Mark-to-Market (or Wealth) Taxation in the U.S.: Evidence from Options

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July 14, 2021

PRELIMINARY AND INCOMPLETE – DO NOT CIRCULATE

Keywords: Investor Taxes, Mark-to-Market Taxation, Wealth Taxes, Estate Taxes, Index Options, Asset Pricing, Section 1256 Contracts

JEL codes: H24, G12, G23

Data Availability: Data used in this study are available from public sources identified in the paper.

We appreciate helpful comments from Ben Ayers, Kirsten Cook, Nathan Goldman, Russ Hamilton, Brad Hepfer, Trent Krupa, Stephen Lusch, Kevin Markle, Thaddeus Neururer, George Plesko, John Robinson, Alessio Saretto, Brady Williams, the Texas Tech University Tax Readings Group, and workshop participants at the 2018 National Tax Association Annual Conference and the 2019 ATA Midyear Meeting. We also gratefully acknowledge the support of our respective institutions.

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Abstract

Recent U.S. tax proposals under various names (e.g., wealth taxes, estate tax reform, etc.) center on mark-to-market (MTM) taxation, which eliminates investors' ability to defer or avoid capital gains taxes. To provide insight on potential effects of these tax proposals, we exploit a unique U.S. setting where "index" options on the S&P 500 Index (SPX) face MTM taxation whereas nearly identical "non-index" options on the exchange traded fund (ETF) tracking the S&P 500 Index (SPY) do not. We find new evidence of asset price consequences to MTM taxation, suggesting that MTM taxation depresses asset prices as investors appear to avoid assets subject to MTM near year-end. Additional analysis suggests this result is driven by tax, rather than administrative, costs of MTM. From a policy perspective, this suggests that 1) MTM taxation has negative, unintended market consequences in the U.S. and 2) U.S. investors will engage in actions to avoid MTM rules. Both attributes caution policymakers in any attempts to broaden MTM taxation.

I. INTRODUCTION

The U.S. generally imposes a tax on capital gains upon the *realization* of gains – for example, upon the sale of assets (e.g., *Eisner v. Macomber* 252 U.S. 189 [1920]). This provides investors with a "timing option" in which they can defer – or in some cases, completely eliminate – capital gains taxation by delaying the sale of an asset (e.g., Constantinides and Scholes 1980; Constantinides 1983, 1984). Because assets subject to capital gains taxes are primarily held by wealthy taxpayers (e.g., Piketty and Zucman 2014), recent U.S. legislative proposals aimed at both raising revenue and reducing inequality focus on eliminating investors' timing option and instead imposing an annual mark-to-market (MTM) tax on assets.[1] While much speculation surrounds the effects of these proposals (e.g., Wolff 2019; Stowe 2020), to our knowledge, no U.S-based empirical evidence exists regarding the effects of MTM taxation. Our study fills this gap by providing initial empirical evidence on U.S. MTM, which is especially important as policymakers currently consider expanding the U.S. MTM rules.

Under annual MTM taxation, a taxpayer's assets are treated as if they are sold at their fair market value on the last day of the year, with a taxable gain or loss recognized at that time (e.g., Wyden 2019). While annual MTM taxation may focus on investment assets (i.e., assets most commonly subject to capital gains taxes), some recent proposals related to wealth taxes or gift and estate tax reform would require periodic MTM on a broader set of assets (e.g., Irwin 2019; Curry 2021; Ordower 2021; Sapirie 2021). That is, MTM can apply to all property, including personal (e.g., homes, cars) and business assets, in addition to investment assets. Therefore, proposed MTM taxation has broad implications for most U.S. taxpayers.

A common misconception holds that the "United States has never levied an annual

[1] MTM is one of several possible ways to eliminate investors' ability to benefit from the deferral of capital gains taxation. See Auerbach (1988) and Gravelle (2020) for alternative approaches.

wealth tax" (Scheuer and Slemrod 2021, p. 208). However, the U.S. currently imposes a very narrow annual wealth tax, implemented through a MTM regime, but only on certain assets or investors. Broadly, *certain types of investors* are required to use, or are allowed to elect, MTM taxation on most or all of their financial assets under Internal Revenue Code (IRC) Section 475. Separately, under IRC Section 1256, *certain assets* generally face annual MTM taxation. These attributes of the U.S. tax system allow us to provide new insight on MTM taxation.

We investigate MTM in the U.S. by exploiting a unique setting where certain types of assets face annual MTM, but similar assets do not. Specifically, we analyze "index" options on the S&P 500 Index (SPX) and "non-index" options on the exchange traded fund (ETF) tracking the S&P 500 Index (SPY). While non-index (SPY) options face taxation under the general rules for taxing capital assets (e.g., gain deferral until realization, preferential tax rates if held long-term), index (SPX) options face a different set of rules, despite being tied to the same underlying basket of securities. Specifically, SPX options are considered "Section 1256 contracts," which face an MTM requirement. That is, for tax purposes, Section 1256 contracts are treated as if they are sold at the end of the tax year. This accelerates the recognition of gain or loss on these investments, in contrast to the deferral of capital gains or losses typically granted to investment assets.[2] Comparing index (or 1256) options on SPX and non-index options on SPY provides an ideal setting to examine how taxes – specifically MTM – affects asset pricing because we hold the underlying basket of securities (and associated risks and macroeconomic effects) constant, allowing us to clearly identify differences in prices due to MTM.

However, it is an empirical question as to the extent to which MTM taxation affects asset

[2] Section 1256 contracts can also receive favorable tax treatment: 60% of any gain is subject to preferential long-term capital gains tax rates while the remaining 40% is subject to short-term capital gains (i.e., ordinary) tax rates, regardless of the actual holding period of the contract. Mason and Utke (2021) analyze this feature, which our analyses control for, allowing us to focus on the MTM feature.

prices. If MTM is beneficial to investors, because of the possible acceleration of losses, then we expect to find higher asset prices for assets subject to MTM. In contrast, if MTM is viewed unfavorably due to either tax administrative costs or the acceleration of gains taxation, then we expect that asset prices for assets subject to MTM will be lower. Further, we focus on exploiting the difference in MTM between nearly identical assets that do or do not face MTM taxation. Because *certain types of investors* face MTM on all (or nearly all) assets, if these investors own a substantial share of the assets we study, no difference in taxation will exist.[4] We study differences in MTM taxation for certain assets rather than for certain investors because MTM assets are both observable and have a natural control group, whereas neither is true for investors.

To test the difference in prices between index and non-index options, we analyze option implied volatility from OptionMetrics following existing literature (e.g., Bakshi, Cao, and Chen 1997; Bollen and Whaley 2004). Implied volatility is derived directly from inputs to the option pricing model and reflects a standardized measure of option value, with option prices monotonically increasing in volatility (Black and Scholes 1973).[5] Conceptually, using option implied volatility to identify price effects in options studies is similar to existing bond research that often uses yields rather than prices (e.g., due to scaling issues). Therefore, we compare the implied volatility of index options on SPX, subject to MTM when held as of year-end, to other index options on SPX not subject to MTM (i.e., not held at year end) and to non-index options on the SPY ETF to determine the effects of MTM taxation on asset prices.

We find that SPX index options that require MTM have lower implied volatility as

[4] To our knowledge, except for Mason and Utke (2021), all empirical option pricing studies ignore taxes, seeming to assume that options traders are not tax-sensitive (Black and Scholes 1973; Scholes 1976). While this may provide another reason not to expect a tax effect, Mason and Utke (2021) empirically document tax effects in option pricing.
[5] We thank an experienced option market participant for highlighting the appropriateness of using implied volatility rather than price. There are several subtle differences between SPX and SPY options including the style of option (American versus European), the treatment of dividends, and the way positions are closed. We take careful steps to mitigate these differences and discuss them in more detail in Sections 2.2 and 4.

compared to non-MTM SPX index options and to non-index SPY options. These findings suggest an inherent tax cost – either directly through the acceleration of gains or indirectly through higher tax compliance costs – associated with MTM. This is consistent with anecdotal evidence suggesting that many traders try to close (i.e., dispose of) Section 1256 positions before year-end to avoid MTM requirements (e.g., Green, 2016). Thus, MTM proposals currently under consideration likely have negative unintended consequences. Further, estimates of possible revenue increases from implementing MTM proposals may be understated to the extent they fail to consider taxpayers' avoidance of MTM taxation (Oh and Zolt 2020).[6]

As an additional test, we use alternative non-price measures capturing investor's demand for options. As noted above, a reduction in investors' demand for an asset may partially drive the price decrease (e.g., Guenther and Willenborg, 1999; Ayers et al. 2008). We analyze whether investor demand for SPX MTM options, as measured by daily option trading volume and option open interest (e.g., Longstaff 1995; Dennis and Mayhew 2002; Bollen and Whaley 2004), is affected by the existence of MTM taxation. We find that MTM taxation is associated with reduced option volume, but not open interest, for SPX options subject to MTM. This evidence provides further support for MTM taxation negatively affecting asset demand, and therefore, the price of assets subject to MTM provisions.

