Infrastructure Asset Reporting and Pricing Uncertainty in the Municipal Bond Market

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ABSTRACT: We examine the infrastructure provision of the GASB’s Statement No. 34 to determine whether there is unique information content in the modified approach versus traditional depreciation, both allowable under this provision. Using a dataset containing investor bid spreads on secondary market bond auctions from states using the modified approach as well as those from states using traditional depreciation, we find bonds from modified approach states have significantly narrower bid spreads than bonds from traditional depreciation states, indicating the modified approach provides unique information about governments’ financial condition. Findings suggest the modified approach reduces uncertainty about infrastructure condition, improving market efficiency.

Keywords: GASB Statement No. 34; infrastructure assets; municipal bonds; modified approach; secondary markets.

INTRODUCTION

The Governmental Accounting Standards Board’s (GASB 1999) issuance of Statement No. 34, Basic Financial Statements—and Management’s Discussion and Analysis—for State and Local Governments, significantly changed and increased the GAAP reporting requirements for governments. One of the most significant and controversial changes brought about by Statement No. 34 is that it added a requirement that governments capitalize fixed assets, including infrastructure assets, in the government-wide accrual basis financial statements and
report depreciation in the Statement of Activities. There was significant debate and criticism during the comment period surrounding the costs versus the potential benefits of retroactively determining and then capitalizing infrastructure assets and then assigning depreciable lives (Vermeer, Patton, and Styles 2011; Gomeau 2000). Ultimately, a modified approach for reporting infrastructure assets was developed as an option in the final version of Statement No. 34, allowing states to capitalize certain infrastructure assets, report on their condition, and then expense charges to preserve and maintain the assets, rather than reporting depreciation on assets with potentially indefinite lives.

Roughly half of the U.S. states ultimately adopted the modified approach to reporting some of their infrastructure assets, while the other half adopted traditional depreciation accounting (Vermeer et al. 2011). This study evaluates whether there is unique information content in the information provided by the modified approach versus that provided by traditional depreciation accounting. Specifically, this study evaluates whether a state’s choice of infrastructure reporting affects pricing uncertainty on its seasoned bonds, using investor bid spreads on state bonds trading in the seasoned municipal capital markets. This is the first study that evaluates investor reaction to the modified approach. It is an important contribution to the body of literature on GASB Statement No. 34 because the infrastructure reporting provision was extremely controversial and few studies have empirically examined its effects more than a decade after its implementation. If investors’ bid spreads are different for governments using the modified approach than to those using traditional depreciation, then this could indicate that infrastructure reporting methods have unique information content about governments’ financial condition.

Although the GASB believed that in concept traditional depreciation was more appropriate for showing the costs associated with capital assets (Patton and Bean 2001), the modified approach was developed as an alternative to traditional depreciation accounting after receiving criticism in response to the Exposure Draft. The modified approach was designed, along with other modifications to the GASB’s initial proposal, to ease the burden on governments to have to retroactively determine historical cost on all infrastructure assets and then estimate a useful life, record annual depreciation, and further capitalize and depreciate future infrastructure improvements. Instead, recognizing this burden as well as the potential limitations of depreciation as a measure of the use of an asset, under the modified approach, governments could retroactively capitalize certain infrastructure assets at either historical or estimated historical cost and then report on the physical condition of those assets and the costs to preserve and maintain that condition at a level determined in advance by the governments. Such “preservation” costs would then be expensed in lieu of depreciation. Reporting on physical condition, along with expensing preservation costs, represent key differences brought about by the introduction of the modified approach. The introduction of this approach, along with the other adjustments, diminished much of the controversy surrounding the infrastructure provision (Vermeer et al. 2011).

In order for governments to choose the modified approach under Statement No. 34, they would have to maintain an adequate asset management system to manage the infrastructure assets, and maintain the assets at or above a predetermined level. Governments using the

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1 For example, the Government Finance Officers Association (GFOA) considered allowing governments not complying with the infrastructure provisions to continue to participate in its Certificate of Achievement for Excellence in Financial Reporting Program, but ultimately did not do so.

2 For example, in its public policy statement on infrastructure reporting, the GFOA (1999) stated that the requirements for infrastructure reporting proposed by the GASB would be “potentially costly and provide information of little practical benefit to financial statement users” and that it would “‘tip the scales’ in favor of capital expenditures at the expense of other services to citizens.”
modified approach would also have to provide evidence that they adequately maintain these assets. Governments reporting under Statement No. 34 have been known to choose traditional depreciation over the modified approach or to switch from the modified approach for a variety of reasons, including the inability to adequately maintain their assets due to lack of funding, the challenge of maintaining detailed records, or a belief that traditional depreciation is the appropriate accounting method (Vermeer et al. 2011).

Reporting on the condition and maintenance of infrastructure assets is a different approach to informing investors and other financial statement users about the use of assets than recording depreciation, and may actually provide a better window into the condition and use of government infrastructure than traditional depreciation accounting (Pryor 2013). Although both methods require the initial retroactive capitalization of infrastructure assets, traditional depreciation accounting does not require reporting on the actual condition of the infrastructure assets, instead recognizing their use by taking annual depreciation. Although in theory depreciation represents the use of assets over time, in practice most governments choose straight-line depreciation with widely varying useful lives (Vermeer et al. 2011). In contrast, the modified approach requires continuous evaluation of infrastructure and condition reporting to a predetermined level.

