges, and rents generated by the facility built with the proceeds of the bond issue. Public projects financed by revenue bonds include the following: toll roads, bridges, airports, water, and sewage treatment facilities, hospitals, and subsidized housing.

From another perspective, tax-free bonds are classified as being:

1. Simply tax-exempt, i.e., not subject to federal income taxation.
2. Dual-exempt, i.e., not subject to federal or state income taxation.
3. Triple-exempt, i.e., not subject to federal, state, or city/local income taxation.

Each of these three classifications has a simple formula to convert the tax-free yield into its taxable equivalent yield (Poterba and Rueben, 1999& 2001).

---

[2] Interestingly, as observed by Drukker et al. (2020), tax-exempt bonds have been used to finance a variety of factors, including stadiums for professional sports teams.

[3] For the interested reader, although IRC § 103(a) is the actual statutory provision that establishes the exclusion of interest paid on municipal bonds from federal income taxation, there are other rules that pertain to private activity bonds, arbitrage, and hedge bonds exist in the Internal Revenue Code. See, for example, sections 140 through 150, as well as 1394, 1400, and 7871.

Let's assume, for example, that two bonds are equally rated in terms of quality, including default risk, Bond A (the interest on which is fully taxable by the IRS) and Bond B (the interest upon which is free from income taxation by the IRS). The yield on Bond A is expressed as $R_{.A.}$, whereas the yield on Bond B is expressed $R_{.B}$. The conversion of $R_{.B.}$ into $R_{.A.}$ is expressed as either:

$$R_A = R_B/(1\text{-}ATR) \text{ or } R_A = R_B/(1\text{-}MPM) \quad (1A)$$

where *ATR* is the average federal personal income tax rate and *MPM* is the most pertinent marginal federal personal income tax rate, which may in some cases turn out to be the maximum prevailing marginal federal income tax rate in the Internal Revenue Code. Clearly, the higher the federal income tax rate, the higher the *equivalent* taxable yield.

Furthermore, equation (1) can be easily modified to reflect either dual- or triple tax-exemption status, which will depend upon one's legal geographic residence and the geographic location at which a given tax-free bond was issued. For example, if *STR* is the applicable state income tax rate, these two formulae become, respectively:

$$R_A = R_B/(1\text{-}ATR\text{-}STR) \text{ and } R_A = R_B/(1\text{-}MPM\text{-}STR) \quad (1B)$$

It is perhaps noteworthy, especially given the migration impact of state taxes, that of the 50 states, 41 impose personal state income taxation, with state personal income tax receipts on average constituting approximately 37% of aggregate state tax collections annually. Of these 41 states, eight impose a flat-tax rate system, whereas 33 impose a progressive tax rate system. California and Missouri have the most tax brackets (ten). The lowest (positive) marginal state income tax rate is 2.9% (North Dakota), with the highest marginal state income tax rate being 13.3% (California).

Most states derive their "taxable income base" predicated at least in part on IRS Schedule 1040, inclusive of other IRS personal income tax forms. Indeed, Indiana, Illinois, and Colorado impose their respective state income tax liabilities as a percentage of federal taxable income. Michigan and Georgia impose their state taxable income tax as a percentage of a slightly modified federal adjusted gross income. In any case, it is clear that state personal income tax receipts significantly reflect the pattern of federal personal income tax receipts and taxable personal income reported to the IRS.

There is also another case, the one that involves local income taxation and a corresponding local income tax rate system. In addition to Washington, D.C., 17 states permit cities, counties, and municipalities to levy personal income taxes. Those states are Alabama, California, Colorado, Delaware, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, Ohio, Oregon, Pennsylvania, and West Virginia. Such third-tier personal income taxation is not an isolated case, so a reasonable argument for considering it (where it is relevant) when expressing tax-free yields in terms of taxable-equivalent yields can easily be made.

In such cases, the most relevant local effective income tax rate, *LTR*, is included in the conversion. In this case, the conversion of the triple-exempt yield into its taxable equivalent yield is described by the following:

$$R_A = R_B/(1\text{-}ATR\text{-}STR\text{-}LTR) \text{ or } R_A = R_B/(1\text{-}MPM\text{-}STR\text{-}LTR) \quad (1C)$$

THE FRAMEWORK AND STUDY OBJECTIVES

THE BASIC MODEL

To provide insights into the factors influencing the *ex-post*-real yield on tax-exempt bonds, *EPRTFR*, a loanable funds model is adopted in which the *ex-post* real yield on municipal bonds is, assuming all other bond markets are in equilibrium, determined by:

$$D + NCI/Y + QE/Y = S + DEF/Y \quad (2)$$

where: *D* is private domestic demand for high-grade municipal bonds; *NCI/Y* is the ratio of net financial capital inflows to GDP, expressed as a percent; *QE/Y* is the ratio of quantitative easing to GDP, expressed as a percent [adopted here as a measure of monetary policy actions that resemble monetary policy/net open market operations such that the tax-free yield is expected to be a decreasing function of *QE/Y*]; *S* is the market supply of high-grade municipal bonds; and *DEF/Y* is the total federal budget deficit, expressed as a percent of GDP. The value of the *ex-post* real yield on tax-exempt bonds is simply the nominal tax-free yield (*NOMTXFR*) minus the actual inflation rate (*P*):

$$EPRTFR = NOMTXFR - P \quad (3)$$

The demand for tax-exempt bonds is expressed as follows:

$$D = D\,(EPRTFR, EPR30, Y, ATR) \quad (4)$$

Such that:

$$D_{EPRTFR} > 0, D_{EPR30} < 0, D_{Y} > 0, D_{ATR} > 0 \quad (5)$$

and the supply of high-grade municipal bonds is expressed as follows:

$$S = S\,(EPRTFR) \quad (6)$$

Such that:

$$S_{EPRTFR} < 0, \quad (7)$$

where *EPRTFR* is the *ex-post* real tax-free yield on high-grade municipal bonds; *EPR30* is the *ex-post* real yield on thirty-year Moody's Aaa-rated corporate bonds; *Y* is the percentage increase in real GDP; and *ATR* is the average effective federal personal income tax rate.