To further corroborate our findings, we analyze options on two additional indices, the Dow Jones Industrial Average (Dow) and the Russell 2000 Index, and options on the ETFs they track, the SPDR Dow Jones Industrial Average ETF and the iShares Russell 2000 ETF. Importantly, options on the Dow and the Russell 2000 are considered Section 1256 contracts and

[6] The ease of tax avoidance in response to MTM depends on the attributes of the MTM tax system, such as exemptions, thresholds, and assets subject to MTM as well as the availability of third-party information reporting regarding asset values (e.g., Zoutman 2015). As we discuss later, avoidance is likely relatively easy in our setting.

therefore face MTM taxation. Consistent with our baseline analysis, we find lower implied volatility for index options on the Dow that are subject to MTM as compared to non-MTM index and non-index options. We also find that the Dow index options facing MTM have lower open interest. We find some very limited evidence that Dow (Russell 2000) index options subject to MTM have lower volume (volume and open interest), consistent with investors avoiding MTM options. However, we find no evidence of MTM taxation reducing option implied volatility for Russell 2000 index options. This could be due to a tax clientele effect in options if traders in options on the SPX and DJI are tax-sensitive whereas traders in options on the Russell 2000 Index are tax-insensitive, or similarly, if Russell 2000 investors are the investor type already facing MTM taxation. In sum, our evidence generally suggests MTM taxation presents additional costs in terms of either accelerated tax costs or additional administrative costs.

To tease out whether tax or administrative costs drive our MTM results, we exploit a tax rate change. As we discuss in more detail later, the American Taxpayer Relief Act of 2012 (ATRA) reduced the tax cost of avoiding MTM. Thus, if tax costs primarily drive the MTM effect, we should see more negative (less positive) effects of MTM before ATRA. ATRA did not change administrative costs, so we expect no difference if administrative costs drive the MTM results. Consistent with tax costs driving MTM effects, we generally find stronger negative (weaker positive) effects of MTM taxation for implied volatility prior to ATRA.

We acknowledge that our setting faces limitations. On one hand, the assets we analyze are near-perfect, relatively liquid substitutes with easily observable fair values. This implies that we could observe stronger effects in our setting than other settings due to the ease of substitution. On the other hand, pricing effects could be understated in our setting because investors incur few costs to avoid MTM – in cases where MTM is more costly to investors, prices could be more negatively affected. Second, and relatedly, any distortions in our liquid/easy-substitution/easy-valuation setting are likely to relatively small. In contrast, in settings where investors must choose between liquid and illiquid assets to avoid MTM (and where illiquid assets may require costly valuations), distortions and price effects are likely to be larger to compensate for those costs. Third, for certain investors (discussed previously and in Section 2), most assets are subject to MTM so that both index and non-index options generally face MTM, which will also reduce the effect that we can detect in our setting. Finally, we examine a setting where only a limited number of assets face MTM (i.e., index options) and our results may not apply to a more comprehensive MTM regime. That said, we view it as difficult to impose an MTM regime that covers *all* assets (e.g., including foreign assets), so that leakage from any MTM system is likely.

Our paper makes a timely contribution to the literature by providing new insight on recent tax proposals regarding full or partial MTM taxation, including a wealth tax (Weisbach 1999; Hammer 2013; Toder and Viard 2016; Miller 2017; Fama 2019; Irwin 2019; Rubin 2019; Viard 2020; KPMG 2021). While prior work examines the implications of MTM taxation, those studies generally involve unique MTM taxes outside of the U.S., many of which no longer exist (e.g., Jakobsen, Jakobsen, Kleven, and Zucman 2020). Further, to our knowledge, prior studies focus on behavioral changes and misreporting, but do not focus on how MTM taxes affect asset prices. Our evidence suggests the MTM taxation of assets is costly to investors and will depress asset prices. Our evidence also suggests that investors will avoid MTM taxation, both reducing the amount of revenue that an MTM regime can raise and resulting in distorted capital allocation. Thus, policymakers should consider these issues before proceeding with MTM taxation.

II. INSTITUTIONAL SETTING AND HYPOTHESIS DEVELOPMENT

2.1 General Attributes of Mark-to-Market (MTM) Taxation Systems

A number of recent proposals call for MTM taxation for several reasons. First, MTM taxation presents one solution to the concentration of wealth (i.e., income inequality) problem. Intuitively, taxing wealth reduces the amount of wealth held by a taxpayer and allows for redistribution. Second, the current U.S. tax system taxes capital gains only upon realization. Further, the basis of all assets held by a taxpayer at death are able to adjusted to the current fair market value of the asset (often referred to as a basis step-up), so that the assets can be sold immediately without any capital gains taxes. This minimizes the effectiveness of capital gains taxes (and increases to the capital gains tax rate) in taxing wealth because taxpayers may simply delay realization to death to avoid tax (Gravelle 2020). Third, and relatedly, MTM can be an additional revenue raiser to fund legislative priorities. In this section we discuss general attributes that policymakers must consider (and that are being considered) in MTM systems, rather than limiting our discussion to any specific proposal.[7] Broadly, there are three main attributes of MTM that policymakers must decide on: 1) which assets are covered; 2) which taxpayers are covered; and 3) at what point(s) in time must MTM occur. Edwards (2019) and Scheuer and Slemrod (2021) summarize some of these attributes across European wealth taxes.

Regarding the assets covered by MTM, policymakers have numerous options. On one hand, and most directly, financial assets can face MTM taxation. These assets are generally easy to value and may be subject to third-party reporting by financial institutions, which reduces the administrative burden on both taxpayers and the government. However, even financial assets, such as pensions and life insurance, can be difficult to value. Several European wealth taxes exclude these assets due to valuation difficulties (Scheuer and Slemrod 2021). The disadvantage

[7] Wolff (2019), Herzfeld (2021), Willis and Chipi (2021), and Scheuer and Slemrod (2021), among many others, discuss specific attributes of a variety of MTM proposals.

of this approach is that it can encourage taxpayers to shift wealth to exempt assets (cf. Bach, Bozio, Guillouzouic, and Malgouyres 2020; Bjørneby, Markussen, and Røed 2020). On the other hand, all assets – financial, personal, and business – can be subject to MTM. While, on its face, this solves the wealth-shifting issue (in theory, at least; taxpayers could still engage in attempts to hide wealth offshore), it creates new issues. Specifically, illiquid assets are difficult to value, imposing administrative burdens on taxpayers and governments. Further, taxpayers may use flexibility in these difficult valuations to minimize wealth. Finally, MTM can cover a range of assets broader than financial assets but narrower than all assets.

Regarding the taxpayers covered by MTM, exemption thresholds or liability caps may exist in MTM systems. Under the argument that MTM taxation reduces issues of inequality, MTM taxes can be imposed only on "wealthy" taxpayers (we do not discuss specific threshold levels defining "wealthy"). A potential problem with this approach is that taxpayers can plan (through real actions or artificial evasion) to reduce their wealth to fall below the exemption threshold. A separate issue with an MTM tax, which affects who faces the tax, is taxpayer liquidity (EY 2021). The general realization principle relies, in part, on the fact that realization provides taxpayers the wherewithal to pay the tax. Cash generated upon asset sale enables taxpayers to pay taxes. Under an MTM system, there is no realization, leaving taxpayers no way to pay the tax. This may force taxpayers to sell assets, which can result in capital misallocation – especially if the bulk of the taxpayers' wealth is tied up in a business. To reduce liquidity concerns, one solution is to impose a cap on the MTM tax liability. The disadvantage of this approach is that it effectively exempts the wealthiest taxpayers from a tax intended for them.

The final consideration relates to the point(s) in time when an MTM tax applies. A logical date is annually at the end of the year, December 31, but the government can set any date for applying the MTM. Setting any specific date could lead to “window dressing” around that date (e.g., Sikes 2014) to artificially depress asset prices. The government may also wish to impose MTM taxation at the point that certain non-sale events, such as gifts, occur. Again, taxpayers may have flexibility in planning these events to their advantage. For difficult to value assets or illiquid assets, one option in an MTM system involves a form of retrospective taxation (e.g., Auerbach 1988; Wyden 2019), where the tax is applied at realization but an additional charge (e.g., interest) is applied to the value of the tax deferral. That is, MTM does not occur per se, but upon asset sale the tax liability is increased to account for the taxes saved by not implementing an annual MTM.

In the options setting we study, MTM occurs annually on December 31. Section 1256 assets – SPX (index) options in our setting – face MTM at this point in time. We also note that, as discussed later, certain investors face MTM on most or all financial assets, including assets not covered by Section 1256. There are no exemption thresholds or liability caps in the current U.S. MTM system. As discussed earlier, the existence of SPY (non-index) options as a near-perfect substitute may reduce or increase the pricing effects we observe in our setting. Therefore, our setting does not address all attributes in MTM proposals, but allows us to study the effect of the U.S. MTM regime on the asset prices of relatively liquid, easily valued assets traded in capital markets (i.e., in markets generally dominated by wealthy taxpayers).