Maintaining assets at such a level can have financial benefits such as reducing the need for deferred maintenance projects. This asset maintenance can reduce the life-cycle costs of that infrastructure because maintenance is generally less costly when it is not deferred (Yarnell 2004). Thus, from an investor’s perspective, the financial statements of governments using the modified approach could provide a clearer picture about a government’s infrastructure than those using traditional depreciation accounting. However, there is scant research on investors’ reactions to the disclosures made under Statement No. 34, in particular research studying investor reaction to the infrastructure provisions. This is the first study directly testing investor reaction to government infrastructure reporting. Vermeer et al. (2011) report on the “state” of government infrastructure reporting and disclosure, but do not further investigate how financial statement users, including investors, react to these disclosures. Given the differences discussed previously between the reporting by governments choosing the modified approach versus the reporting by those choosing traditional accounting, and the possible enhanced view of a government’s infrastructure under the modified approach, it warrants further review of whether investors see unique information content in these disclosures.

To examine whether there is unique information content in the modified approach, this study analyzes a unique dataset comprising the results of secondary market auctions of municipal bonds. Each day several thousand individual municipal bonds are sold through auctions hosted at electronic trading platforms. These auctions are an ideal setting to observe how financial disclosures shape investor behavior. All auction participants are well-informed, institutional investors. Their bids represent their contemporaneous pricing of a bond, holding constant market dynamics and other potential confounding factors. The distance between the lowest and highest bid prices—known here as the “bid spread”—is a good proxy for investor disagreement about a bond’s fundamental value.

The findings presented here suggest the modified approach does have unique information content. The estimates from a multivariate regression model show that bonds from states using the modified approach trade at bid spreads roughly 24 percent narrower than states that do not use the modified approach. The findings are robust and economically meaningful, suggesting that the use of the modified approach reduces information asymmetry in the municipal capital markets, reducing uncertainty by providing investors with information that enables them to trade more efficiently with each other.
This paper contributes to both the literature about Statement No. 34 and to the fixed income literature addressing the relationship between information asymmetry and municipal bond pricing. The findings also provide important practical information to governments evaluating the potential effects of using the modified approach, to regulators in evaluating the success of Statement No. 34 on bond market efficiency, and to investors for understanding whether either the modified approach or traditional depreciation reduces market uncertainty. If one approach is considered more transparent by investors, then it can provide better overall market efficiency as well as a potential opportunity to lower the costs of debt for governments choosing to switch to the more transparent method.3

The following section will review literature relevant to this study, the next section discusses theory and develops the hypothesis, the fourth section develops models to test the hypothesis, the fifth section discusses the findings, and the sixth section concludes and discusses implications.

LITERATURE REVIEW

Two main bodies of literature inform this study: one is the small body of literature examining motivations and implications of government infrastructure reporting under Statement No. 34, and second is the much more robust literature that broadly examines the role of government financial disclosure in the municipal capital markets.

Vermeer et al.’s (2011) is the most comprehensive study to date on governments’ adoption of the modified approach. This study reviews the comprehensive annual financial reports (CAFRs) for all 50 states, Puerto Rico, and the District of Columbia, finding that more governments use depreciation (56 percent) than the modified approach (44 percent). Perhaps more importantly, they also find that governments applying the modified approach do not report uniformly; states are generally inconsistent on the scope and depth of the infrastructure condition information they disclose, and the methods they use to measure that condition. In follow-up interviews with state officials they also found that the crucial factor for adopting the modified approach was the presence of an asset management system. States choosing traditional depreciation generally did not have an asset management system in place, or they believed the modified approach was too difficult or less accurate than traditional depreciation. One state switched to full depreciation because it was not able to maintain its assets at the level set by the government and thought it would be “unpalatable” to reduce the required condition level (Vermeer et al. 2011). Pryor (2013) studied cities’ adoption of the modified approach and reached similar conclusions about the rate of adoption and motives for adopting the modified approach. However, both Vermeer et al. (2011) and Pryor (2013) study infrastructure reporting qualitatively, focusing on the motivations for choosing one method over the other, the consistency of reporting and associated disclosures across governments, and implementation rates. They do not evaluate whether there is any economic consequence of governments’ infrastructure reporting choice.

There are a small number of related studies on the benefits and costs of government infrastructure reporting, and that literature is a key motivation for this paper. For instance, van Daniker and Harris (1999) surveyed state comptrollers for their perspective on the impending capitalization changes prior to the final issuance of Statement No. 34. Respondents indicated that they believed the costs for capitalizing and depreciating infrastructure assets would be high, while the benefits would be low. Respondents indicated a preference for reporting focusing on the costs

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3 Governments would also have to consider the transaction costs of switching from one method to the other to determine whether the benefits of switching outweigh the costs.
of maintaining assets into the future, because the calculation of historical cost would be arbitrary in many cases. However, the survey was prior to the final issuance of Statement No. 34 and did not provide any “actual” costs or benefits of the new infrastructure provision. Yarnell (2004) takes the reader through the implementation of infrastructure reporting for Cole County, Missouri, and highlights the extensive work and coordination required to set up the asset management program. At the same time, the study describes the potential financial benefits from better tracking and updated and more nuanced analysis of infrastructure condition, noting it can lead to a reduction in deferred maintenance costs and provide justification for maintenance projects. Although this case study provides potential costs and benefits to a government implementing the modified approach, it does not provide empirical evidence of such benefits, focusing only on the implementation process.