According to the model, the private sector demand for high-grade tax-free municipal bonds is an increasing function of *EPRTFR*, *ceteris paribus*; this is because rational investors (bond buyers) prefer a higher real rate of return on their investment over a lower rate of return. On the other hand, bond suppliers/issuers of tax-free bonds (state, county, and municipal governments) would supply/issue fewer high-grade municipal bonds in response to a higher *EPRTFR* since such a condition would raise the debt service costs of their bond issues, *ceteris paribus*, and hence the total cost of their public investment undertakings. Next, the higher the *ex-post* real yield on Moody's Aaa-rated thirty-year corporate bonds (*EPR30*), the lower the private sector demand for high-grade tax-free municipal bonds, as investors substitute these higher-paying Aaa-rated thirty-year issues for the tax-frees, *ceteris paribus*. Furthermore, the higher the percentage growth rate of real GDP(*Y*), the greater the market demand for high-grade tax-free municipal bonds and, consequently, the higher the price on said bonds, *ceteris paribus* (and, as a result, the lower the *ex post* real yield on those tax-exempt bonds). Finally, although the tax benefits from qualified municipal bonds are logically greater for investors in the highest tax bracket, there certainly can be tax benefits for those not in the highest. Arguably, then, the higher the average effective federal personal income tax rate (*ATR*), the greater the demand for tax-frees in the financial marketplace and hence the higher the price of tax-exempt bonds (Choate et al., 2010; Poterba and Verdugo, 2011); consequently, the higher the *ATR*, the lower the real yield on those bonds, *ceteris paribus*.

Aside from these hypothesized relationships, the model includes a net financial capital inflows variable, *NCI/Y*. Following the conventional wisdom, it is hypothesized that the greater the extent of net capital inflows relative to GDP, the greater the extent to which debt issues are absorbed and hence the less the upward pressure on yields, *ceteris paribus*. Strong empirical support for this perspective is found in Cebula and Koch (1994). As for the relative quantitative easing variable, *QE/Y*, it is, in effect, *de facto* structured net open market purchases by the FED, be it in the form of "toxic assets" on the one hand or in the form of Treasury debt issues on the other hand. Consequently, the greater the relative magnitude of *QE/Y*, the greater the demand for the securities involved and hence the higher their price and the lower their yield, *ceteris paribus*.

In addition, there is the federal budget deficit, which is, as noted above, the central focus of this study. Following the conventional wisdom (Carlson and Spencer, 1975), it is hypothesized that the greater the federal budget deficit relative to the GDP (*DEF/Y*), the greater the upward pressure on interest rates generally (including *EPRTFR*) as a reflection of the federal government's competing with the remainder of the economy for funds, *ceteris paribus* (Al-Saji, 1993; Barth et al. 1984, 1985; Cebula and Koch, 2014; Cebula, 2014; Choi and Holmes, 2014; Ewing and Yanochik, 1999; Gale and Orszag, 2003; Gissey, 1999; Hoelscher, 1986; Johnson, 1992; Swamy, et al., 1990; Tanzi, 1985; Quayes and Jamal, 2007; Laubach, 2009; Cotton, 2021). Interestingly, the most recent such deficit-interest rate evidence is, for the most part, effectively a decade old. Furthermore, the related literature largely excludes considerations, such as quantitative easing (*QE/Y*), and thus may be reasonably regarded as dated and less dependable. Given the growth in the magnitude of budget deficits in recent years (a non-trivial portion of which is COVID related in terms of (e.g., stimulus checks), and the experience of quantitative easing (which is related extensively to the Great Recession of December 2007 through July 2009 and several years after that as well as to COVID and the pandemic associated in addition to that), the impacts of these two variables should be of particular interest to policymakers and researchers.

TWO FEDERAL STATUTES REGARDED AS CONTROL VARIABLES

Before specifying the complete final model to be estimated, this study also endeavors to allow for the potential interest rate effects of two federal statutes, one a banking industry statute and the other a significant piece of tax legislation. The major banking statute in question is one that, in specific ways, changed the landscape for the banking industry in the U.S. during the study period, namely, the *CRA* (the Community Reinvestment Act of 1977 and its major revisions in 1995 and 2005), whose objectives included, among other things, putting an end to the practice of "red-lining" (Madura, 2008, p. 500). According to Cebula et al. (2016), there is strong evidence that the bank failure rate was increased by statutory provisions in the Community Reinvestment Act of 1977, which arguably imposed more significant risks and costs on banks and thereby led to increased bank failures. To the extent that such failures reduced banking competition, it is hypothesized that the *CRA* acted to elevate interest rates, including the *EPRTFR*.