2.2 Section 1256 Contracts

The Economic Recovery Tax Act of 1981 included the adoption of Section 1256 of the IRC. Section 1256 governs certain futures, options, and currency contracts and was originally established, in conjunction with several related rules implemented in the Economic Recovery Tax Act of 1981, to mitigate taxpayer abuse through the use of financial instruments such as those covered by Section 1256 (Kaufmann 2016). Specific to our setting, Section 1256 applies to "any nonequity option," which includes options on "broad-based" stock indices. One example of a broad-based stock index is the S&P 500 Index. Under Section 1256, options on broad-based indices are eligible to receive favorable tax treatment where 60% of any gain from the sale of the option is treated as a long-term capital gain taxed at preferential tax rates (IRC §1256(a)(3)). The remaining 40% of the gain is taxed as a short-term capital gain at less favorable rates.[8] This tax treatment is available regardless of an investors' actual holding period. Because most options contracts are short term contracts, non-index options that do not benefit from Section 1256 face the less favorable short-term capital gains tax rate on 100% of the gain.

Most importantly for our study, Section 1256 contracts (i.e., index options) are subject to an (MTM) requirement where, for tax purposes, the assets are treated as if they are sold at the end of the tax year (IRC §1256(a)(1)). This MTM creates a taxable event (at the Section 1256 rates) for investors with open index option positions at the end of the year. This contrasts with the general treatment of capital assets, where taxation is deferred until the asset is sold.[9] Anecdotal evidence suggests that many traders try to close open positions on Section 1256 contracts before the end of the year to avoid MTM requirements (e.g., Green 2016).

Unlike index options, non-index options, such as options on ETFs or on other equity securities, are not considered Section 1256 contracts and thus do not receive favorable capital gains tax treatment or face an MTM (e.g., Green 2016). That is, even though the SPY ETF tracks the S&P 500 Index, the ETF itself is a security, and options on a single security are generally not

[8] While Section 1256 capital losses also receive the same 60/40 split, all capital losses for non-corporate taxpayers are deductible against ordinary income up to $3,000, regardless of the asset type. Note, however, that Section 1256 losses have the unique feature of being permitted a three-year carryback period to offset prior Section 1256 gains (Green 2016).

[9] Corporations that invest in the options market face no differential tax *rate* – corporations are not eligible for preferential long-term capital gains rates – but may still benefit from deferral for non-MTM options. Note that corporations may also have year-ends other than December 31, so that they face MTM on a different date.

eligible for Section 1256 treatment.[10] This unique setting allows a comparison of index options facing MTM under Section 1256 to non-index options tracking the same underlying basket of securities, but without MTM treatment, allowing us to identify the effect of MTM on asset prices. Mason and Utke (2021) evaluate the effects of preferential Section 1256 tax rates on option pricing (which we control for in our analyses) but do not consider the effect of MTM taxation, which is the focus of our study.

There are several other important tax details related to options trading relevant for our study. First, the taxation of options can vary by the activity an investor engages in, as well as with the tax elections an investor makes (e.g., Harmon and Kulsrud 2010; Soled et al. 2014; Freedman 2015). Broadly, the tax code classifies taxpayer-investors as either "dealers," "traders," or "regular investors." While Section 1256 applies to each of these subsets, dealers and traders can be subject to additional requirements or eligible to make additional elections that alter the tax treatment of options.[11] Importantly, certain dealers ("securities" dealers, as defined by the tax law) must use MTM for most or all assets under Section 475, which also requires that these gains be treated as ordinary rather than capital. Certain other dealers, as well as traders, can elect into MTM accounting for many assets. An advantage of this treatment is that losses are treated as ordinary and not subject to capital loss limitations.[12]

There are several other important technical differences relevant to the options in our

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[10] There is some debate as to whether options on the SPY ETF qualify as Section 1256 options (see, e.g., CXO Advisory Group, 2010). To our knowledge, the general consensus is that they do not (e.g., Freedman 2015).
[11] For example, certain Section 1256 contracts specifically designated as hedges are not subject to the MTM rules. Overall, Sections 1256, 475 (an election/requirement – depending on the taxpayer's activity – to apply MTM to all positions and have gains and losses taxed at ordinary rates), 1092 (straddles – special tax rules when holding offsetting positions, which may also lead to MTM), and to a lesser extent 1236 (applying ordinary tax rates to certain transactions, although 475 generally takes precedence and covers most of these transactions) interact in extremely complex ways. However, we highlight that all subsets of investors may be subject to Section 1256 under various circumstances. We especially thank the National Tax Office of a Big 4 firm for explaining these issues.
[12] Interestingly, for traders, the ordinary gain election generally is not available for Section 1256 assets, so that 1256 assets receive MTM but not ordinary treatment. Of course, there are exceptions to this rule (Freedman 2015).

setting. First, European options (index options in our setting) cannot be exercised early, whereas American options (non-index options) can be exercised early. This difference can affect option prices, especially for American *put* options (Dueker and Miller 2003). Second, the index options' underlying assets do not pay dividends, whereas the ETFs underlying the non-index options pay dividends (e.g., quarterly dividends for the SPY ETF). Option pricing models include assumptions about dividends and therefore dividends warrant consideration. Because the previously discussed differences can affect prices of the index and non-index options we study, we carefully account for each item in our empirical analyses and discuss the steps we take to address these potential issues in Section 4.

2.3 Hypothesis Development

Despite some intuitive appeal, MTM taxation faces numerous adoption and implementation challenges. First, the tax must be politically feasible. Recent evidence in Bowman (2020) and Fisman, Gladstone, Kuziemko, and Naidu (2020) suggests that survey respondents favorably view a wealth tax suggesting political feasibility in the U.S. However, Fisman et al.'s (2020) survey respondents ignore the second challenge of MTM taxes: increased tax avoidance through taxpayers modifying their tax base. For example, studies outside the U.S. find evidence of behavioral (but not asset price) responses by taxpayers subject to MTM such that they reduce their assets subject to MTM (Seim 2017; Brülhart, Gruber, Krapf, and Schmidheiny 2019; Jakobsen et al. 2020; Pomerleau 2020).[13] Third, MTM tax is based on the market value of assets, which for some assets (e.g., marketable securities) is easily determinable, yet for other assets, such as homes and businesses, is much more difficult. Hard-to-value asses

[13] In contrast, Ring (2020) finds that taxpayers subject to a wealth tax increase labor income to offset the increase in taxes. Berzins, Bøhren, and Stacescu (2019) find that wealth taxes cause shareholders to force higher dividends out of corporations, which negatively affects firm performance.

may facilitate evasion and MTM may encourage resource misallocation by distorting incentives to own easy- versus hard-to-value assets (cf. Cai, He, Jiang, and Xiong 2020). Further, for hard-to-value assets, obtaining required valuations could be costly and burdensome to taxpayers (e.g., Wilford 2021). On the flip side, the tax authority also faces challenges valuing these assets, requiring litigation where they disagree with the taxpayers' valuations (e.g., Willis and Chipi 2021). Fourth, legal scholars are engaged in a debate as to whether certain types of MTM taxes – specifically wealth taxes – are constitutional, a discussion beyond the scope of our study.

Scheuer and Slemrod (2021) review the effects of several MTM taxes, which can vary substantially in their design. Broadly, taxpayers take steps to reduce their wealth in response to an MTM wealth tax. Evidence suggests that this occurs through misreporting and evasion, primarily related to non-financial assets (e.g., Londoño-Vélez and Ávila-Machecha 2020). However, to our knowledge, there are no studies on how wealth taxes affect asset pricing.

Given the evidence of behavioral responses to wealth taxes, we may observe asset pricing responses as well. That is, because the U.S. MTM system is, to some extent, optional in that MTM applies only to (non-dealer, non-electing) taxpayers owning index rather than non-index options, asset prices could be depressed if taxpayers avoid MTM taxation by avoiding MTM assets. In our setting, these alternative, non-MTM options are near-perfect, relatively liquid substitutes. This implies that we could observe stronger effects in our setting than other settings due to the ease of substitution.

On the other hand, pricing effects could be understated or non-existent in our setting for several reasons. First, investors incur few non-tax costs to avoid MTM – in cases where MTM is more costly to investors, prices could be more negatively affected. Thus, no effect may exist in our low-cost setting. Second, and relatedly, any distortions in our setting are likely relatively small; in other settings where investors must choose between liquid and illiquid assets to avoid MTM (and where illiquid assets may require costly valuations), distortions and price effects are likely to be larger to reflect these costs, again reducing our ability to find any effect in our setting. That said, Mason and Utke (2021) show that taxable investors appear to prefer owning index options due to the favorable capital gains tax treatment afforded to these options, so even in our setting these investors may view the substitution to avoid MTM as costly. Third, for certain dealers and electing traders (as discussed in Section 2.2), most assets are subject to MTM so that both index and non-index options generally face MTM. Lakonishok, Lee, Pearson, and Poteshman (2007) show that most options market investors are dealers. This would reduce the effect that we can detect in our setting, because most assets would face MTM eliminating any pricing difference between assets. That said, Mason and Utke (2021) find that taxable investors have pricing effects in options markets.