There is also a limited literature on how analysts other than investors use information about infrastructure condition. Walker and Jones (2012) survey accounting professionals, engineers, and other managers in Australian firms for their opinions about infrastructure condition and reporting practices and for the type of infrastructure reporting that best assists with judgment and decision making when assessing an entity. Respondents overwhelmingly preferred condition reporting including the cost of maintaining assets at an acceptable level, and found historical cost information to be far less helpful. In a related paper, Jones, Hensher, Rose, and Walker (2012) use the feedback from an experiment employing public sector managers to evaluate the circumstances where managers want more extensive reporting. The study finds that managers want more extensive reporting of infrastructure assets when they perceive that a government has poor asset condition. In addition, more extensive reporting is desired when infrastructure is expensive to maintain and when infrastructure use is important to provide citizens with services.

Complementing the small body of literature specifically addressing infrastructure reporting disclosure practices, is a rich literature on how government financial disclosure shapes pricing, credit analysis, and other dynamics in the public capital markets. Since Statement No. 34 was issued and implemented, several scholars have examined how investors respond to the accrual basis, net asset information as provided by Statement No. 34 (Plummer, Hutchison, and Patton 2007; Pridgen and Wilder 2013; Marlowe 2010, among others). This literature affirms that full-accrual-basis reporting provides information incremental to the traditional modified-accrual-basis information. However, this literature focuses on the macro-level financial statement information and does not evaluate the content or the variation in accounting choices among municipalities in the reported information.

There is a related body of literature in governmental accounting from the period prior to Statement No. 34 that studies information asymmetry and information transparency in the municipal markets and their impact on market pricing. Municipal bonds trade on proprietary exchanges and this market has historically lacked effective regulation. This is due in part to the lack of jurisdiction by the SEC to directly set and enforce municipal reporting regulation, a result of the Securities and Exchange Act of 1933 and 1934 and later affirmed by the Tower Amendment of 1975. The result has been an opaque municipal reporting environment. In fact, the municipal markets are thought to have higher information asymmetry environments than the corporate sector, as indicated by lower liquidity (Downing and Zhang 2004) and higher transactions costs (Harris and Piwowar 2006). In addition, most municipal bonds do not trade with regularity and often have complex features, making it difficult for uninformed investors to price them in markets where pricing and quotes are not transparent (Harris and Piwowar 2006).

Findings consistently indicate that higher information asymmetry environments are associated with higher yields, larger bid spreads, and higher borrowing costs on municipal debt than lower
information asymmetry environments (Baber and Gore 2008; Reck, Wilson, Gotlob, and Lawrence 2004; Reck and Wilson 2006; Ingram and Copeland 1982; Raman and Wilson 1994; Benson, Kidwell, Koch, and Rogowski 1981; Benson, Marks, and Raman 1991; Hong and Warga 2004). Prior literature has shown that in the municipal bond market, information search costs are high and price transparency is low (Harris and Piwowar 2006; Bessembinder, Maxwell, and Venkataraman 2006; Goldstein, Hotchkiss, and Sirri 2007; Edwards, Harris, and Piwowar 2007; Green, Hollifield, and Schurhoff 2007b). All this prior literature suggests more detailed disclosures about actual infrastructure condition might help address that information asymmetry.

Prior literature on financial markets in the corporate sector indicates that bid-ask spreads are larger in higher information asymmetry environments (Wittenberg-Moerman 2008; Choi, Salandro, and Shastri 1988), and that bid-ask spreads decline with the introduction of policies that are likely to reduce or remove such asymmetry, or the uncertainty about the information advantage of one party over the other. Studies show a decline in bid-ask spreads after the introduction of International Financial Reporting Standards (Frino, Palumbo, Capalbo, Gerace, and Mollica 2013), the release of management forecasts (Coller and Yohn 1997), or that bid-ask spreads are lower in firms with strong disclosure policies (Welker 1995). Literature in this area recognizes that the spreads can be viewed as resulting from three different types of dealer costs: order processing costs, inventory-holding costs, and adverse information costs (Stoll 1989). This study addresses the difference in bid spreads for municipalities using the modified approach versus those using traditional depreciation to evaluate whether the modified approach mitigates adverse information costs and the related uncertainties.

**THEORY AND HYPOTHESIS DEVELOPMENT**

As prior literature and theory indicate, information asymmetry leads to market inefficiencies, but such inefficiencies may be mitigated through reporting policies that remove adverse information costs and hence the information advantage of one party over the other. In the corporate sector investment markets, regulations are in place to mitigate private information and communications in order to prevent adverse selection and help capital markets function effectively. In fact, much attention is given to the public availability of information, and the efficient incorporation of such information into securities pricing. There is extensive literature that studies the public company investment markets under assumptions that the markets are efficient in this way and that information is impounded quickly into prices (Fama 1970; Fama 1991; Kothari 2001).

