Taxation, Regulation, and Cryptocurrency Pricing**

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Abstract

This paper examines whether and how jurisdictional gaps in crypto taxation and certain forms of regulation affect cross-jurisdictional variation in prices of the same underlying cryptocurrency. We find that, after controlling for capital controls and exchange liquidity, Bitcoin (Ethereum) trades at a discount relative to the world market price in jurisdictions that impose heavier income tax burdens on crypto exchanges. Interestingly, Bitcoin price deviations are more sensitive to tax laws when the crypto tax reporting system is more transparent, as in the case of KYC procedures in place and more information flowing from third parties to tax authorities. Furthermore, Bitcoin (Ethereum) trades at a premium in jurisdictions with a clearly communicated regulatory framework for cryptocurrency and in jurisdictions that are yet to apply the AML/CTF laws to crypto exchanges. Comparatively, the association is more pronounced for jurisdictions with tighter capital controls and for crypto exchanges that predominantly serve domestic markets. To address the omitted correlated variable problem, utilizing staggered adoptions of cryptocurrency policies, we identify the effect of crypto taxation and regulation on pricing using both the difference-in-differences design and the regulatory event study methodology. The incremental explanatory power of jurisdictional gaps in cryptocurrency taxation and regulation for the price disparity of the same cryptocurrency derives from both the demand and supply sides.

Keywords: cryptocurrency; Bitcoin; regulation; tax; law of one price; blockchain

JEL codes: G12; G15; G18; F38

1. Introduction

Despite the exponential growth and institutionalization of cryptocurrency transactions, an important feature of the cryptocurrency market is that different jurisdictions have adopted different approaches to taxing cryptocurrency and regulating its development. This paper attempts to shed some light on the effect of taxation and regulation on cryptocurrency pricing by examining whether and how jurisdictional gaps in crypto taxation and certain forms of crypto regulation affect cross-jurisdictional variation in prices of the same underlying cryptocurrency.

Theoretically, it is not clear whether jurisdictional gaps in crypto taxation and regulation affect cross-jurisdictional variation in cryptocurrency prices. On the one hand, the decentralized blockchain system underlying cryptocurrency and its function as a medium of exchange for cross-border transactions imply that cryptocurrency operates out of the reach of *jurisdictional* regulation and taxation (e.g., Nakamoto 2008). Furthermore, because crypto exchanges, which play a critical and dominant role in the industry (Griffin and Shams 2020; Amiram, Lyandres, and Rabetti 2021), could operate across multiple countries and regions and thus serve the global market, the influence of one jurisdiction's cryptocurrency taxation and regulation, if any, is unlikely to be confined to its own jurisdiction. On the other hand, Makarov and Schoar (2020) suggest that cross-border capital flow controls increase the cost of moving cryptocurrencies from one country to another, and thus limit arbitrage and result in mildly segmented crypto markets. In segmented crypto markets, the price could deviate from the law of one price (e.g., Errunza and Losq 1985). Market segmentation is a *necessary*, but not *sufficient*, condition for the existence of the large price differences for seemingly identical assets in different markets (e.g., Cochrane, 2008). In fact, for prices to differ demand and/or supply must also differ across markets. If certain forms of cryptocurrency taxation and regulation influence the relative demand for and supply of cryptocurrencies, jurisdictional gaps in crypto taxation and regulation, conceptually another form of friction, are likely to influence the cross-jurisdictional variation in prices of the same underlying cryptocurrency.

Because no comprehensive framework for taxation of crypto transactions has yet emerged, this study takes the first step in systematically characterizing and quantifying the income tax, VAT, and property tax

treatment of the creation, exchange, and holding of cryptocurrencies. In the context of tax pricing literature, there is no universally accepted theory on how taxation relates to equilibrium returns and prices. The capitalization effect considers the tax impact from buyers' perspective and argues that investors demand a *lower* price to *buy* assets on which they have to pay taxes in the future. The lock-in effect considers the tax impact from sellers' perspective and argues that investors require *higher* prices to *sell* assets if they have to pay taxes on selling them (see Hanlon and Heitzman (2010) for a review of the literature on taxes and stock prices). Compared with equity pricing of taxes, a number of unique institutional features in the crypto market may yield different predictions on the effect of taxation on crypto pricing. For instance, the pseudo anonymity inherent in crypto transactions and lack of tax reporting framework for cross-border crypto transactions could make compliance and enforcement of crypto tax laws challenging.