Section 1256 requires a mark-to-market (MTM) for open option positions at the end of the taxpayers' tax year. This MTM gives rise to a realized gain or loss (40% treated as short-term capital gain taxed at ordinary rates and 60% treated as long-term capital gain taxed at preferential rates) that is recognized in taxpayers' taxable income as if the option contract was sold at year-end, in contrast to most investment assets where gain is deferred until the asset is actually sold. We expect that the demand, and the price, for index options that require MTM at year-end will increase if investors favorably view the acceleration of losses, which provides a tax benefit. In contrast, we expect the demand, and the price, for MTM options to be lower if investors prefer to defer long-term and short-term capital gains recognition, or if MTM adds administrative complexity because it differs from the usual treatment of investment assets. If option traders are indifferent to taxes, MTM should have no effect on prices. Based on these competing predictions, we state our hypothesis in the null:

> **H1**: MTM taxation has no effect on asset prices, as reflected by no difference in prices of similar options where one faces MTM and the other does not.

III. EMPIRICAL METHODOLOGY

To assess the effect of MTM taxation on option prices, we first identify options on a broad-based index, focusing on S&P 500 Index (SPX) options, which are eligible for favorable tax treatment under Section 1256 as discussed earlier. We next identify non-index options, focusing on options on State Street Global Advisors' SPY ETF, which tracks the S&P 500 Index. These non-index options are similar to index options in terms of the underlying basket of securities – members of the S&P 500 Index – yet are not subject to MTM under Section 1256. This allows us to compare options with similar characteristics but different tax treatment.[16] We focus on options related to the S&P 500 because they are relatively widely traded (e.g., Roy 2017). In subsequent analysis, we analyze alternative Section 1256 contracts using options on other broad-based indices (i.e., Dow Jones Industrial Average; Russell 2000).

We estimate an OLS regression to compare the implied volatilities (*Impl_Vol*) of these index and non-index options to identify differences due to capital gains tax rates using the following model:

$$Impl\_Vol_{it} = \beta_1 Next\ Year\ Expiration_{it} * SPX_{it} + \beta_2 SPX_{it} + \beta_3 Next\ Year\ Expiration_{it} + \delta_t + \varepsilon_{it} \quad (1)$$

where our dependent variable, *Impl_Vol*, is the implied volatility of each option from the Ivy DB database from OptionMetrics. Implied volatilities are the primary measure of option pricing (e.g., Stein 1989; Bakshi et al. 1997; Bollen and Whaley 2004; Gârleanu et al. 2009; Li, Nissim, and

[16] Overall, our design is conceptually similar to prior work (e.g., Jordan and Jordan 1991; Egan, 2019; Mason and Utke 2021) comparing across extremely similar securities that differ on one main dimension: taxation in our setting.

Penman 2014; see Bates 2003 for a review) and are commonly used in accounting and finance studies (e.g., Patell and Wolfson 1981; Fleming 1998; An, Ang, Bali, and Cakici 2014; Neururer, Papadakis, and Riedl 2016, 2020). Options can be thought of as a market for volatility (Stein 1989), thus volatility is the relevant pricing measure. Further, like returns, volatility provides a measure on a common basis, whereas stock or option prices alone can differ due to scaling with unscaled measures not being commonly used in asset pricing studies.

Our independent variables include *Next Year Expiration*, which takes the value of 1 if the option expires in the following year and 0 otherwise. *SPX* is an indicator variable taking the value of 1 (0) if the option is an index (non-index) option. The interaction term, *Next Year Expiration * SPX* identifies those SPX options that expire next year, representing options facing MTM taxation. δ represents either day-year or month-year time fixed effects, or is excluded. Time fixed effects are important for our study because the price of the underlying asset varies through time. To further account for time variation in the underlying S&P 500 Index, we include the S&P 500 daily return and price in most of our models. At the most restrictive level, we compare the pricing difference between SPX and SPY options on each day. We are most interested in this comparison, but we examine month-year time fixed effects or the exclusion of time fixed effects for robustness. We cluster standard errors by month-year to account for heteroskedasticity.[17] A negative (positive) β_1 is consistent with MTM reducing (increasing) option prices. An insignificant β_1 fails to reject the null. This methodology allows us to identify the capital gains tax effect on option implied volatility while considering macroeconomic factors that influence the S&P 500 and option values. Because the options cover the same underlying securities, we do not need to control for the performance of the S&P 500 Index yet we generally

[17] Our results are robust to using cluster-robust standard errors as discussed in Cameron and Miller (2015), which address potential issues that arise from clustering on the same dimension as the fixed effects.

do so for completeness. Mason and Utke (2021) find that the coefficient on β_2 should be positive to reflect the general tax rate preference afforded to index options under Section 1256.

Because our hypothesis implies that option price is influenced, in part, by investors' demand for options facing MTM taxation, we also analyze investors' option trading activity. We use two separate measures to capture option trading activity: option volume and option open interest (e.g., Longstaff 1995; Dennis and Mayhew 2002; Bollen and Whaley 2004). Each measure is computed using the non-standardized data from OptionMetrics with open interest (volume) on index and non-index options computed as the natural logarithm of total daily open (traded) call option contracts on the SPX and SPY, respectively.[18] Using daily option volume traded and open option interest, we separately estimate equation (1) exchanging option volume or open interest for implied volatility as the dependent variable. As in our baseline model, a negative (positive) β_1 would be consistent with MTM reducing (increasing) investors' demand for options subject to an MTM whereas an insignificant β_1 would suggest investors are indifferent towards an MTM. As we discuss later, however, these demand measures face limitations relative to our primary implied volatility measure.

IV. SAMPLE SELECTION AND DESCRIPTIVE STATISTICS

We obtain our sample from the Ivy DB database from OptionMetrics. We use the standardized pricing file to gather all options traded on SPY (non-index options) and SPX (index options). According to OptionMetrics, using the ticker of the underlying security to identify options on the SPY and SPX may be incorrect. Thus, we ensure correct identification of options on the SPY and SPX by restricting the sample to options where the security ID, SECID, is either

[18] The non-standardized data contains daily trade data for all options on index and non-index options allowing us to calculate total volume and open interest for SPX and SPY options. The standardized data does not include this data.

108105 for SPX options or 109820 for options on the SPY ETF. OptionMetrics's standardized file provides option prices and implied volatilities based on a 'standardized' or interpolated price and volatility for at-the-money forward options with a particular length of time until maturity. Because we are interested in comparing option volatility for similar index and non-index options, the standardized option data allows us to compare options with similar moneyness and strike price, which is difficult when analyzing non-standardized option data.[19]

We restrict our main S&P 500 sample to include only observations in 2005 or later because options on the SPY do not trade before this time (Chicago Board Options Exchange, n.d.). We end our sample in 2016 because that is the most recent available year at the time of our data collection. We also exclude option trades that occur 30 days before the ex-dividend date because the SPY ETF pays quarterly dividends and the SPX index does not, which, as previously discussed, can influence option prices according to the Black-Scholes model. As discussed in Section 2, another important distinction between options on the SPX and SPY is that SPX options are European options, which cannot be exercised early, whereas SPY options are American options, which can be exercised early.[21] Theoretically, the pricing model for European and American *call* options is identical under the data restrictions we impose (e.g., Roll 1977;

[19] OptionMetrics is commonly used in options research (e.g., Andersen et al. 2015; Bardgett, Gourier, and Leippold 2019), and we believe it is reliable for our setting. Constantinides, Jackwerth, and Perrakis (2009) examine the concern that index option mispricing may be due to low data quality in OptionMetrics and show this is not the case. van Binsbergen et al. (2012) use intraday and minute-level data from multiple data sources and find index option volatility and prices differ from OptionMetrics because, for example, options exchanges close later than the equity markets. However, the most current Ivy DB database manual states "OptionMetrics compiles the IvyDB data from raw 3:59 PM EST price information" showing no difference in market closing times. Regardless, van Binsbergen et al.'s (2012) criticism is not relevant to our study because we use daily data, rather than intraday or minute-by-minute data, and compare SPX options to SPY options, which both have the same option market closing times.

[21] Harvey and Whaley (1992) show that a constant dividend yield assumption, as used in Ivy DB to calculate implied volatilities, can lead to large pricing errors for American options due to the ability to exercise the option early. While this issue is only pertinent for SPY options, which have the early exercise potential, more recent work (Hait 2001) argues that the constant dividend yield assumption is valid for large, mature firms that pay consistent dividends, which is common for firms listed on the S&P 500. Hait (2001) also shows that any pricing errors due to this assumption are small.