In contrast to the private sector, municipal secondary markets are largely unregulated and known to be particularly opaque. Moreover, market participants have wide variations in access to available pricing information across the market on the bonds being traded (SEC 2012). Although trades are posted shortly after they are completed, experienced dealers who sell municipal bonds often have access to significantly more information than the smaller investors who are frequently buying these bonds. This leads to markups on the sales to customers (Green, Hollifield, and Schurhoff 2007a; Green, Li, and Schurhoff 2010). There is also an information advantage among lenders who may be privy to private information provided to them confidentially by borrowers, and are then allowed to trade on this information in the secondary markets (Bushman, Smith, and Wittenberg-Moerman 2010).

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4 For example, Regulation FD.
Theoretical support for disclosure to a secondary market is that it levels the playing field, creating liquidity in the market because it makes firms’ private information public, thereby discouraging adverse selection that results from traders engaging in private information acquisition (Gao and Liang 2013; Mercer, Moore, Whitby, and Winters 2013). Although the SEC cannot directly regulate municipal issuers, disclosure regulations such as SEC Rule 15c2-12 seek to improve municipal disclosure and help alleviate this issue by requiring other municipal financing participants to reasonably cause the issuer to file continuing disclosures. In addition, the GASB provides accounting and reporting standards as well as guidance for municipal entities to promote transparency and consistency in government reporting. Statement No. 34 was a significant change in reporting for governments, causing entities to report full-accrual-basis financial statements in addition to the traditional modified-accrual-basis statements, with infrastructure information to be capitalized and reported on the face of the full-accrual statements. The reporting of infrastructure using either traditional capitalization and depreciation or the modified approach with condition reporting are allowable methods under Statement No. 34. However, no one has studied whether one method of infrastructure reporting provides better disclosure to financial statement users than the other.

Prior literature in contracting theory addresses circumstances in which information asymmetry exists between the contracting parties because one party to the contract is better informed than the other. This information imbalance causes imperfect competition, which may lead to inaccurate pricing and, in extreme circumstances, failure of the market (Akerlof 1970). Prior literature has found that signaling and public disclosure of information can help to remove information asymmetry, thereby reducing uncertainty in the capital markets (Gao and Liang 2013; Welker 1995). While it is beyond the scope of this paper to evaluate the GASB’s intent in offering governments a choice of how to report their infrastructure, governments’ choice to apply one method over the other potentially provides a signal to investors about the quality of government operations, or it may provide better information to investors to help reduce their uncertainty about the governments’ financial position. It is an empirical question whether the modified approach and the full depreciation approach are equal competent providers of information or whether one reduces information asymmetry and thereby levels the playing field more than the other.

Theory and prior literature do not directly indicate whether one approach provides superior disclosure or signals to the other. The modified approach provides information about infrastructure condition that financial statement users may find useful; however, depreciation expense is not reported in the Statement of Activities to recognize the periodic utilization of certain infrastructure assets using this approach. However, this may not matter with governments whose purpose is not to earn a profit, but instead to provide services to citizens and maintain and improve infrastructure within their jurisdiction.

A government’s choice of infrastructure reporting may also be a proxy for other government characteristics as opposed to a unique signal or form of disclosure. Government managers choosing the modified approach may choose to do so because they are confident that they have the resources and management in place to easily maintain their assets at a predetermined level. In this case, rather than providing unique disclosures, the use of the modified approach may represent a government operating professionally. Prior literature indicates that professional governments will likely have professional managers with CPAs or a government structure like council-manager, which also tends to be associated with less political and more “businesslike” government (Khumawala, Marlowe, and Neely 2014; Choi, Feiock, and Bae 2013).

On the other hand, professional managers might believe that reporting the actual condition of their infrastructure could undermine their municipality’s contracting position if they have to reveal...
the condition of their infrastructure. There is a similar issue in the private sector where disclosure can reveal proprietary information about companies that can be used by competitors or contractors (Bowen, DuCharme, and Shores 1995). Alternatively, managers may not have the professional background to understand the purpose of depreciation, so they may default to the modified approach.

The use of the modified approach could also be an indication of agency problems within the government, whereby self-interested government asset managers set asset condition levels to channel more funding toward capital assets, even when actual asset conditions do not warrant such funding. Some say that the modified approach is inherently biased toward capital outlays (GFOA 2005). These government managers may also choose the modified approach in order to remove depreciation from the Statement of Activities for the governments they run. Although governments are not in the “business” of making a profit, managers may believe that citizens will perceive them as better managing agents if the change in net position is higher.

An analysis of why states choose one method of reporting infrastructure versus the other is beyond the scope of this study. However, if infrastructure reporting choice proxies other government characteristics, then it further remains unclear whether governments using the modified approach represent more professional governments or, the alternative, less professional governments, than those choosing traditional depreciation.

An alternative explanation to those provided above is that the modified approach to reporting infrastructure is not exclusively a proxy for government professionalism nor exclusively an indication of possible agency problems, but that it actually provides new information to investors over and above that of traditional depreciation, making governments' financial condition less opaque, so that there is less uncertainty in pricing of bonds in the municipal markets for governments using this approach. This would be consistent with the sentiment surrounding the infrastructure provision of Statement No. 34 that it may provide more transparent information about infrastructure condition, while also encouraging adequate asset maintenance (Walker and Jones 2012; Yarnell 2004; Vermeer et al. 2011). In fact, at the time that the GASB proposed condition reporting for infrastructure assets, they received letters from 1,000 governments protesting this type of disclosure, with one letter writer indicating that this disclosure would “effectively infringe upon our city’s prerogative to make its own public policy decisions regarding expenditures for infrastructure as opposed to expenditures for other services to citizens” (Barrett and Greene 2004). An interpretation by Barrett and Greene (2004) was that “the letter writers didn’t want information to get in the way of their making decisions about what to do with taxpayer dollars.” Governments’ reactions and the subsequent interpretations of such reactions suggest that using the modified approach removes information asymmetry between government managers and their citizens.5