As for the tax statute, Musgrave observed (1987, p. 59) that "The Tax Reform Act of 1986 is the most sweeping reform since the early 1940s …" Indeed, the *TRA* did introduce several reforms, many of which are outlined in broad terms in Barth (1991), Barth and Brumbaugh (1992), and Ott and Vegari (2003). For example, as Ott and Vegari (2003, p. 279) observed, "The Act introduced major cuts in the personal tax rate. Once the *TRA* became fully effective (1988), only two tax brackets set at 15 and 28 percent were to replace the 14-bracket tax schedule with rates in the range of 11 to 50 percent...[while it] broadened the tax base by reducing the itemized deduction." Lowering the personal income tax rates would *reduce* the demand for and hence lower the price of tax frees, thereby raising their yield. Accordingly, it is hypothesized here that this stature exercised a positive impact on *EPRTFR*. Thus, it is expected that:

$$EPRTFR = g(CRA, TRA) \quad (8A)$$

$$g_{CRA} > 0, g_{TRA} > 0 \quad (8B)$$

SYNTHESIS

Next, we substitute equations (4) through (8A) and (8B) along with the text involving the same into equation (2). Then, after including binary dummies for CRA and TRA as well as for the pandemic years, *COVID*, we solve for *EPRTFR*, which yields:

$$EPRTFR = f\,(EPR30, Y, ATR, NCI/Y, DEF/Y, CRA, TRA, QE/Y, COVID) \quad (9)$$

Regarding the COVID-19 pandemic and the impact of variable *COVID*, it can be argued that the demand for bonds was increased at the expense of equities, especially for more risk-averse market participants. Consequently, to some degree, the price of bonds would have experienced upward pressure, thereby creating downward pressure on bond yields. Alternatively stated, unemployment rates in the U.S. rose sharply during the pandemic. In such an environment, investors would have become more risk-averse. This would have led to a rise in the demand for bonds, leading to higher bond prices. In turn, higher bond prices would imply lower bond yields. Hence, it is expected that the COVID-19 experience would reduce yields, in our case, municipal bond yields, which would be reflected by negative coefficients on the variable *COVID*.

It, therefore, follows that we expect the following signs on the partials corresponding to the variables identified in the model shown in equation (9):

$$f_{EPR30} > 0, f_{Y} < 0, f_{ATR} < 0, f_{NCI/Y} < 0, f_{DEF/Y} > 0, f_{CRA} > 0, f_{TRA} > 0, f_{QE/Y} < 0, f_{COVID} < 0 \quad (10)$$

THE EMPIRICAL MODEL, ANALYSIS, AND FINDINGS

To assess the impact or lack thereof of the above factors on the *ex-post* real tax-free yield on high-grade municipal bonds, we estimate the following model:

$$EPRTFR = \alpha + \beta_1 EPRTFR_{t-1} + \beta_2 EPRTFR_{t-2} + \sum_{i=1}^{k} \gamma_i X_t^i \quad (11)$$

where *EPFTFR* represents the average quarterly *ex-post* real tax-free yield on high-grade municipal bonds. The Augmented Dickey-Fuller (ADF) A test was adopted to test the stationarity of the *EPFTFR* variable. The test statistic has a value of -4.481 (p-value of 0.000). In other words, the variable *EPFTFR* was found to be stationary at the 1% level of statistical significance.

To establish the lag length of two for the *EPFTFR* variable as presented in model (11), we use the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC) to find the optimal lag length that maximizes the fit between the observed time series and the estimated predicted process. (Lütkepohl 1993, Enders 1995). Table 1 presents the estimated value and indicates that the measures of FPE, AIC, HQIC, and SBIC forecast precisions are all minimized at the order of 2, which implies that the optimal lag length for the given dataset was 2.

Table 1. Lag Order Selection Criteria
Number of observations: 155

Lag	LL	LR	p-value	FPE	AIC	HQIC	SBIC
0	*-52.489*			*0.131*	*0.806*	*0.886*	*1.003*
1	*-48.732*	*7.514*	*0.006*	*0.127*	*0.771*	*0.858*	*0.987*
2	*-45.777*	*5.910**	*0.015*	*0.123**	*0.746**	*0.841**	*0.981**
3	*-45.563*	*0.429*	*0.512*	*0.125*	*0.756*	*0.859*	*1.011*
4	*-45.020*	*1.084*	*0.298*	*0.125*	*0.762*	*0.873*	*1.036*

Note: The table reports the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC) lag order selection statistics. LL is the log likelihood, the LR is the likelihood ratio test statistic. The optimal lag length will fit with the lowest value of each selection statistics among different lag order. * denotes minimum value in the last four columns of the table, which suggests the optimal lag.

In Model (11), X^i represents factors mentioned in the previous section potentially affecting the *ex-post* real tax-free yield on high-grade municipal bonds. These variables include *EPR30, Y*, *ATR*, *NCIY, DEFY, CRA, TRA, QEY,* and *COVID*. Table 2 contains information on all the variables used in the empirical estimations. This table includes summary information on the variables, how the variables are constructed, and the data sources. Overall, our data cover 162 quarters from 1980.Q1 through 2020.Q4.

Table 3 reports the empirical results for Model (11), both without robust standard errors (see Column (1)) and with robust standard errors (see Column (2)). Overall, the empirical results from both columns of Table 3 support the expected relationships between the *ex-post* real tax-free yield on high-grade municipal bonds (*EPFTFR*) and the exogenous variables in the model. On the one hand, the *EPFTFR* is found to be significantly and positively correlated with the *ex-post* real yield on Moody's Aaa-rated thirty-year corporate bonds (*EPR30*), the federal budget deficit (*DEFY*), provisions in the Community Reinvestment Act (*CRA*), and the Tax Reform Act (*TRA*). On the other hand, the *ex-post* yield on tax-free municipal bonds (*EPFTFR*) is negatively correlated with the real GDP growth rate (*Y*), the average federal personal income tax rate (*ATR*), and net financial capital inflows (*NCIY*). However, Table 3 results do not reveal a significant relationship between *EPFTFR* and either quantitative easing (*QEY*) or the COVID-19 period (*COVID*).