Bodie, Kane, and Marcus 2011, 716). Because an early exercise premium exists between American and European options, especially for *put* options (Dueker and Miller, 2003), we include only call options and exclude all put options in our analyses.[22]

We further restrict our sample to include options on the SPX and SPY with a 60-day maturity that trade in either November or December.[23] This leaves us with 914 observations for both SPX options and SPY options. We then identify options that expire in the following year and those options that expire in the current year.[24] We have 239 observations each for both SPX and SPY options that trade and expire in the current year, and 675 observations each for SPX and SPY options that trade in November or December yet expire in the following year. For SPX (index) options, the observations crossing the year-end are subject to MTM. Table 1, Panel A provides detail of our sample by year and by expiration date for SPX and SPY options.

INSERT TABLE 1 HERE

In Table 1, Panel B, we compare the implied volatility for index options subject to MTM to index options not subject to MTM, as well as to non-index options that cross or do not cross the year end. Because the SPY ETF trades at approximately 1/10th the price of SPX, we cannot strictly compare option prices and thus rely on option implied volatilities, consistent with the option pricing literature. We find lower implied volatility for MTM SPX index options compared to SPX index options not subject to MTM (column 2), although the difference is statistically insignificant in this univariate analysis. This is also the case when we compare implied

[22] This exclusion is common in the existing option literature (e.g., Longstaff 1995). Harvey and Whaley (1992) show any early exercise premium on call options is minimal (estimated to be only 2 to 3 cents).
[23] We use 60 days to maturity to ensure we capture relatively liquid options (Goyal and Saretto 2009). We also analyze options with 30 days left to maturity and find similar results. We use options with 60 days to maturity or less to ensure sufficient sample size, noting that our narrow timeframe (around year-end) shrinks the sample size.
[24] We use December 31 as the cutoff for determining whether an option expires in the next year or the current year. It is possible that some option investors have an alternative tax year-end and thus would not be affected by a calendar year-end mark-to-market. To the extent this occurs frequently, we would not expect a significant difference between MTM SPX options, non-MTM SPX options, and similar non-index SPY options.

volatilities for non-index options with current versus next year expiration dates (column 4). Similarly, the univariate difference-in-difference (column 5, bottom) indicates that the MTM on SPX options results in lower implied volatilities, as compared to similar options on SPY, although this difference is not statistically significant. When comparing across SPX and SPY options (column 2 versus column 4, reported in column 5), regardless of expiration date, we find higher implied volatilities for the SPX options, consistent with Mason and Utke (2021), although these results are not statistically significant. While statistically insignificant, these implied volatility comparisons are simply a univariate comparison that ignores time variation in prices; as such we defer our main inferences to our multivariate analyses in Section 5.1.

V. RESULTS

5.1 Main Results

Table 2 presents results from estimating equation (1) for S&P 500 options using implied volatility as the dependent variable. We find that after accounting for time trends in option prices, index options requiring a MTM at year-end have lower implied volatility (i.e., lower prices) as compared to similar non-index options and those options not expiring in the following year (coefficient on *Next Year Expiration* * *SPX*). This price decrease offsets about 40% (0.002/0.005) of the baseline tax premium to Section 1256 options (as identified in Mason and Utke 2021). This suggests that investors have lower demand for options that require MTM. This could indicate that the acceleration of tax gains results in higher tax costs, and therefore lower prices, or could indicate additional administrative costs associated with the MTM tax rules. In additional analyses, we attempt to tease out which effect is at play. We also note that the positive main effect on index options (*SPX*) is consistent with Mason and Utke's (2021) finding of higher implied volatility for index options that face lower capital gains tax rates.

INSERT TABLE 2 HERE

5.2 Option Trading Activity Results

To corroborate our implied volatility results, that MTM reduces option prices, we next estimate the effect of MTM on investors' option trading activity. The price decrease observed in our baseline results may be driven by lower demand for MTM options. In that case, we expect that option traded volume and open interest will be lower for options subject to MTM as compared to non-MTM index and non-index options due to investors having a disincentive to hold MTM options. The results from the volume (open interest) analyses are presented in Table 3, Panels A (B).

Consistent with our baseline findings, we find evidence of lower daily traded volume for index options subject to MTM as compared to other index and non-index options not subject to MTM. However, the result is statistically insignificant, yet economically similar, when using day-year fixed effects. Further, we find no evidence that MTM is associated with a lower level of open interest for index options in Panel B.

INSERT TABLE 3 HERE

While the results using volume and open interest provide some evidence of MTM reducing investor demand, we caution the reader from drawing strong inferences from this analysis. Because investors' option positions captured in option open interest and traded volume can include both the opening and closing of an option position, these measures of investor demand are noisy proxies (Dennis and Mayhew 2002; Bollen and Whaley 2004). In addition, it is possible that prices change without a simultaneous change in volume (e.g., Bamber 1986). This situation may be more likely in relatively illiquid markets (versus equity markets) with highly sophisticated investors such as option markets.

VI. ADDITIONAL ANALYSES

6.1 Alternative Section 1256 Contracts

To ensure our results are not an artifact of the S&P 500 Index, we analyze options on two additional indices that are covered by Section 1256: the Dow Jones Industrial Average and Russell 2000 Index. The Dow Jones Industrial Average (Dow) (ticker symbol DJI) covers the 30 largest publicly traded firms in the U.S. whereas the Russell 2000 (ticker symbol RUT) is an index benchmarking small capitalization firms in the U.S. Results could differ for these options if, for example, option clienteles facing different taxation have differing demand for options on differing underlying assets (e.g., small- versus large-cap underlying assets; Dow and S&P better known to taxable individual investors). Important to our setting, the Dow and Russell 2000 both have active index option markets, which are covered under Section 1256 and face an MTM at year-end. Further, both indices have corresponding ETFs that track each index. The Dow has a corresponding ETF under the name SPDR Dow Jones Industrial Average ETF, often referred to as 'Diamonds' (ticker DIA). The Russell 2000 has a corresponding ETF under the name iShares Russell 2000 ETF (ticker IWM). Using options on DJI and RUT (index options) and options on DIA and IWM (non-index options) separately, we estimate equation (1) replacing SPX with DJI or RUT. As in our baseline analysis, we examine implied volatility, option volume, and option open interest. Results from these estimations are presented in Tables 4 and 5.

Table 4 presents results for options on the Dow Jones Industrial Average Index and the SPDR Dow Jones Industrial Average ETF with Panels A, B, and C presenting results for implied volatility, option volume, and option open interest, respectively. Consistent with our main results, Panel A reports that index options on the Dow subject to an MTM have lower implied volatility as compared to index options without an MTM and non-index options. This result is statistically significant at the 10% level using a one-sided t-test. The MTM offsets about 1/3rd (0.002/0.006) of the baseline tax premium that investors pay for the tax advantages of Section 1256, identified in Mason and Utke (2021). In Table 4, Panels B and C, we observe lower levels of traded option volume and option open interest for index options subject to an MTM. However, the result is only statistically significant when analyzing option open interest. These findings, together with our implied volatility results, suggest that investors of options on the Dow have lower demand for options subject to MTM taxation as compared to non-MTM options.

INSERT TABLE 4 HERE

Table 5 presents results for options on the Russell 2000 Index and the iShares Russell 2000 ETF with Panels A, B, and C presenting results for implied volatility, option volume, and option open interest. In Panel A, we observe evidence inconsistent with our baseline findings; Russell 2000 index options subject to an MTM do not have lower implied volatility. We acknowledge this is difficult to explain from a tax perspective. The most plausible explanation is that, around year-end, sophisticated investors – that likely are required to apply MTM to all assets, so that MTM has no differential effect on taxation – use Russell 2000 options to exploit "turn-of-the-year" effects in small cap stocks (see, e.g., Ng and Wang 2004). These institutions may prefer index (section 1256) options because index option holdings do not have to be reported to the SEC on Form 13F, allowing institutions to conceal their trading.[25] Further examination of this possibility, though worthwhile, is beyond the scope of our study.

[25] Other options positions are reported on Form 13F and options holdings data is available from WhaleWisdom (Aragon, Martin, and Shi 2019). For the list of positions required to be reported on Form 13F, see http://www.sec.gov/divisions/investment/13flists.htm.

INSERT TABLE 5 HERE

Table 5, Panels B and C present results for traded option volume and option open interest. Consistent with the results for the S&P 500 and the Dow, suggesting investors have lower demand for options subject to MTM, we observe a negative, but at best marginally significant (one-tailed), coefficient on the MTM interaction term. Collectively, our results from analyzing options related to the Russell 2000 Index indicate some evidence of MTM affecting the demand for and price of options subject to MTM (see Cready et al. 2020 for discussion on the interpretation of statistically insignificant results). The somewhat mixed results across indices are consistent with clientele effects, with investors with different tax sensitivities or tax characteristics focusing their option trading on different indices.

6.2 Analysis Surrounding the American Taxpayer Relief Act of 2012

The results of our analysis show MTM taxation reflects a cost under Section 1256, leading MTM options to have a lower price and lower investor demand. This contrasts with the baseline tax advantage, and price premium, for Section 1256 arising from favorable tax treatment where 60% (40%) of any gain from the sale of the option is treated as a long-term (short-term) capital gain taxed at preferential (ordinary) tax rates (Mason and Utke 2021). It is not clear, however, whether the cost of MTM arises from tax costs of accelerating gains or from administrative costs of accounting for the relatively unusual MTM treatment (e.g., updating and tracking post-MTM basis).