According to Vermeer et al. (2011), municipal managers were less likely to use the condition reporting if they felt they could not maintain assets to an adequate predetermined condition level. Use of the modified approach provides an opportunity for managers to improve asset management and can be used to support spending on maintenance of that infrastructure, reducing the need for deferred emergency maintenance, which can be much more costly (see, for example, Yarnell 2004), and it requires that an adequate asset management system be in place. Managers do not want to report a reduced assets condition requirement, nor change to depreciation accounting, so

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5 Barrett and Greene (2004) highlight a quote from one letter as representative of the “letter writers,” and they acknowledge that the letters make a “number of points.” It is possible that the letter writers may have also been motivated to write letters out of concern with the costs of compiling and reporting information about infrastructure assets, among other reasons.
they have an incentive to adequately maintain assets once they are using this approach. For these reasons the use of the modified approach could provide investors with assurance that a government has adequate asset management.

Theory and prior literature make it clear that information environments within which information asymmetry is lower create more level playing fields among investors and that in this environment investment pricing is found to be more accurate. This is particularly evident in the secondary markets, where information can be opaque (Gao and Liang 2013; Mercer et al. 2013). If using the modified approach presents an opportunity for managers to improve asset management and more adequately maintain assets as prior literature suggests, then its use would be expected to improve disclosure about infrastructure and provide important signals to investors and other financial statement users, thereby reducing uncertainty about a government’s financial condition depending upon how infrastructure is reported.

Theory and prior literature suggest that when information asymmetry or uncertainty are lower, bid-ask spreads are also lower (Frino et al. 2013; Coller and Yohn 1997; Welker 1995; Wittenberg-Moerman 2008), suggesting that larger bid-ask spreads signify uncertainty about an organization’s value. This theory and prior literature suggest the following hypothesis:

**H1:** Governments using the modified approach will have less bond pricing uncertainty, evidenced by narrower bid-spreads in secondary market trades than governments using traditional depreciation.

### DATA AND METHODOLOGY

This analysis is based on a novel dataset of secondary market auctions of municipal bonds. These auctions offer a unique opportunity to scrutinize investors’ contemporaneous pricing decisions and how financial information affects those decisions.

The municipal bond market is large, decentralized, and fragmented. There are nearly $4 trillion in active municipal bonds issued by more than 60,000 individual units of government. In 2014 investors traded nearly $3 trillion through roughly 8.9 million secondary market transactions (Securities Industry and Financial Markets Association [SIFMA] 2016).

Municipal bonds trade in an over-the-counter market. There is no central exchange for municipal bonds, so virtually all transactions occur through an interconnected network of intermediaries (Green et al. 2007a). Investors enlist a broker to buy or sell a bond on their behalf, and that broker searches across a network of related dealers to find an appropriate counterparty. According to our data, around 20 percent of these searches are successful.

When a search does identify a potential counterparty, the brokers negotiate a price and the bonds are transferred from the seller to the buyer through several intermediated transactions. Many of those transactions are inter-dealer trades that flow through firms that connect brokers, known generally as “brokers-brokers.” Each intermediary who participates in the transaction marks up the price. Prices are not available in real time, so some intermediaries command substantial market power. Moreover, most buyers are buy-and-hold investors, so some bonds are quite illiquid. In fact, a typical municipal bond will trade only four times from issuance to maturity (Downing and Zhang 2004). For these and other reasons, bid-ask spreads and price dispersion on similar bonds can be quite high. There is a rich body of literature on the relationship between this market structure and the prices and transaction costs incurred by municipal bond investors (Green et al. 2007a; Schultz 2012).
Bid-Wanted Auctions

The analysis presented here is based on a specific part of this market structure. Some brokers-brokers offer a “bid-wanted” auction mechanism. In this scenario an investor who wants to sell a municipal bond contacts their broker and identifies the quantity of that bond they wish to sell. The dealer then posts a “bid-wanted” notice on an electronic trading platform maintained by one of the brokers-brokers. The dealer agrees to take bids on that bond at a given date and time, and to sell the bond to the counterparty that offers the highest price. For many brokers this is an efficient alternative to searching across many potential buyers.

Today there are ten main brokers-brokers who offer the “bid-wanted” mechanism. In a typical day, they collectively offer approximately 6,000 bid-wanted engagements, and those engagements generate around 20,000 bids in response. In the summer of 2013, a group of eight of those brokers-brokers agreed to pool and market the data from their bid-wanted engagements. These pooled bid-wanted data are the basis for this analysis.

The sample data here are from bid-wanted engagements from these eight brokers-brokers from August 2013 through December 2014. The company that manages their pooled data is Municipal Bond Information Services (MBIS). MBIS makes a version of these data available for a fee.