Empirically, this study uses a comprehensive dataset of Bitcoin prices against fiat currencies from January 2017 to December 2021 across forty-two crypto exchanges. We only include bitcoin-to-fiat pairs because investors in different countries trade different bitcoin-to-fiat pairs, for example, U.S. investors trading bitcoin-to-dollar while Japanese investors trading bitcoin-to-yen. We exclude bitcoin-to-crypto pairs because capital flow restrictions ae less binding for the bitcoin-to-crypto pairs (Makarov and Schoar, 2020). Using the platform-oriented approach, this study uses the IP address of an exchange's URL to identify the jurisdiction in which the exchange's server is located as the impacted jurisdiction. Using the clientele-oriented approach, this study uses SimilarWeb, a web traffic tool, to identify the jurisdiction in which an exchange's largest customer base is located and use this jurisdiction as the affected jurisdiction.

For the baseline analysis, under both approaches, we find that jurisdictional gaps in taxation of cryptocurrency provide additional explanatory power for the cross-jurisdictional variation in Bitcoin price deviations (relative to the world market price) incremental to exchange liquidity, capital controls, investor attention, and macro factors. Bitcoin price deviations are lower, i.e., Bitcoin trades at a discount relative to the world market price, in jurisdictions that impose heavier income tax burdens on crypto transactions, which largely supports the tax capitalization hypothesis. When income tax burdens are broken down into tax burdens on the creation (mining) and exchanges of cryptocurrencies, we find that Bitcoin price

deviations are lower in jurisdictions with heavier tax burdens on the exchanges of cryptocurrencies. Specifically, Bitcoin price deviations decrease with the number of taxable exchanges and with the range of their applicability with respect to personal and business exchanges. Comparatively, Bitcoin price deviations are more sensitive to crypto tax laws, especially the income tax treatment, when the crypto tax reporting system is more transparent, as in the case of KYC procedures in place and more information flowing from third parties to tax authorities. The comparative statistic on the tax capitalization effect is largely consist with the interpretation that more transparent crypto tax reporting system improves tax compliance and enforcement, and thus, tax laws have a more pronounced effect on cryptocurrency pricing.

Given that regulatory uncertainty and lack of regulation have received mixed responses from market participants, this paper differentiates between regulatory uncertainty and the receptiveness of specific cryptocurrency policies and develops two broad predictions. The regulatory uncertainty hypothesis contends that uncertainty in the regulatory framework substantially increases regulatory risks for investors and impairs the ease of doing business for institutions who want to participate in the crypto market as service providers. The increased regulatory risk dampens the demand for cryptocurrencies and the supply of crypto-related services, which hinders the potential adoption of cryptocurrencies and negatively influences prices. The regulatory receptiveness hypothesis contends that more receptive regulatory climates are likely to attract more investors as well as crypto businesses, which increases the potential adoption of cryptocurrencies and positively influences prices.

We classify uncertainty in the regulatory framework as low (high) if regulators have (have not) clearly communicated their position on whether cryptocurrencies satisfy the criteria to be classified as money. We gauge the receptiveness of crypto regulation in three dimensions. First, the legal framework defines and sets the legal standing of cryptocurrencies, which varies significantly among countries: cryptocurrencies are legal in most jurisdictions, but many jurisdictions have imposed full or partial bans on cryptocurrencies. Second, we examine exchange-based regulation, especially the applicability of anti–money laundering (AML) and counterterrorism financing (CTF) laws to cryptocurrency exchanges. Although the presence of regulation provides insights on the extensive margin, regulatory enforcement could provide additional

insights on the intensive margin. Enforcement action against violations of exchange-based regulations is the third dimension. For the baseline analysis, we find that Bitcoin price deviations are higher, i.e., Bitcoin trades at a premium relative to the world market price, in jurisdictions with a clearly communicated regulatory position on whether cryptocurrencies satisfy the criteria of money. The positive association suggests that regulatory uncertainty substantially increases regulatory risks for participants in the crypto market, which lowers the price of cryptocurrencies. Bitcoin price deviations are also lower in jurisdictions that apply the AML/CTF laws to crypto exchanges. The negative association suggests that the applicability of AML/CTF laws dampens the demand for Bitcoins for *illicit* activities more than the potential increase in demand from a broader base of market participants for *legitimate* transactions as a result of enhanced investor protection.