In order to tease out whether tax costs or administrative costs drive the MTM effects we observe, we use the passage of The American Taxpayer Relief Act of 2012 (ATRA), which changed tax rates but not administrative costs. ATRA was signed into law by President Obama on January 2, 2013 and increased the tax rate on both long-term capital gains and dividends from

15 to 20 percent for individuals in the top tax bracket. ATRA also introduced the Net Investment Income tax, which was a 3.8% on all investment income such as capital gains. Further, ATRA increased the top ordinary tax rate from 35% to 39.6%. Therefore, from the start of our sample period (i.e., 2005) to the passage of ATRA, the maximum tax rate for Section 1256 contracts' MTM was 23% (15% * 60% + 35% * 40%). In contrast, the short-term rate that would be applicable to most options was 35%. As such, avoiding MTM by owning non-index options effectively cost individuals (including non-corporate dealers) 12%. Following the passage of ATRA, the maximum tax rate for Section 1256 contracts' MTM was 31.64% (23.8% * 60% + 43.4% * 40%), which includes the 3.8% Net Investment Income Tax. The short-term tax rate for non-corporate dealers (individuals) became 39.6 (43.4) % so that the cost disadvantage to owning non-index options shrinks to 7.96 (11.76) %. Because ATRA altered the tax rates for option traders during our sample period, it is possible that option prices reflect MTM taxation differently before and after ATRA. Specifically, if tax costs drive the MTM effects we observe, we should find more negative (less positive) effects of MTM options before ATRA because it is more costly to avoid MTM. In other words, the difference between MTM and non-MTM options is smaller after ATRA, so we should see less effect.[26]

To test for a change across tax regimes, we analyze the implied volatility of options on the S&P 500, Dow Jones Industrial Average, and the Russell 2000 Indices, splitting our sample based on whether the observations fall before or after ATRA. Table 6 presents results, with Panels A, B, and C showing results separately for options related to the S&P 500 Index, Dow Jones Industrial Average, and the Russell 2000 Index, respectively.

INSERT TABLE 6 HERE

[26] Consistent with this, Mason and Utke (2021) find the baseline tax advantage to Section 1256 options shrinks after the ATRA decreases the difference in taxation between index and non-index options.

We find that the negative price effect of MTM – that is, lower implied volatilities – for index options on the S&P 500 and Dow subject to MTM taxation is concentrated in the time period prior to ATRA. This suggests that tax, rather than administrative, costs drive the MTM effect that we observe in our earlier analyses. After ATRA, when the tax difference between MTM and non-MTM options is smaller, results are insignificant. For options related to the Russell 2000 Index, we observe the higher implied volatilities for options subject to MTM, concentrated in the post-ATRA period. While, as discussed earlier, we have trouble explaining the positive coefficient on Russell 2000 Index options, the weaker positive result in the pre-ATRA period are consistent with more negative (less positive) effects of MTM when the tax costs of avoiding MTM are higher.

VII. CONCLUSION

Recent tax proposals suggest instituting an MTM or wealth tax can both generate revenue and redistribute wealth so as to reduce income inequality. However, to our knowledge, there is no empirical evidence in the U.S. as to the effects of MTM taxation. Further, we are not aware of any evidence on the effect of MTM on asset prices. We fill these gaps by analyzing how U.S. wealth taxes, specifically annual year-end MTM taxation, affects asset prices.

We compare the option implied volatility, a measure of option price, of options on the S&P 500 (index options) that require an MTM to other options on the S&P 500 that do not require an MTM as well as to options on the SPY ETF (non-index options), which tracks the same underlying index. We find that index options subject to MTM provisions have lower implied volatility as compared to other index and non-index options that do not require an MTM. Additional analysis suggests that this MTM effect is driven by direct tax costs associated with the MTM, which leads to investors engaging in activities to avoid MTM taxation. Results across other indices and using option volume and open interest also provide some evidence that investors reduce demand for MTM index options. In sum, our results suggest MTM taxation likely has unintended consequences and that implementing an MTM regime could be costly to investors (see also Fama 2019 and Cochrane 2020).

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Table 1: Descriptive Statistics

Panel A: SPX and SPY Options by Year and MTM requirements

	SPX		SPY	
	(1)	(2)	(3)	(4)
Year	Current Year Expiration	Next Year Expiration (MTM)	Current Year Expiration	Next Year Expiration
2005	23	61	23	61
2006	23	59	23	59
2007	23	60	22	60
2008	20	62	20	62
2009	21	63	21	63
2010	23	63	23	63
2011	23	61	23	61
2012	22	60	22	60
2013	21	61	21	61
2014	20	62	20	62
2015	21	63	21	63
Totals	239	675	239	675

Panel B: Average Option Implied Volatility Comparison for MTM options

	SPX		SPY			
	(1)	(2)	(3)	(4)	(5)	(6)
Variable	Obs	Mean	Obs	Mean	Diff (SPX-SPY)	p-value
Current Year Expiration	239	0.199	239	0.194	0.005	(0.668)
Next Year Expiration (MTM for SPX)	675	0.195	675	0.193	0.003	(0.652)
	914		914			
Difference (Next Year-Current Year)		-0.004		-0.001	-0.002	
p-value		(0.665)		(0.880)	(0.845)	

This table presents estimation results for options prices on call options on the SPY and SPX that trade in November and December and expire in the following year, requiring a mark-to-market in some instances. Impl_Vol is equal to the option implied volatility from the standardized option price database from OptionMetrics' Ivy DB database. Panel A presents summary statistics for options that trade and expire in the current period and those that trade in the current year and expire in the following year. SPX is an indicator variable taking the value of 1 if the option is on the SPX index and 0 otherwise. Next Year Expiration signifies the option crosses the year-end and takes the value of 1 if the option expires in the next year and 0 if the option expires in the current period. Next Year Expiration * SPX identifies those options subject to the MTM rules (MTM) and takes a value of 1 for those options, and 0 otherwise. For SPX, those options that trade and expire in the current period are referred to as Non-MTM options. We also refer to SPY options as Non-MTM, or not having an expiration date that crosses into the next year. Panel A details the observations by year and type of option, as well as whether or not the option crosses the year-end. Panel B provides a univariate analysis of option implied volatility by underlying security, mark-to-market requirements, and those that expire in the following tax year. Two-tailed p-values are in parenthesis with ***, **, and * indicating significance at the one percent, five percent, and ten percent levels, respectively.

Table 2
Regression Comparison for SPX and SPY Options Considering on Mark-to-Market Rules

	(1)	(2)	(3)	(5)	(6)	(4)
DV=	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol
Next Year Expiration * SPX (i.e., MTM)	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**
	(0.011)	(0.025)	(0.011)	(0.011)	(0.025)	(0.012)
SPX	0.005***	0.005***	0.005***	0.005***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Next Year Expiration	-0.001	0.005	0.003	0.002	0.005	0.004
	(0.967)	(0.121)	(0.273)	(0.925)	(0.121)	(0.147)
S&P 500				-0.000**	-0.000	-0.001***
				(0.015)	(0.276)	(0.000)
S&P 500 Ret				-0.802***	-6.355***	-0.222***
				(0.000)	(0.000)	(0.001)
Constant	0.194***	0.125***	0.107***	0.449***	0.108***	1.035***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Observations	1828	1828	1828	1828	1828	1828
R-squared	0.000	0.996	0.943	0.336	0.996	0.969
Clustered SE's (month-year)	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes	No	No	Yes

This table presents estimation results for options prices on call options on the SPY and SPX that trade in November and December and expire in the following year, requiring a mark-to-market in some instances. The dependent variable, *Imp_Vol*, is equal to the option implied volatility from the standardized option price database from OptionMetrics' Ivy DB database. SPX is an indicator variable taking the value of 1 if the option is on the SPX index and 0 otherwise. Next Year Expiration signifies the option crosses the year-end and takes the value of 1 if the option expires in the next year and 0 if the option expires in the current period. Next Year Expiration * SPX identifies those options subject to the MTM rules (MTM) and takes a value of 1 for those options, and 0 otherwise. For SPX, those options that trade and expire in the current period are referred to as Non-MTM options. We also refer to SPY options as Non-MTM, or not having an expiration date that crosses into the next year. *S&P 500* equals the day's S&P 500 value and *S&P 500 Ret* equals the S&P 500 daily return. Two-tailed p-values are in parenthesis with ***, **, and * indicating significance at the one percent, five percent, and ten percent levels, respectively.