The start date is the first date when data from all eight participating brokers-brokers became available. We focus here on two dependent variables. First is the spread between the highest and lowest bids for each auction. Second is the inter-quartile range on the bids for each auction. Although these are intuitively similar measures of range, bid spread captures the range between highest and lowest bids, while inter-quartile range takes the difference between the upper and lower quartiles, potentially reducing the influence of outliers or skewed datasets. Using this measure acknowledges the possibility of outlier bids and reduces their influence. Both variables have been used extensively in prior literature to study liquidity or uncertainty in the financial markets (see, for example, Lang, Lins, and Maffett 2012; Amihud and Mendelson 2008; Kelley and Tetlock 2013; Janakiraman, Radhakrishnan, and Szwejkowski 2007), and there is no single accepted measure of range used exclusively in the literature. Given that this is the first study to examine infrastructure reporting and its effect on pricing uncertainty in the municipal bond market, both variables were included in the study.

Several additional filters were then applied. To focus on investor perceptions of states’ overall credit, the sample is limited to auctions of state general obligation bonds. By definition, an auction is also excluded if it had less than two bids. To filter out any data entry errors, an auction was excluded if its winning bid price was less than the 0.05 percentile (price = 50.9) or greater than the 99.5 percentile (price = 149.6) of the distribution of all bid prices. After applying these filters, the sample that remains includes 26,793 auctions. These auctions cover 5,319 individual bonds. There were at least ten auctions on every trading day during the sample period.

Bid-wanted auctions are an ideal setting to look at the investor response to the information disclosed through the modified approach. Inter-dealer trades that originate with bid-wanted engagements typically do not involve significant inventory and search costs, and if they do, then those costs are more or less the same across all market participants. This eliminates the types of transaction costs known to distort pricing. Bids arrive contemporaneously, so there is little chance that near-term market movements will affect pricing. Investors are more or less uniformly informed at the time of the auction. Moreover, bid-wanted engagements cover a large number of trades but comprise a small percentage of the total par value traded in the market. This suggests many bid-
wanted auctions are on behalf of retail investors. As such, this analysis offers some insight into how retail investors are or are not influenced by modified approach disclosures.

**Sensitivity Analysis—Matched Sample**

The problem with this analytical approach is that states’ use of the modified approach is probably not random. For instance, a state might develop a sophisticated infrastructure reporting system if it has large capital spending needs and wants to deploy its capital resources as efficiently as possible. States with large capital needs also borrow money more frequently and have better “name recognition” and less investor uncertainty in the market. At the same time, if a state has a sophisticated infrastructure management system in place, then that system will lower the costs to implement the modified approach. Put differently, use of the modified approach might be subject to some selection bias, particularly with respect to the quality of a state’s overall infrastructure management system and its name recognition in the municipal market.

To address this problem we constructed a matched sample of auctions designed to mimic a random distribution of the incidence of the modified approach. For each auction of a bond from a state that uses the modified approach, we used propensity score matching (Garrido et al. 2014). Propensity score matching is a technique to estimate the effect of a “treatment” variable—in this case use of the modified approach—when that treatment is not randomly distributed throughout a sample population. Each observation where the treatment is observed, in this case an auction of a bond from a state that uses the modified approach, is matched to a similar observation where the treatment is not observed, in this case an auction of a bond from a state that does not use the modified approach. We employed a version of propensity score matching based on the “nearest neighbor” algorithm (see Dehejia and Wahba 2002, among others). This approach is designed to mitigate the effect of selection bias on our estimates of the relationship between the modified approach and secondary market bid spreads.

We matched auctions on three criteria to capture characteristics of both the bond issue and the underlying government’s professionalism. First was the par value of the overall bond issue that contained the auctioned bond. The intuition here is that states with larger infrastructure networks to maintain are more likely to borrow greater amounts of money and access the capital markets more often. In turn, they are also more likely to use the modified approach and to sell larger bond issues. States with larger bond issues also have greater capital needs and are more likely to have sophisticated infrastructure management systems to manage those needs.

Second was a direct measure of infrastructure management practices. In 2008 The Pew Charitable Trusts released the second iteration of its “Grading the States” report (Pew 2008). In this report Pew (2008) graded state infrastructure management systems on how well they produce information about infrastructure condition and performance, and consequently how well this information is used to drive decisions long term about infrastructure investments.6 States with integrated information and performance management systems, such as Utah and Virginia, earned infrastructure management grades as high as A−. States with no such systems, like Massachusetts, earned grades as low as D+, and more than half of the states earned a B−. Panel D of Table 1 shows the distribution of those grades.

The third matching criterion was the auctioned bond’s offering method. Some states require all general obligation bonds to be issued through competitive auctions among underwriters. Bonds sold through competitive sale are not necessarily priced differently in the secondary market, but

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6 In addition to information, the grading system is also based on people, money, and infrastructure.
competitive sale itself is a proxy for the quality, professionalism, and transparency of the state’s debt management practices.