Reflecting in principle empirical results from the earlier literature focusing on the interest rate impact of the federal budget deficit (e.g., Al-Saji, 1993; Barth et al. 1984, 1985; Cebula, 2014; Choi and Holmes, 2014; Cotton, 2021; Engen and Hubbard, 2004; Ewing and Yanochik, 1999; Gale and Orszag, 2003; Gissey, 1999; Hoelscher, 1986; Johnson, 1992; Kolluri and Giannaros, 1987; Swamy, et al., 1990; Tanzi, 1985; Quayes and Jamal, 2007; Laubach, 2009), we find that for each one percentage point increase in the federal budget deficit variable (*DEFY*), there is a 1.7 basis point increase in the *ex post* real tax-free yield on high-grade municipal bonds (*EPFTFR*).[4]

Thus far, we have used the *actual* inflation rate to convert the nominal yields in the model into *ex-post* real yields for the computations. As a robustness check to the findings in Table 3, we now use quarterly *expected* inflation rate data, as estimated by the Federal Reserve of Cleveland (2022), to convert the nominal yields in the model to real yields. Thus, nominal interest rates minus the expected inflation rate

[4] Interestingly, in the very recent study by Cotton (2021, p. 1) that focuses on nominal as opposed to *ex post* or *ex ante* real interest rates, it is found that a rise "in the magnitude of the deficit-to-GDP ratio of one percentage point raises the 10-year nominal rate by 8.1 basis points. This is estimated using the deficit release surprise. I find quantitatively similar results across other maturities. I estimate that an increase in the deficit-to-GDP ratio of 1 percentage point raises the 2-, 5-, and 30-year nominal rates by 4.9, 8.0, and 6.8 basis points, respectively. I also find that an increase in the deficit-to-GDP ratio of 1 percentage point raises the corporate 10-to-15-year interest rate by a significant 7.1 basis points." Clearly, then, it follows that the impacts of federal deficits upon federal government debt yields in the U.S. similarly influence other financial market yields, including presumably that for tax-frees.

now become *ex-ante* real interest rates to be considered within the system. Using these new real interest rate measures, we now re-estimate Model (11). The new data cover the period from 1982Q1 through 2020Q4. The main findings shown in Table 3 effectively remain robust (i.e., essentially parallel the empirical results in Table 3 for the *ex-post* real yield on municipals). The new estimation results are reported in Table 4, where the *ex-ante* real yield on tax frees (*EARTFR*) is an increasing function of the federal budget deficit variable (*DEFY*), a result that parallels its counterpart in Table 3. The other results in Table 4 also parallel their counterparts in Table 3, although the coefficient on the Community Reinvestment Act is not statistically significant, in contrast to the positive and statistically significant impact it exercised on *EPRTFR*. Thus, the *ex-ante* real yield on tax-frees (*EARTFR*) is negatively correlated with the real GDP growth rate (*Y*), the average federal personal income tax rate (*ATR*), and net financial capital inflows (*NCIY*). In addition, *EARTFR* positively correlated not only with the federal budget deficit but also the *ex-post* real yield on Moody's Aaa-rated thirty-year corporate bonds (*EPR30*) and the Tax Reform Act (*TRA*).

Notably, Table 4 shows that the *ex-ante* real interest rate yield on tax-free municipal bonds (*EARTFR*) is significantly negatively associated with the COVID-19 period dummy (*COVID).* Since the *ex-ante* real municipal bond interest rate expressly involves economic behavior in the form of expectations, it may provide potentially better insights into how financial markets conjecture and respond to the COVID-19 pandemic than the *ex-post* real municipal bond rate.

Even though there are studies that provided evidence of short-term increases in municipal bond yield at the breakout of the COVID-19 pandemic (Li and Lu, 2020; Cusatis and Hoxha, 2022; Finlay et al., 2020; Bi and Marsh, 2021), our results shed light into a longer-term impact of how the financial market reacted to Federal Reserve intervention during COVID-19 pandemic. When the COVID-19 pandemic began in March of 2020, one of the major concerns in the U.S. was its potential impact on the ability of state and local governments to borrow when necessary to maintain spending levels on public goods and services. To help state and local governments avert or at least significantly mitigate deep spending cuts and to be able to function normally throughout the pandemic, the Federal Reserve, on April 9, 2020, announced the formation of the Municipal Liquidity Facility (MLF). The purpose of the MLF was to purchase municipal bond issues from large municipalities and states (Brandl, 2020, pp. 356-357). The interest rate would depend on the rating of the municipal bond issuer, and it would be priced to fit within more normal interest rate spreads over Treasury yields for those rating classes plus an initial 100 basis point fee (later made 50 basis points). The MLF intended to stop feedback from expected increases in the unemployment rate from increasing the magnitude of muni spreads[5], thereby preventing various municipal governments from accessing the municipal bond market.

As a matter of fact, muni spreads stopped rising in the week of the Fed announcement, well before the muni facility opened on May 26, 2020. The existence of the MLF may have contributed to marginalizing the COVID-19 dummy *(COVID)* from influencing real tax-free yields. This idea is supported by Bordo and Duca (2023, p.1), who found that the MLF has capped muni spreads and "limited the extent to which interest rate spreads could have amplified the impact of the Covid pandemic." In this regard, our empirical finding partially aligns with what was obtained by Cusatis and Hoxha (2022, p. 100), namely, that "following the pandemic, municipal yields are found to be negatively related to U.S Treasury issue yields."