Table 3
Regression Comparison for SPX and SPY Options Considering on Mark-to-Market Rules
Panel A: Option Volume

	(1)	(2)	(3)
DV=	Volume	Volume	Volume
Next Year Expiration * SPX (i.e., MTM)	-0.572***	-0.324	-0.573**
	(0.010)	(0.431)	(0.016)
SPX	-0.199	-0.252	-0.199
	(0.346)	(0.385)	(0.345)
Next Year Expiration	-0.085	0.381	-0.162
	(0.763)	(0.156)	(0.330)
S&P 500	0.000	0.000	0.005
	(0.502)	(0.548)	(0.222)
S&P 500 Ret	17.772***	-168.144	16.629***
	(0.000)	(0.106)	(0.001)
Constant	8.641***	5.777***	2.156
	(0.000)	(0.000)	(0.651)
Observations	913	913	913
R-squared	0.072	0.711	0.274
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

Table 3 (cont'd)
Regression Comparison for SPX and SPY Options Considering on Mark-to-Market Rules
Panel B: Option Open Interest

DV=	(1) Open_Int	(2) Open_Int	(3) Open_Int
Next Year Expiration * SPX (i.e., MTM)	0.213	0.245	0.174
	(0.347)	(0.518)	(0.444)
SPX	0.416***	0.394**	0.426***
	(0.003)	(0.036)	(0.003)
Next Year Expiration	-0.852***	-0.162	-0.707***
	(0.001)	(0.455)	(0.002)
S&P 500	0.001***	0.001***	0.008***
	(0.007)	(0.000)	(0.004)
S&P 500 Ret	9.785***	167.808***	5.051**
	(0.000)	(0.000)	(0.027)
Constant	11.551***	10.631***	2.121
	(0.000)	(0.000)	(0.499)
Observations	913	913	913
R-squared	0.234	0.868	0.467
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

This table presents estimation results for options prices on call options on the SPY and SPX that trade in November and December and expire in the following year, requiring a mark-to-market in some instances. Panel A presents results using *Volume* as the dependent variable, which is equal to the natural logarithm of daily traded option volume from the non-standardized option price database from OptionMetrics. Panel B presents results using *Open_Int* as the dependent variable, which is equal to the natural logarithm of total daily open call option contracts. *SPX* is an indicator variable taking the value of 1 if the option is on the SPX index and 0 otherwise. Next Year Expiration signifies the option crosses the year-end and takes the value of 1 if the option expires in the next year and 0 if the option expires in the current period. *Next Year Expiration * SPX* identifies those options subject to the MTM rules (MTM) and takes a value of 1 for those options, and 0 otherwise. For SPX, those options that trade and expire in the current period are referred to as Non-MTM options. We also refer to SPY options as Non-MTM, or not having an expiration date that crosses into the next year. *S&P 500* equals the day's S&P 500 value and *S&P 500 Ret* equals the S&P 500 daily return. Two-tailed p-values are in parenthesis with ***, **, and * indicating significance at the one percent, five percent, and ten percent levels, respectively.

Table 4
Regression Comparison for Options on the Dow Jones Industrial Average and SPDR Dow Jones Industrial Average ETF while Considering Mark-to-Market Rules

Panel A: Implied Volatility

	(1)	(2)	(3)
DV=	Imp_Vol	Imp_Vol	Imp_Vol
Next Year Expiration * DJI (i.e., MTM)	-0.002	-0.002	-0.002
	(0.123)	(0.178)	(0.125)
DJI	0.006***	0.006***	0.006***
	(0.000)	(0.000)	(0.000)
Next Year Expiration	0.004	0.006*	0.004*
	(0.879)	(0.065)	(0.084)
Dow Jones	-0.000**	0.000**	-0.000***
	(0.032)	(0.014)	(0.001)
Dow Jones Ret	-0.773***	-3.439***	-0.216**
	(0.000)	(0.000)	(0.010)
Constant	0.432***	0.100***	0.908***
	(0.003)	(0.000)	(0.000)
Observations	1828	1828	1828
R-squared	0.281	0.996	0.966
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

Table 4 (cont'd)
Regression Comparison for Options on the Dow Jones Industrial Average Index Considering on Mark-to-Market Rules

Panel B: Option Traded Volume - Dow Jones Industrial Average

	(1)	(2)	(3)
DV=	Volume	Volume	Volume
Next Year Expiration * DJI (i.e., MTM)	-0.142	-0.119	-0.230
	(0.606)	(0.725)	(0.331)
DJI	-1.057***	-1.081***	-1.036***
	(0.000)	(0.000)	(0.000)
Next Year Expiration	0.013	0.170	-0.059
	(0.959)	(0.359)	(0.650)
Dow Jones	-0.000	-0.000***	-0.000
	(0.131)	(0.000)	(0.348)
Dow Jones Ret	5.669*	-135.200***	9.533***
	(0.076)	(0.000)	(0.007)
Constant	9.377***	11.935***	11.472***
	(0.000)	(0.000)	(0.000)
Observations	912	912	912
R-squared	0.133	0.841	0.604
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

Table 4 (cont'd)
Regression Comparison for Options on the Dow Jones Industrial Average Index Considering on Mark-to-Market Rules

Panel C: Option Open Interest

	(1)	(2)	(3)
DV=	Open_Int	Open_Int	Open_Int
Next Year Expiration * DJI (i.e., MTM)	-0.453*	-0.588*	-0.586***
	(0.057)	(0.080)	(0.004)
DJI	-0.697***	-0.663**	-0.659***
	(0.000)	(0.015)	(0.001)
Next Year Expiration	0.030	0.257	-0.031
	(0.887)	(0.126)	(0.792)
Dow Jones	-0.000**	-0.000***	0.000
	(0.013)	(0.000)	(0.192)
Dow Jones Ret	3.212	-10.229***	3.133
	(0.223)	(0.000)	(0.158)
Constant	12.255***	15.397***	9.217***
	(0.000)	(0.000)	(0.000)
Observations	912	912	912
R-squared	0.167	0.853	0.692
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

This table presents estimation results for call options on the Dow Jones Industrial Average Index and the SPDR Dow Jones Industrial Average ETF that trade in November and December and expire in the following year, requiring a mark-to-market in some instances. Panel A presents results on options prices where the dependent variable, *Imp_Vol*, is equal to the option implied volatility from the standardized option price database from OptionMetrics' Ivy DB database. Panel B presents results using *Volume* as the dependent variable, which is equal to the natural logarithm of daily traded option volume from the non-standardized option price database from OptionMetrics. Panel C presents results using *Open_Int* as the dependent variable, which is equal to the natural logarithm of total daily open call option contracts. *DJI* is an indicator variable taking the value of 1 if the option is on the Dow Jones Industrial Average Index and 0 otherwise. Next Year Expiration signifies the option crosses the year-end and takes the value of 1 if the option expires in the next year and 0 if the option expires in the current period. *Next Year Expiration * DJI* identifies those options subject to the MTM rules (MTM) and takes a value of 1 for those options, and 0 otherwise. For DJI, those options that trade and expire in the current period are referred to as Non-MTM options. We also refer to SPDR ETF options as Non-MTM, or not having an expiration date that crosses into the next year. *Dow Jones* and *Dow Jones Ret* represents the daily value and daily return of the Dow Jones Industrial Average Index, respectively. Two-tailed p-values are in parenthesis with ***, **, and * indicating significance at the one percent, five percent, and ten percent levels, respectively.

Table 5

Regression Comparison for Options on the Russell 2000 Index and the iShares Russell 2000 ETF while Considering Mark-to-Market Rules

Panel A: Implied Volatility

	(1)	(2)	(3)
DV=	Imp_Vol	Imp_Vol	Imp_Vol
Next Year Expiration * RUT (i.e., MTM)	0.002	0.002	0.002
	(0.118)	(0.173)	(0.120)
RUT	0.005***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)
Next Year Expiration	-0.003	0.001	-0.000
	(0.909)	(0.862)	(0.874)
Russell 2000	-0.000***	-0.000***	-0.001***
	(0.003)	(0.000)	(0.000)
Russell 2000 Ret	-0.553***	-6.760***	-0.193***
	(0.004)	(0.000)	(0.001)
Constant	0.553***	0.289***	0.865***
	(0.000)	(0.000)	(0.000)
Observations	1828	1828	1828
R-squared	0.439	0.995	0.975
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

Table 5 (cont'd)

Regression Comparison for Alternative Indices' Options Considering on Mark-to-Market Rules

Panel B: Analysis of Option Traded Volume - Russell 2000 Index

	(1)	(2)	(3)
DV=	Volume	Volume	Volume
Next Year Expiration * RUT (i.e., MTM)	-0.553	-0.942	-0.551
	(0.216)	(0.288)	(0.254)
RUT	1.869***	2.017***	1.872***
	(0.000)	(0.005)	(0.000)
Next Year Expiration	0.306	0.523	0.248
	(0.330)	(0.393)	(0.394)
Russell 2000	-0.001	0.002*	-0.001
	(0.151)	(0.071)	(0.595)
Russell 2000 Ret	5.899**	-121.523***	7.960**
	(0.016)	(0.000)	(0.014)
Constant	8.557***	4.502***	8.770***
	(0.000)	(0.000)	(0.000)
Observations	914	914	914
R-squared	0.253	0.611	0.395
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