With those matching criteria established, each auction of a bond from a state that uses the modified approach was then matched with an auction of a bond from a state that does not use the modified approach. Each matched pair had similar state infrastructure management grades, the same offering method, and nearly the same total bond issue offering size. These matched auctions were different only in their use of the modified approach, and in other characteristics that we believe are randomly distributed and that we control for later in our multivariate analysis.

| TABLE 1 | Descriptive Statistics | n = 26,793 |
|---------|------------------------|------------|

**Panel A: Dependent Variables**

|                      | Mean  | Std. Dev. | Minimum | Maximum |
|----------------------|-------|-----------|---------|---------|
| Bid Spread           | 3.834 | 6.684     | 0.003   | 25.37   |
| Bid Spread–IQ Range  | 0.644 | 2.121     | 0.002   | 19.24   |

**Panel B: Explanatory Variables**

|                                | Mean  | Std. Dev. | Minimum | Maximum |
|--------------------------------|-------|-----------|---------|---------|
| Modified Approach              | 0.6   | NA        | 0       | 1       |
| Maturity                       | 11.02 | 6.947     | 1.01    | 30      |
| Maturity Par Value ($ millions)| $15.32| $641.02   | $0.06   | $1,280.02|
| Taxable                        | 0.098 | NA        | 0       | 1       |
| Insured                        | 0.145 | NA        | 0       | 1       |
| Rating                         | 4.816 | 1.58      | 1       | 7       |
| Callable                       | 0.84  | NA        | 0       | 1       |
| Auction Par Value ($ thousands)| $157.30| $547.38   | $1.00   | $3,375.00|
| Auction Number of Bids         | 9.24  | 5.583     | 3       | 104     |
| Original Issue Discount Bond   | 0.224 | NA        | 0       | 1       |

**Panel C: Matching Variables**

|                                      | Mean  | Std. Dev. | Minimum | Maximum |
|--------------------------------------|-------|-----------|---------|---------|
| Total Issue Offering ($ millions)    | $968.30| $1,421.00| $0.55   | $10,000.20|
| Competitive Offering                 | 0.536 | NA        | 0       | 1       |

**Panel D: Infrastructure Management Grades**

| Grade | Percentage |
|-------|------------|
| A     | 0.74%      |
| A−    | 0.69%      |
| B+    | 12.60%     |
| B     | 6.06%      |
| B−    | 50.30%     |
| C+    | 10.60%     |
| C     | 11.79%     |
| C−    | 0.58%      |
| D+    | 6.64%      |
The final matched sample contained 10,731 auctions of bonds from states that use the modified approach, and 10,731 auctions of bonds from states that do not use the modified approach. The original sample of 26,793 auctions contained 5,331 auctions of bonds from non-modified approach states for which there was no available auction from a modified approach for matching. We compare regression estimates based on this matched sample of auctions to the estimates from our overall sample of auctions. Panel C of Table 1 reports the descriptive statistics for these matching variables.

**Empirical Model**

As described above, the dependent variables in the empirical model are the total bid spread on individual auctions and the inter-quartile range of bids on those same auctions. Panel A of Table 1 presents the descriptive statistics for the dependent variables. Spreads are expressed as a percentage of par value. To illustrate, consider that the mean bid spread is 3.834 percent. We would observe that spread if, for instance, an auction received bids at prices ranging from 101 percent of par to 104.834 percent of par. These spreads are generally consistent with the overall population of auctions and auction bids.

The key independent variable is whether a state government’s annual financial report indicated that it used the modified approach at the time of the auction. To our knowledge, no state government switched to or from the modified approach during the time period of this analysis. The model also includes several control variables known to influence pricing of municipal bonds or costs in the municipal secondary market (see, for example, Green et al. 2010; Green et al. 2007b; Harris and Piwowar 2006). Bonds with longer maturities have more interest rate risk and reinvestment risk, so we expect greater pricing uncertainty (i.e., higher bid spreads). To correct for this we control for the bond’s years to maturity at the time of the auction. Bonds with call features present a similar uncertainty about interest rate risk and reinvestment risk, so we control for whether the bond is callable. Bonds sold with original issue discount also present pricing uncertainty, especially as they near maturity. To address this we also control for whether the bond had an original discount, and we expect that that discount will correlate positively with bid spreads. Bonds whose interest payments are subject to federal income taxes will have naturally higher yields and, in turn, greater potential bid spreads.

We also control for the bond’s credit risk. We expect that bonds with greater credit risk are more difficult to price and, in turn, will have higher bid spreads. Following previous work on the relationship between state credit ratings and bond pricing (Johnson and Kriz 2005), we control for this by including in the model a seven-point ordinal scale variable that identifies the higher of Moody’s Investor Service or Standard & Poor’s rating on the bonds. Bonds rated AAA received a score of 7 and bonds rated A– received a score of 1, with all ratings at one-notch intervals in between. The model also includes whether the auctioned bond carried third-party default insurance. Insurance would mitigate credit risk and, as such, reduce the bid spread.

The model also includes two characteristics of the bond auction. First is the par value of the bonds auctioned. Consistent with Downing and Zhang (2004) and other work on volume and price volatility for municipal bonds, we expect that larger auctions are more likely to attract attention from more sophisticated and better-informed investors. That will likely reduce the bid spread. By contrast, we expect the number of bids received will naturally increase the spread as more bids are likely to arrive at greater spreads. Descriptive statistics on the explanatory variables are reported in Panel B of Table 1. These characteristics are consistent with the overall population of bonds offered for sale on these electronic trading platforms; but note that par value is slightly larger given that states’ general obligation bonds tend to be some of the largest bonds in the market.
We estimate this model using ordinary least squares regression. The model includes the natural log of the bid spread and the natural log of the inter-quartile range of bids as dependent variables. We employ the natural log because these distributions were noticeably right-skewed. For the same reason the model includes the natural log of maturity par value, auction par value, and the number of bids received. The model also includes fixed effects (i.e., individual dummy variables) for each state. These fixed effects are designed to correct for any state-specific factors not directly related to the bond’s or the auction’s observable characteristics. The model also includes fixed effects for each month during the sample period. These effects are intended to correct for any idiosyncratic market movements that might have affected bid spreads. Finally, since the sample contains multiple auctions of bonds from the same state, we report robust standard errors clustered by state.