Interestingly, Cusatis and Hoxha (2022) find that *before* the COVID-19 pandemic, municipal yields were positively related to U.S. Treasury yields. Alternatively stated, under ordinary economic and other circumstances,[6] municipal bond yields tend to be positively associated with Treasury yields; this finding is consistent with the earlier studies by Quayes and Jamal (2007), Cebula (2018), and Finlay et al. (2020).

[5] "Muni spread" refers to the spread or difference between the interest rate yield on Baa-rated municipal bonds and the yield on ten-year U.S. Treasury bonds.
[6] Consider, e.g., the sub-prime mortgage crisis of 2008 as an example of an unordinary circumstance.

Table 2. Descriptive Statistics and Data Sources

Variables	Observations	Mean	Standard Deviation	Min	Max	Coding	Source
EPRTFR	162	2.709	1.741	-4.385	7.057	*Ex post real yield on high grade tax-free municipal bonds (Percentage)*	*Economic Indicators*
EPR30	162	4.053	2.105	-1.359	9.817	*Ex post real yield on Moody's Seasoned Aaa Corporate Bond (Percentage)*	*Economic Research*
Y	162	0.644	1.150	-8.937	7.548	*Real GDP growth (Percentage)*	*Economic Research*
ATR	162	13.967	1.184	11.390	16.400	*Average effective federal personal income tax rate (Percentage)*	*Mudry and Bryan (2008), FRED*
NCIY	159	1.413	1.103	-1.028	5.113	*Lagged net capital inflow-to-GDP (Percentage)*	*Economic Research*
DEFY	161	3.608	4.652	-8.242	41.025	*Total federal budget deficit-to-GDP (Percentage)*	*Economic Research*
CRA	162	0.642	0.481	0.000	1.000	*Dummy variable with value of 1 if the year is after 1994; and 0 otherwise*	*Self-constructed*
TRA	162	0.049	0.217	0.000	1.000	*Dummy variable with value of 1 if the year is after 1987; and 0 otherwise*	*Self-constructed*
QEY	162	2.509	3.917	0.000	10.594	*Changes in quantitative easing-to-GDP (Percentage)*	*FRED*
COVID	162	0.025	0.156	0.000	1.000	*Dummy variable with value of 1 if the year is 2020 or 2021; and 0 otherwise*	*Self-constructed*
Seasonal	162	0.247	0.433	0.000	1.000	*Dummy variable with value of 1 if the quarter is quarter one for each year; and 0 otherwise*	*Self-constructed*
EARTFR	156	2.679	1.054	0.564	6.922	*Ex ante real yield on high grade tax-free municipal bonds (Percentage)*	*Economic Indicators*
EAR30	156	3.959	1.658	0.887	9.035	*Ex post real yield on Moody's Seasoned Aaa Corporate Bond (Percentage)*	*Economic Data*

Note: The table provides summary statistics, coding, and data sources of all variables at the household and county level.
Source: Authors' calculations based on Economic Indicators prepared by Council of Economic Advisers for the Joint Economic Committee, published by the United State Government Printing Office; the Economic Research from the Federal Reserve Bank of St. Louis (FRED), and the Economic Data from the Federal Reserve Bank of Cleveland.

Table 3. Estimates with Ex Post Real High Grade Tax-free Municipal Bonds

	(1) EPRTFR	(2) EPRTFR
L1. EPRTFR	*0.235**** *(0.055)*	*0.235**** *(0.077)*
L2. EPRTFR	*-0.058* *(0.038)*	*-0.058* *(0.045)*
EPR30	*0.730**** *(0.037)*	*0.730**** *(0.051)*
Y	*-0.075*** *(0.032)*	*-0.075*** *(0.031)*
ATR	*-0.125**** *(0.032)*	*-0.125**** *(0.032)*
NCIY	*-0.105**** *(0.030)*	*-0.105**** *(0.026)*
DEFY	*0.017** *(0.009)*	*0.017*** *(0.009)*
CRA	*0.702**** *(0.090)*	*0.702**** *(0.095)*
TRA	*0.478**** *(0.142)*	*0.478**** *(0.145)*
QEY	*-0.017* *(0.042)*	*-0.017* *(0.032)*
COVID	*0.150* *(0.215)*	*0.150* *(0.139)*
Constant	*0.681* *(0.444)*	*0.681** *(0.408)*
Observations	*157*	*157*
R-squared	*0.955*	*0.955*
Root MSE	*0.354*	*0.354*
Robust standard errors	*NO*	*YES*

Note: The table presents the autoregressive estimation with EPRTFR as the dependent variable. Column (1) shows the results without robust standard errors, and Column (2) shows the results with robust standard errors.
Source: Authors' calculations based on Economic Indicators prepared by Council of Economic Advisers for the Joint Economic Committee, published by the United State Government Printing Office; the Economic Research from the Federal Reserve Bank of St. Louis, and the Economic Data from the Federal Reserve Bank of Cleveland.
***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

However, global financial markets first reacted to the news about the pandemic by starting a process of "flight to quality" (Finlay et al., 2020). This market reaction likely accounts at least in part for the finding by Cusatis and Hoxha (2022, p. 100) that following the COVID-19 pandemic, municipal bond yields are inversely related to the yields on U.S. Treasuries.