Table 5 (cont'd)

Regression Comparison for Alternative Indices' Options Considering on Mark-to-Market Rules

Panel C: Analysis of Option Open Interest - Russell 2000 Index

	(1)	(2)	(3)
DV=	Open_Int	Open_Int	Open_Int
Next Year Expiration * RUT (i.e., MTM)	-0.395	-0.603	-0.472
	(0.285)	(0.422)	(0.247)
RUT	0.520	0.588	0.554
	(0.137)	(0.267)	(0.118)
Next Year Expiration	0.215	0.489	0.190
	(0.386)	(0.319)	(0.445)
Russell 2000	-0.001**	-0.000	0.002
	(0.024)	(0.720)	(0.535)
Russell 2000 Ret	3.128**	77.137***	2.964*
	(0.015)	(0.000)	(0.082)
Constant	11.916***	11.479***	9.964***
	(0.000)	(0.000)	(0.000)
Observations	914	914	914
R-squared	0.053	0.459	0.213
Clustered SE's (month-year)	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes

This table presents estimation results for call options on the Russell 2000 Index and the iShares Russell 2000 ETF that trade in November and December and expire in the following year, requiring a mark-to-market in some instances. Panel A presents results on options prices where the dependent variable, *Impl_Vol*, is equal to the option implied volatility from the standardized option price database from OptionMetrics' Ivy DB database. Panel B presents results using *Volume* as the dependent variable, which is equal to the natural logarithm of daily traded option volume from the non-standardized option price database from OptionMetrics. Panel C presents results using *Open_Int* as the dependent variable, which is equal to the natural logarithm of total daily open call option contracts. *RUT* is an indicator variable taking the value of 1 if the option is on the Russell 2000 Index and 0 otherwise. Next Year Expiration signifies the option crosses the year-end and takes the value of 1 if the option expires in the next year and 0 if the option expires in the current period. *Next Year Expiration * RUT* identifies those options subject to the MTM rules (MTM) and takes a value of 1 for those options, and 0 otherwise. For RUT, those options that trade and expire in the current period are referred to as Non-MTM options. We also refer to iShares Russell 2000 ETF options as Non-MTM, or not having an expiration date that crosses into the next year. *Russell 2000* and *Russell 2000 Ret* represents the daily value and daily return on the Russell 2000 Index, respectively. Two-tailed p-values are in parenthesis with ***, **, and * indicating significance at the one percent, five percent, and ten percent levels, respectively.

Table 6
Difference-in-Difference Regression of Option Prices on Underlying Indices Around Year-End Surrounding the American Taxpayer Relief Act

Panel A: S&P 500 Index

	PRE-ATRA			POST-ATRA		
	(1)	(2)	(3)	(4)	(5)	(6)
DV=	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol
Next Year Expiration * SPX (i.e., MTM)	-0.003***	-0.003**	-0.003***	0.000	0.000	0.000
	(0.006)	(0.013)	(0.006)	(0.428)	(0.488)	(0.430)
SPX	0.006***	0.006***	0.006***	0.004***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Next Year Expiration	-0.003	0.003	0.002	0.019**	0.011***	0.011***
	(0.920)	(0.456)	(0.602)	(0.025)	(0.000)	(0.000)
S&P 500	-0.001***	0.000***	-0.001***	0.000**	-0.000***	-0.001***
	(0.003)	(0.000)	(0.000)	(0.022)	(0.000)	(0.001)
S&P 500 Ret	-0.667***	-1.551***	-0.212**	-0.802***	-5.477***	-0.114*
	(0.003)	(0.000)	(0.013)	(0.000)	(0.000)	(0.092)
Constant	0.855***	-0.221***	1.159***	-0.017	0.313***	1.002***
	(0.000)	(0.000)	(0.000)	(0.669)	(0.000)	(0.001)
Observations	1332	1332	1332	496	496	496
R-squared	0.551	0.996	0.968	0.369	0.979	0.862
Clustered SE's (month-year)	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes	No	No	Yes

Table 6 (cont'd)
Difference-in-Difference Regression of Option Prices on Underlying Indices Around Year-End Surrounding the American Taxpayer Relief Act

Panel B: Dow Jones Industrial Average Index

	PRE-ATRA			**POST-ATRA**		
	(1)	(2)	(3)	(4)	(5)	(6)
DV=	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol
Next Year Expiration * DJI (i.e., MTM)	-0.003	-0.003	-0.003	-0.001	-0.001	-0.001
	(0.103)	(0.153)	(0.104)	(0.741)	(0.774)	(0.742)
DJI	0.006***	0.006***	0.006***	0.007*	0.007	0.007*
	(0.000)	(0.001)	(0.000)	(0.094)	(0.134)	(0.096)
Next Year Expiration	-0.001	0.004	0.002	0.020*	0.010***	0.011***
	(0.963)	(0.303)	(0.452)	(0.055)	(0.001)	(0.001)
Dow Jones	-0.000**	0.000***	-0.000***	0.000*	-0.000***	-0.000***
	(0.021)	(0.000)	(0.001)	(0.098)	(0.000)	(0.003)
Dow Jones Ret	-0.654***	-1.270***	-0.187*	-0.936***	-3.174***	-0.251***
	(0.004)	(0.000)	(0.055)	(0.000)	(0.000)	(0.004)
Constant	0.788***	-0.066***	1.041***	-0.045	0.188***	0.858***
	(0.005)	(0.001)	(0.001)	(0.564)	(0.000)	(0.001)
Observations	1332	1332	1332	496	496	496
R-squared	0.401	0.996	0.966	0.326	0.963	0.850
Clustered SE's (month-year)	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes	No	No	Yes

Table 6 (cont'd)
Difference-in-Difference Regression of Option Prices on Underlying Indices Around Year-End Surrounding the American Taxpayer Relief Act

Panel C: Russell 2000 Index

	PRE-ATRA			POST-ATRA		
	(1)	(2)	(3)	(4)	(5)	(6)
DV=	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol	Imp_Vol
Next Year Expiration * RUT (i.e., MTM)	0.002	0.002	0.002	0.002*	0.002*	0.002*
	(0.269)	(0.335)	(0.271)	(0.059)	(0.088)	(0.060)
RUT	0.004***	0.004***	0.004***	0.006***	0.006***	0.006***
	(0.003)	(0.009)	(0.004)	(0.001)	(0.002)	(0.001)
Next Year Expiration	-0.005	-0.002	-0.003	0.012*	0.008***	0.008***
	(0.848)	(0.686)	(0.408)	(0.063)	(0.002)	(0.001)
Russell 2000	-0.001***	0.000	-0.001***	0.000	-0.000***	-0.001***
	(0.000)	(0.964)	(0.000)	(0.651)	(0.000)	(0.000)
Russell 2000 Ret	-0.420**	-1.021***	-0.167**	-0.550***	-5.016***	-0.202**
	(0.012)	(0.000)	(0.015)	(0.000)	(0.000)	(0.022)
Constant	0.942***	0.218***	1.014***	0.116	0.674***	0.732***
	(0.000)	(0.000)	(0.000)	(0.267)	(0.000)	(0.000)
Observations	1332	1332	1332	496	496	496
R-squared	0.607	0.995	0.974	0.231	0.947	0.750
Clustered SE's (month-year)	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects (Day-Year)	No	Yes	No	No	Yes	No
Fixed Effects (Month-Year)	No	No	Yes	No	No	Yes

This table presents estimation results for options prices on call options on multiple underlying indices. Panels A, B, and C present results using options on the SPY and SPX, the Dow Jones Industrial Average and SPDR Dow Jones Industrial Average ETF, and the Russell 2000 Index and iShares Russell 2000 ETF, respectively, that trade in November and December and expire in the following year, requiring a mark-to-market in some instances. The dependent variable, Impl_Vol, is equal to the option implied volatility from the standardized option price database from OptionMetrics' Ivy DB database. SPX, DJI, and RUT are indicator variables taking the value of 1 if the option is on the SPX, Dow Jones Industrial Average, or Russell 2000 Index, respectively, and 0 otherwise. Next Year Expiration signifies the option crosses the year-end and takes the value of 1 if the option expires in the next year and 0 if the option expires in the current period. Next Year Expiration * SPX, DJI, or RUT identifies those options subject to the MTM rules (MTM) and takes a value of 1 for those options, and 0 otherwise. For SPX, DJI, or RUT, those options that trade and expire in the current period are referred to as Non-MTM options. We also refer to options on each underlying indices' ETF as Non-MTM options, or not having an expiration date that crosses into the next year. *S&P 500* equals the day's S&P 500 value and *S&P 500 Ret* equals the S&P 500 daily return. *Dow Jones* and *Dow Jones Ret* represents the daily value and daily return of the Dow Jones Industrial Average Index, respectively. *Russell 2000* and *Russell 2000 Ret* represents the daily value and daily return on the Russell 2000 Index, respectively. Two-tailed p-values are in parenthesis with ***, **, and * indicating significance at the one percent, five percent, and ten percent levels, respectively.