RESULTS

The regression model estimates are reported in Table 2. The results show that the modified approach has a statistically significant and negative relationship with bid spreads. The estimates suggest that bid spreads on auctions of bonds from states that use the modified approach are around 24 percent lower than spreads on bonds from states that do not use the modified approach. In other words, the coefficient of $-0.24$ indicates the modified approach reduces the bid spread by 0.24 natural logs. Here we interpret the natural log as a “percent of a percent.” That is, the bid spread is a percent of the price of the bond, and the natural log is a percent of that spread.

This difference is both statistically significant and economically meaningful. Consider the previous example and imagine an auction with a low bid of 101 percent and a high bid of 104.834 percent. Also imagine this auction is for $1 million of bonds. Under this typical scenario the lowest bidding investor was willing to pay $1,010,000 for those bonds and the highest bidding investor was willing to pay $1,048,340, a difference of more than $38,000. If we reduce that spread by 24 percent and distribute it evenly across the high and low bids, then the difference in potential price is $9,120. If we aggregate this average difference across roughly 6,000 auctions each day in the market, then the modified approach reduces the total market-wide pricing discrepancy by more than $54 million each day.

This finding is robust, as we see similar estimates across both dependent variables and across both the full sample and the matched sample. The control variables are also in their expected directions, and the $R^2$ are between 0.2 and 0.22.

CONCLUSION

This study evaluates whether infrastructure-reporting choice impacts investors’ secondary market pricing decisions, indicating a variation in uncertainty about a government’s financial condition depending upon how infrastructure is reported. Overall findings indicate that bid spreads on auctions of bonds from states that use the modified approach are around 24 percent lower than spreads on bonds from states that do not use the modified approach. The findings are economically meaningful and contribute to both the literature about Statement No. 34 and to the fixed income literature addressing the relationship between information asymmetry and municipal bond pricing. The findings also provide important practical information to governments evaluating the potential effects of using the modified approach, to regulators in evaluating the success of Statement No. 34 on improving bond market efficiency, and to investors for understanding how the modified approach reduces market uncertainty.
To mitigate the effect of selection bias on the estimates of the relationship between the modified approach and secondary market bid spreads, the study used propensity scores based on “nearest neighbor” matching to match bonds from modified approach states with similar bonds from similar states not using the modified approach. The states were matched on characteristics that captured both the bond issue and the government’s level of professionalism. This is the first study that evaluates investor reaction to the modified approach, and it is an important contribution to the body of literature on the GASB’s Statement No. 34 because the infrastructure reporting provision was extremely controversial and few studies have empirically examined the effects of this provision more than a decade after its implementation. Findings indicate that the modified approach method has unique information content about governments’ financial condition.

|                       | Full Bid Spread | Inter-Quartile Range | Full Bid Spread | Inter-Quartile Range |
|-----------------------|-----------------|----------------------|-----------------|----------------------|
| Modified Approach     | -0.24**         | -0.311**             | -0.243**        | -0.295**             |
|                       | (0.061)         | (0.087)              | (0.059)         | (0.088)              |
| Maturity              | 0.035**         | 0.045**              | 0.033**         | 0.042**              |
|                       | (0.006)         | (0.008)              | (0.007)         | (0.006)              |
| Maturity Par Value (ln)| 0.035**        | 0.045**              | 0.033**         | 0.042**              |
|                       | (0.008)         | (0.006)              | (0.006)         | (0.005)              |
| Taxable               | 0.236*          | 0.297*               | 0.315*          | 0.376*               |
|                       | (0.136)         | (0.151)              | (0.139)         | (0.162)              |
| Insured               | -0.094          | -0.097               | -0.056*         | -0.043**             |
|                       | (0.091)         | (0.099)              | (0.034)         | (0.026)              |
| Rating                | -0.012*         | -0.034*              | -0.024*         | -0.047*              |
|                       | (0.056)         | (0.017)              | (0.062)         | (0.019)              |
| Callable              | 0.02**          | 0.057**              | 0.045**         | 0.097                |
|                       | (0.048)         | (0.057)              | (0.032)         | (0.072)              |
| Original Issue Discount Bond | 0.121**     | 0.115**              | 0.157**         | 0.121**              |
|                       | (0.032)         | (0.039)              | (0.047)         | (0.045)              |
| Auction Par Value (ln)| -0.134**        | -0.122**             | -0.135**        | -0.123**             |
|                       | (0.013)         | (0.014)              | (0.013)         | (0.014)              |
| Auction Number of Bids (ln) | 0.48**        | 0.474**              | 0.479**         | 0.475**              |
|                       | (0.024)         | (0.023)              | (0.024)         | (0.023)              |
| Intercept             | 1.85**          | 1.108*               | 1.714**         | 1.09**               |
|                       | (0.522)         | (0.541)              | (0.497)         | (0.546)              |

*  ** Indicate p < 0.05, p < 0.01, respectively. Standard errors reported in parentheses are robust standard errors clustered by state. Model includes fixed effects on state and auction month; estimates not reported here.
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