Cusatis and Hoxha (2022, p. 101) proceed to argue that their "results provide support to the theory that, in times of crisis, there exists a flight-to-quality, where most market participants buy U.S. Treasuries, even though municipal bonds should be relatively more secure than corporate bonds or

Table 4. Estimates with Ex Ante Real High Grade Tax-free Municipal Bonds

	(1) EPRTFR	(2) EPRTFR
L1. EPRTFR	*0.482**** *(0.079)*	*0.482**** *(0.088)*
L2. EPRTFR	*-0.099* *(0.063)*	*-0.099* *(0.078)*
EPR30	*0.371**** *(0.041)*	*0.371**** *(0.045)*
Y	*-0.035** *(0.019)*	*-0.035* *(0.021)*
ATR	*-0.039** *(0.020)*	*-0.039** *(0.021)*
NCIY	*-0.038*** *(0.019)*	*-0.038** *(0.019)*
DEFY	*0.012*** *(0.006)*	*0.012**** *(0.005)*
CRA	*0.084* *(0.069)*	*0.084* *(0.066)*
TRA	*0.224**** *(0.085)*	*0.224** *(0.127)*
QEY	*0.007* *(0.025)*	*0.007* *(0.018)*
COVID	*-0.251** *(0.136)*	*-0.251*** *(0.118)*
Constant	*0.670*** *(0.278)*	*0.670*** *(0.263)*
Observations	*151*	*151*
R-squared	*0.953*	*0.953*
Root MSE	*0.214*	*0.214*
Robust standard errors	*NO*	*YES*

Note: The table presents the autoregressive estimation with EARTFR as the dependent variable. Column (1) shows the results without robust standard errors, and Column (2) shows the results with robust standard errors.
Source: Authors' calculations based on Economic Indicators prepared by Council of Economic Advisers for the Joint Economic Committee, published by the United State Government Printing Office; the Economic Research from the Federal Reserve Bank of St. Louis, and the Economic Data from the Federal Reserve Bank of Cleveland.
***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

common stock." A relevant concurrent phenomenon is that federal government spending rose substantially during 2019 and 2020 as well as 2021, bringing with it historically huge budget deficits (and correspondingly large increases in the national debt). It created upward pressure on Treasury yields, especially longer-term Treasury yields (Gale and Orszag, 2003; Cebula, 2014). As a result, the circumstances implied downward pressure on municipal bond yields (Cusatis and Hoxha, 2022), given that, following the pandemic's beginning, municipal yields were negatively related to U.S Treasury issue yields. These conditions combined to contribute to the negative coefficients found on the variable *COVID* shown in Table 4.

We find no statistically significant effects of the quantitative easing variable (*QEY*) on the *ex-post (EPRTFR)* and *ex-ante* (*EARTFR*) real municipal bonds interest rate yields (see Tables 3 and 4). Focusing on the impact of quantitative easing on long-term interest rates during the Great Recession period, Vissing-Jorgensen and Krishnamurthy (2011) found that quantitative easing has significant impact on reducing long-term Treasuries and Agencies bonds on nominal interest rates. However, they only found a much smaller effect on those of less safe assets like Baa corporate bond and mortgage rates. Even though Vissing-Jorgensen and Krishnamurthy (2011) did not examine the municipal bond markets, our findings are supported by the idea that the Federal Reserve did not focus on intervening in the municipal bond market during the Great Recession (Campbell and Wessel, 2021). Therefore, quantitative easing was not a major source of purchases or sales of municipal bonds. Since our *COVID* dummy variable captures the time effect of all related factors during the pandemic, including Federal Reserve intervention through the MLF, the statistically insignificant coefficients of *QEY* in all of our estimates are not surprising.

Considering that the municipal bond markets would be affected by seasonal factors, as a robustness test, Tables 5 and 6 replicate our regressions in Tables 3 and 4, respectively, except for including seasonal dummy variables. The results largely parallel their counterparts in Tables 3 and 4.

CONCLUSION

This study seeks to empirically identify factors that have influenced the *ex-post* real yield on high-grade municipal bonds, $EPRTFR_t$, a variable critically important to towns, cities, counties, and states, and their infrastructure endeavors and objectives for 1980.Q1 through 2020.Q4 study period. This study undertakes autoregressive estimations based upon an open loanable funds model inclusive of various federal statutes as control variables. The findings principally focus on factors influencing the *ex-post* real yields on tax-exempt municipals. However, as a robustness check, the model's re-estimation finds the same factors influence the *ex-ante* real yield on municipals (*EARTFR*). We also present results based on robust and non-robust standard errors.

Thus, it was found that the *EPRTFR* has been an increasing function of the *ex-post* real yield on Moody's 30-year Aaa-rated corporate bonds, the Community Reinvestment Act of 1977, the Tax Reform Act of 1986, and the federal budget deficit expressed as a percent of GDP. On the other hand, it was found to be a decreasing function of the average federal personal income tax rate, the growth rate of real GDP, and net financial capital inflows, expressed as a percent of GDP. Aside from the positive influence of the Community Reinvestment Act on *EARTFR*, the findings for the variable *EARTFR* effectively parallel those for *APRTFR*, with the sole exception that the estimations imply that the COVID-19 pandemic control variable implies a negative impact on *EARTFR* but not on *APRTFR.* Interestingly, quantitative easing exercised no meaningful effect on either *EPRTFR* or *EARTFR.*

The results indicate that the federal budget deficit exerts upward pressure on both *EPRTFR* and *EARTFR*, despite the offsetting impact of other factors, such as international capital inflows. It follows that restraint in issuing Treasury debt (i.e., limiting federal budget deficits and Treasury borrowing) makes financing infrastructure and other projects relevant to cities, counties, and states less burdensome. Furthermore, lawmakers should be more cautious and knowledgeable regarding the effects of statutes they pass, even though the side effects may be entirely unintended. For example, there are opportunity costs to the debt service payment that the Treasury must distribute to holders of federal debt obligations.