As market segmentation is a *necessary* condition for the existence of substantial price differences for seemingly identical assets in different markets (e.g., Cochrane, 2008; Makarov and Schoar 2020; Borri and Shakhnov, 2022), we make the cross-sectional prediction that the influence of cryptocurrency taxation and regulation on price differences is more pronounced in, or only confined to, jurisdictions with tighter capital controls and crypto exchanges that largely serve domestic investors. Consistent with the market segmentation framework, comparatively, we find that Bitcoin price deviations are more sensitive to crypto tax laws, the receptiveness of the legal standing, and anti–money laundering laws among jurisdictions with tighter capital controls and among exchanges that predominantly serve domestic markets.

Crypto taxation and regulation could be endogenously determined by some *unobservable* country characteristics. To mitigate implications of the omitted correlated factors at the jurisdiction level, we take advantage of the rapidly changing regulatory landscape and employ two empirical strategies to identify the effect of taxation and regulation on cryptocurrency prices. First, following Bertrand, Duflo, and Mullainathan (2004) and Armstrong, Balakrishnan, and Cohen (2012), we exploit the staggered adoption of specific cryptocurrency policies and use a difference-in-differences design to identify the pricing effect of crypto-related taxation and regulation. The results from the difference-in-differences design are consistent with the baseline results for Bitcoin price deviations. Next, we use regulatory event study

methodology as an alternative identification strategy (e.g., Schipper and Thompson 1983; Binder 1985). Specifically, we compile a list of material taxation and regulatory updates related to cryptocurrencies and identify the economic impact of taxation and regulation by examining the *changes* in cryptocurrency prices in jurisdictions that have initiated those changes *relative* to those that are yet to implement those changes. We find that both the event-day return and the three-day cumulative return after regulatory updates are statistically significant in the expected direction. Consistent with comparative statistics for the baseline analyses, the event-day return and the three-day cumulative return are more pronounced for jurisdictions with tighter capital controls, suggesting that the change in cryptocurrency prices is more sensitive to taxation and regulation changes in more closed economies. Both the difference-in-differences and the regulatory event study analyses identify the effect of crypto taxation and regulation on Bitcoin pricing.

This paper argues that jurisdictional gaps in crypto taxation and regulation influence the relative demand for and supply of cryptocurrencies and thus result in varied crypto prices across jurisdictions. The Bitcoin price captures the equilibrium derived from the demand and supply sides, and the incremental explanatory power of taxation and regulation for cross-jurisdictional variation in Bitcoin prices could derive from either the demand side or from the supply side or both. We use daily Google search interest for Bitcoin as the proxy for investor demand and the number of business entities that either have a cryptocurrency ATM or offer crypto as an in-store payment method as the proxy for the supply of goods and services by business entities with a cryptocurrency option. The supplementary analyses illustrate that both the demand and supply sides serve as two channels underlying the incremental explanatory power of cryptocurrency taxation and regulation for cross-jurisdictional price deviations of the same underlying cryptocurrency.