Table 5. Estimates with Ex Post Real Tax-free Municipals with a Seasonal Dummy

	(1) EPRTFR	(2) EPRTFR
L1. EPRTFR	0.229*** (0.055)	0.229*** (0.076)
L2. EPRTFR	-0.052 (0.038)	-0.052 (0.044)
EPR30	0.726*** (0.036)	0.726*** (0.052)
Y	-0.063** (0.032)	-0.063* (0.032)
ATR	-0.113*** (0.032)	-0.113*** (0.032)
NCIY	-0.098*** (0.030)	-0.098*** (0.026)
DEFY	0.023** (0.009)	0.023** (0.009)
CRA	0.697*** (0.089)	0.697*** (0.095)
TRA	0.472*** (0.141)	0.472*** (0.138)
QEY	0.008 (0.044)	0.008 (0.034)
COVID	0.067 (0.218)	0.067 (0.153)
Seasonal	-0.134* (0.072)	-0.134* (0.068)
Constant	0.527 (0.448)	0.527 (0.407)
Observations	157	157
R-squared	0.956	0.956
Root MSE	0.351	0.351
Robust standard errors	NO	YES

Note: The table presents the autoregressive estimation with EPRTFR as the dependent variable. Column (1) shows the results without robust standard errors, and Column (2) shows the results with robust standard errors.
Source: Authors' calculations based on Economic Indicators prepared by Council of Economic Advisers for the Joint Economic Committee, published by the United State Government Printing Office; the Economic Research from the Federal Reserve Bank of St. Louis, and the Economic Data from the Federal Reserve Bank of Cleveland.
***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

Table 6. Estimates for Ex Ante Real Tax-free Municipals with a Seasonal Dummy

	(1) EPRTFR	(2) EPRTFR
L1. EPRTFR	*0.497**** *(0.077)*	*0.497**** *(0.085)*
L2. EPRTFR	*-0.115** *(0.062)*	*-0.115* *(0.076)*
EPR30	*0.369**** *(0.040)*	*0.369**** *(0.044)*
Y	*-0.024* *(0.019)*	*-0.024* *(0.022)*
ATR	*-0.029* *(0.020)*	*-0.029* *(0.021)*
NCIY	*-0.031** *(0.018)*	*-0.031* *(0.019)*
DEFY	*0.018**** *(0.006)*	*0.018**** *(0.005)*
CRA	*0.082* *(0.067)*	*0.082* *(0.064)*
TRA	*0.219**** *(0.083)*	*0.219** *(0.121)*
QEY	*0.029* *(0.025)*	*0.029* *(0.020)*
COVID	*-0.321*** *(0.134)*	*-0.321*** *(0.140)*
Seasonal	*-0.136**** *(0.043)*	*-0.136**** *(0.038)*
Constant	*0.539** *(0.273)*	*0.539*** *(0.263)*
Observations	*151*	*151*
R-squared	*0.956*	*0.956*
Root MSE	*0.208*	*0.208*
Robust standard errors	*NO*	*YES*

Note: The table presents the autoregressive estimation results with EARTFR as the dependent variable. Column (1) shows the results without robust standard errors, and Column (2) shows the results with robust standard errors.
Source: Authors' calculations based on Economic Indicators prepared by Council of Economic Advisers for the Joint Economic Committee, published by the United State Government Printing Office; the Economic Research from the Federal Reserve Bank of St. Louis, and the Economic Data from the Federal Reserve Bank of Cleveland.
***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively.

REFERENCES

Al-Saji, A. K. (1993). Government budget deficits, nominal and ex ante real long-term interest rates in the UK, 1960: 1–1990: 2. *Atlantic Economic Journal*, *21*(2), 71-77.

Barth, J. R., & Brumbaugh, R. D. (1992). *The reform of federal deposit insurance: Disciplining the government and protecting taxpayers*. New York, NY: Harper Business.

Barth, J. R., Iden, G. R., & Russek, F. S. (1985). Federal borrowing and short-term interest rates: Comment. *Southern Economic Journal*, 554-559.

Barth, J. R., Iden, G., & Russek, F. S. (1984). Do federal deficits really matter? *Contemporary Economic Policy*, *3*(1), 79-95.

Barth, J. R. (1991). *The Great Savings and Loan Debacle.* Washington, D.C.: American Enterprise Institute.

Bi, H., & Marsh, B. W. (2021). Flight to liquidity or safety? recent evidence from the municipal bond market. *EliScholar – A Digital Platform for Scholarly Publishing at Yale.*

Bordo, M. D., & Duca, J. V. (2023). How the new fed municipal bond facility capped municipal-treasury yield spreads in the Covid-19 recession. *Journal of the Japanese and International Economies*, *67*, 101245.

Brandl, M. (2020). *Money, banking, financial markets* & *institutions*. Boston MA: Cengage Learning.

Campbell, S., & Wessel, D. (2021). How well did the Feds intervention in the municipal bond market work? *Brookings.*

Carlson, K. M., & Spencer, R. W. (1975). Crowding out and its critics. *Federal Reserve Bank of St. Louis Review*, (December 1975).

Cebula, R. J. (2018). Reflections on an inquiry into unfamiliar as well as familiar factors that may influence the market for municipal bonds. *Review of Regional Studies*, *48*(2), 145-154.

Cebula, R. J., & Koch, J. V. (1994). Federal budget deficits, interest rates, and international capital flows: A further note. *The Quarterly Review of Economics and Finance*, *34*(1), 117-120.