This study contributes to two strands of literature. First, our paper is complementary to the emerging literature on cryptocurrency pricing. This study is closely related to Makarov and Schoar (2020), which finds that capital controls drive arbitrage spreads in the cryptocurrency market. Conceptually, market segmentation is a *necessary*, but not *sufficient*, condition for the existence of the large price differences for seemingly identical assets in different markets (e.g., Cochrane, 2008). To our best knowledge, this paper is the first to provide a systematic empirical study of the effect of taxation and regulation on cryptocurrency

pricing using transaction-level data. The results collectively suggest that jurisdictional gaps in crypto taxation and regulation, conceptually another form of friction that influences demand and supply, are associated with cross-jurisdictional variation in cryptocurrency prices incremental to exchange liquidity, investor attention, and capital controls. Complementary to the findings in prior studies (e.g., Makarov and Schoar, 2020; Borri and Shakhnov,2022), the association between crypto-related taxation and regulation and Bitcoin price deviations (relative to the world market price) is more pronounced for, or only confined to, jurisdictions with tighter capital controls and crypto exchanges that predominantly serve domestic. Broadly, this study contributes to the literature on the influence of laws and regulation on finance (e.g., La Porta et al. 1998) and the literature on deviations from one price in different markets (e.g., Rosenthal and Young 1990; Froot and Dabora 1999).

Second, this study contributes to the taxation literature by furthering our understanding of taxation of crypto markets. Prior studies focus almost exclusively on the effect of taxation on trading and pricing in *regulated* securities markets, characterized by a high degree of transparency, existing tax reporting infrastructure, and tax compliance. In contrast, this study examines a counterfactual setting to other securities markets, which is characterized by low transparency, low tax compliance, lack of a tax reporting framework for cross-border crypto transactions, and high uncertainty about the application and enforcement of tax laws. This study systematically characterizes and quantifies each sample country's income tax, VAT, and property tax treatment of cryptocurrencies. Despite a number of unique institutional features of the crypto market, this study finds that Bitcoin prices are lower in jurisdictions that impose heavier income tax burdens on crypto transactions. Interestingly, price deviations are more sensitive to tax laws when the crypto tax reporting system is more transparent, as in the case of KYC procedures in place and more information flowing from crypto exchanges to tax authorities, and when opportunities for cross-border tax arbitrage are rather limited, as in the case of more closed economies and exchanges that predominantly serve domestic investors. This study is the first to provide *cross-country* evidence on the impact of tax laws on the demand and supply side of crypto-based activities and the new insight that the tax capitalization effect varies with existing frictions of the crypto markets, such as lack of transparency in the crypto tax reporting system.

This study is complementary to Cong et al. (2022) that examines crypto *trades* motivated by tax-loss harvesting in response to the heightened tax scrutiny in *one* country, namely the United States. This study quantifies the *cross-jurisdictional* variation in a *broad* range of crypto tax laws and examine its impact on the cross-jurisdictional variation in cryptocurrency pricing and its interaction with transparency of the crypto tax reporting system. The findings from this study highlight the importance of cross-border policy coordination and provide timely guidance and scholarly support for the evolving legislative process for taxation of cryptocurrencies that are under way. For instance, the 2021 Infrastructure Bill requires all exchanges in the United States to provide 1099 tax reporting information to the IRS, which is designed to increase information flowing from third parties to tax authorities and enhance tax compliance. In October 2022, the Organization for Economic Cooperation and Development (OECD) published a framework that requires exchanges to report the identity of their customers, trading activity, and transfers to personal wallets to the tax authorities, which is a timely response in the direction of policy coordination that help tax authorities administer tax rules when taxpayers invest in crypto-assets outside their tax residency.

2. Background on cryptocurrencies, related literature, and hypothesis development

The two most common blockchain-based crypto assets are cryptocurrencies (also known as crypto coins) and crypto tokens. The biggest difference between the two is that cryptocurrencies have their own blockchains, whereas crypto tokens are created as part of a platform that is built on an existing blockchain. A cryptocurrency is issued directly by the blockchain protocol on which it runs and is the currency native to the specific blockchain. Therefore, cryptocurrencies (crypto coins) like Bitcoin have their own blockchain and can be used as a medium of exchange, store of value, or for speculative investments as an alternative to fiat currencies. Crypto tokens, on the other hand, are units of value that blockchain-based organizations or projects develop on top of existing blockchain networks. Crypto tokens like FILECOIN use an existing blockchain, such as Ethereum, to enable customers to access some current or future products or services (classifying them as utility tokens) or to enable investors to generate a financial return by providing certain rights or ownership similar to securities (potentially classifying them as security tokens).

Another major difference is that, unlike crypto tokens, which are issued through an initial coin offering (ICO) to raise capital, cryptocurrencies such as Bitcoin are not issued through an ICO, and, therefore, have never been classified as security tokens by regulators. This study focuses on crypto coins, Bitcoin and Ethereum, in particular. Recent developments demonstrate that cryptocurrencies have made some successful moves toward mainstream adoption. Over 8000 cryptocurrencies have been launched and circulated globally and the overall market capitalization of cryptocurrencies peaked at $3 trillion in November 2021 with participation from both institutional and retail investors (Ossinger 2021).[1]

Research on cryptocurrencies in finance and economics is still in its infancy. Bohme et al. (2015) and Ciaian et al. (2016) provide a broad perspective on the economics of cryptocurrencies. The emerging theoretical literature on cryptocurrencies has suggested a number of factors that are potentially important in the valuation of cryptocurrencies. The first group of papers builds models on the network effect of cryptocurrency adoption and emphasizes the price dynamics induced by the positive externality of the network effect (e.g., Pagnotta and Buraschi 2018 and Biais et al. 2018). The second group of papers focuses on the production side of the coins—the miners' problem—and shows that the evolution of cryptocurrency prices is linked to the marginal cost of production. For instance, Easley, O'Hara, and Basu (2019) and Cong, He, and Li (2020) study Bitcoin mining fees and the incentives of miners in equilibrium.

Some theoretical papers argue that the evolution of cryptocurrency prices should follow a martingale, and thus cryptocurrency returns are not predictable (e.g., Schilling and Uhlig 2019). Others argue that, in dynamic cryptocurrency valuation models, cryptocurrency returns could potentially be predicted by momentum, investor attention, and cryptocurrency valuation ratios (e.g., Cong Li and Wang 2019; Sockin and Xiong 2019). Empirically, Liu and Tsyvinski (2021) find that cryptocurrency returns are exposed to cryptocurrency network factors but not cryptocurrency production factors and that momentum and investor

[1] Survey evidence suggests that, out of 800 institutional investors in North America and Western Europe, 36% are currently investing in digital assets and 60% believe that crypto assets have a place in their portfolios (Fidelity 2020). Fidelity will offer Bitcoin in 401(k) retirement plans to employees at its 23,000 client companies (Duggan 2022). Coinbase alone has 2.8 million monthly users and 7,000 institutional users and supports trading in 45 different cryptocurrencies (Coinbase Global Inc. 2021).

attention strongly predict future cryptocurrency cumulative returns. In particular, the evolution of cryptocurrency prices reflects not only current cryptocurrency adoption but also contains information about expected future network growth. The cryptocurrency community and the academy have also proposed various narratives for cryptocurrencies. For instance, Schilling and Uhlig (2019) argue that, in an endowment economy where fiat money and cryptocurrency coexist and compete, the cryptocurrency returns co-move with the price evolution of the fiat money. The public discourse claims that Bitcoin is "digital gold" and represents a new way to store value. Athey et al. (2016) emphasize the importance of currency exchange rates on cryptocurrency prices. While those theoretical papers link the movements of cryptocurrency prices to those of traditional asset classes, the empirical evidence from Liu and Tsyvinski (2021) suggests the exposure of cryptocurrencies to these traditional assets, including currencies, commodities, stocks, and macroeconomic factors, is low.

Interestingly, the same cryptocurrency can have different prices quoted across various exchanges that are located in various jurisdictions at the same time. Makarov and Schoar (2020) find that price deviations relative to the world market price are much larger across countries (or regions) than across exchanges within the same country. For instance, the daily average price deviation between the United States and the Republic of Korea from December 2017 until the beginning of February 2018 was more than 15% and reached 40% for several days. This large price differential implies a minimum of $2 billion of *potential* arbitrage profit for the corresponding period. In contrast, the price deviations between crypto exchanges in the same country typically do not exceed 1%, on average. Makarov and Schoar (2020) suggest that cross-border capital flow controls increase the cost of moving cryptocurrencies from one country to another, and thus limit arbitrage and result in mildly segmented crypto markets.