Cebula, R. J., Gillis, W., McCrary, S. C., & Capener, D. (2016). New evidence on the impact of economic conditions and banking legislation on the bank failure rate in the US, 1970 to 2014. *Journal of Financial Economic Policy*, *8*(3), 364-376.

Cebula, R. J. (2014). An empirical inquiry into the impact of federal budget deficits and the ex-ante real interest rate yield on long-term treasury notes. *Journal of Public Finance and Public Choice*, *32*(1), 83-97.

Choate, G. M., Hand, M. L., & Thompson, F. (2010). The influence of income tax rates on the market for tax-exempt debt. *Municipal Finance Journal*, 31(1): 41060.

Choi, D. F., & Holmes, M. J. (2014). Budget deficits and real interest rates: a regime-switching reflection on Ricardian equivalence. *Journal of Economics and Finance*, *38*(1), 71-83.

Cotton, C. D. (2021). Debt, deficits, and interest rates. *Research Department: Boston, MA.: Federal Reserve Bank of Boston*, 1-31.

Council of Economic Advisers for the Joint Economic Committee. (1980-2020) *Economic Indicators*, 1980-2020, U.S. Government Printing Office: Washington, D.C.

Cusatis, P., & Hoxha, I. (2022). Municipal bond performance during the COVID-19 pandemic. *Municipal Finance Journal*, 43(1): 93-103.

Drukker, A. J., Gayer, T., & Gold, A. K. (2020). Tax-exempt municipal bonds and the financing of professional sports stadiums. *National Tax Journal*, 73(1): 157-196.

Enders, W. (1995). *Applied econometric time series*. Wiley: New York.

Engen, E. M., & Hubbard, R. G. (2004). Federal government debt and interest rates. *NBER Macroeconomics Annual*, *19*, 83-138.

Ewing, B. T., & Yanochik, M. A. (1999). Budget deficits and the term structure of interest rates in Italy. *Applied Economics Letters*, 6(3), 199-201.

Federal Reserve Bank of Cleveland (2022). *Inflation Expectations*, At: https://www.clevelandfed.org/indicators-and-data/inflation-expectations

Federal Reserve Bank of St. Louis (FRED) (2022). *Economic Research*, At: https://fred.stlouisfed.org/

Finlay, R., Seibold, C., & Xiang, M. (2020). Government Bond Market Functioning and COVID-19. Sydney, NSW: Reserve Bank of Australia, 11–20.

Gale, W. G., & Orszag, P. R. (2003). Economic effects of sustained budget deficits. *National Tax Journal*, 56(3), 463-485.

Gissey, W. (1999). Net treasury borrowing and interest-rate changes. *Journal of Economics and Finance*, 23(1), 23-29.

Heaton, H. (1986). The relative yields on taxable and tax-exempt debt. *Journal of Money, Credit and Banking*, 18(4), 482-494

Hoelscher, G. (1986). New evidence on deficits and interest rates. *Journal of Money, Credit and Banking*, 18(1), 1-17.

Johnson, C. F. (1992). An empirical note on interest-rate equations. *Quarterly Review of Economics and Finance*, 32(2), 141-147

Kolluri, B. R., & Giannaros, D. S. (1987). Budget deficits and short-term real interest rate forecasting. *Journal of Macroeconomics*, 9(1), 109-125.

Laubach, T. (2009). New evidence on the interest rate effects of budget deficits and debt. *Journal of the European Economic Association*, *7*(4), 858-885.

Li, T., & Lu, J. (2020). Municipal finance during the covid-19 pandemic: Evidence from government and federal reserve interventions. *Available at SSRN 3637636*.

Lütkepohl, H. (1993). *Introduction to Multiple Time Series Analysis* (Springer-Verlag, Berlin).

Madura, J. (2008). *Financial Markets and Institutions*. 8th ed. Mason, OH: Thomson Higher Learning.

Mudry, K., & Bryan, J. (2008). Individual tax rates and shares, 2005. *Statistics of Income Bulletin*. At: www.irs.gov/taxstats

Musgrave, R. A. (1987). Short of euphoria. *Journal of Economic Perspectives*, *1*(1), 59-71.

Ott, A. F., & Vegari, S. B. (2003). Tax reform: Chasing the elusive dream. *Atlantic Economic Journal*, *31*(3), 266-282.

Poterba, J. M., & Rueben, K. S. (1999). Municipal bond yields: Whose tax rates matter? *National Tax Journal,* 41, 219-233.

Poterba, J. M., & Rueben, K. S. (2001). Fiscal news, state budget rules, and tax-exempt bond yields. *Journal of Urban Economics*, *50*(3), 537-562.

Poterba, J. M., & Verdugo, A. R. (2011). Portfolio substitution and the revenue cost of the federal income tax exemption for state and local government bonds. *National Tax Journal,* 64(2): 591-614.

Quayes, S., & Jamal, A. M. M. (2007). Budget deficits and interest rates: The US evidence since 1946. *The Singapore Economic Review*, 52(02), 191-200.

Swamy, P. A., Kolluri, B. R., & Singamsetti, R. N. (1990). What do regressions of interest rates on deficits imply? *Southern Economic Journal*, 1010-1028.

Tanzi, V. (1985). Fiscal deficits and interest rates in the United States: An empirical analysis, 1960-84. *IMF Staff Papers*, *32*(4), 551-576.

Tax Policy Center (2017). *Tax Policy Center Briefing Book: Some Background*, At: http://www.taxpolicycenter.org/briefing-book/what-tax-gap

Vissing-Jorgensen, A., & Krishnamurthy, A. (2011). The effects of quantitative easing on interest rates: Channels and implications for policy. *Brookings Papers on Economic Activity*, 43(2), 215-287.