First, we hypothesize that taxation of cryptocurrency could influence the demand for cryptocurrency and/or supply of crypto-related services, and therefore, jurisdictional gaps in the income tax and value-added tax (VAT) treatment of the creation and exchange of cryptocurrencies could vary with the cross-jurisdictional variation in prices of the same underlying cryptocurrency. In the context of tax pricing literature, there is no universally accepted theory on how taxation relates to equilibrium returns and prices,

and sometime, theories generate opposite predictions on the direction between taxes and asset prices (e.g., Hanlon and Heitzman, 2010). The capitalization effect argues that investors demand a lower price to buy assets on which they have to pay taxes in the future. The lock-in effect argues that investors require higher prices to sell assets if they have to pay taxes on selling them. The empirical evidence on the effect of capital gain taxes on equity prices is mixed. The tax capitalization hypothesis is supported by empirical findings that capital gains tax *reduces* stock prices (e.g., Lang and Shackelford, 2000; Sialm, 2009). On the other hand, the lock-in effect is supported by empirical findings that capital gains taxes *increase* stock prices (e.g., Landsman and Shackelford,1995; Poterba and Weisbenner,2001; Klein, 2001; Blouin, Raedy, and Shackelford,2003).

Intuitively, the capitalization effect considers the tax impact from buyers' perspective, while the lock-in effect considers the tax impact from sellers' perspective. A change in capital gains taxes influences asset prices by shifting both the demand for assets and the supply of assets. When the capital gains tax increases, the demand curve for assets is shifted down, reflecting the decline in prices that is necessary to attract buyers, and the supply curve is shifted up, reflecting the boost in prices required to entice current owners to sell. The net effect depends on whether the tax capitalization effect (demand side) or the lock-in effect (supply side) dominates. Dai et al. (2008) find that, following the announcement of the 1997 tax cut, but before its effective date, the tax capitalization effect dominates. However, following the effective date of the lower capital gains tax rates, consistent with relief in the lock-in effect, there are increased supply of stocks with large past price appreciation and high individual ownership, which leads to lower prices.

Compared with equity pricing of taxes, a number of unique institutional features in the crypto market could yield different predictions on the effect of taxation on crypto pricing. A few salient issues include but are not limited to lack of transparency into crypto markets by tax authorities, low compliance with reporting income from crypto activities, lack of tax reporting framework for cross-border crypto transactions, and high uncertainty about the application and enforcement of tax laws.

First, the pseudo anonymity of crypto transactions makes it rather challenging for the tax authorities to identify *who* is active on the crypto market. Pseudo anonymity means that the true identify of a crypto

wallet is mostly unknown, but transactions from or to a particular crypto wallet is available on public blockchains. Moreover, a subset of centralized cryptocurrency exchanges and virtually all decentralized crypto exchanges do not have Know-Your-Customers (KYC) procedures in place that require personal information, such as name, date of birth, and a copy of personal ID. KYC obligations focus on verifying the identity of customers and sufficiently understanding their backgrounds and risk profiles. The lack of KYC procedures exacerbates the challenge in the verification of true identify of investors in crypto markets.

Second, compliance with reporting income from crypto transactions is rather limited. A major impediment to tax compliance is the lack of information flowing from third parties to tax authorities. In contrast to trading in securities in which brokerage firms report trading income to the IRS (e.g., Forms 1099), trading in crypto markets takes place largely outside this third-party reporting system (e.g., Cong et al., 2022). Furthermore, in contrast to the knowledge of bank data that are exchanged internationally on the basis of the Common Reporting Standards, there is no international reporting tax reporting system for cryptocurrency. As cryptocurrency transactions often take place via foreign platforms, the tax authorities have little or no insight into who is active on the crypto market, which amount of these coins is held, and what are crypto traders' gains and losses, especially with respect to cross-border transactions.

Third, regulatory arbitrage and cross-border tax arbitrage opportunities are ample for both crypto exchange service providers and investors. As cryptocurrency largely serves as a medium of exchange for cross-border transactions, jurisdictional gaps in taxation are likely to give rise to regulatory arbitrage (Financial Stability Board 2019; Poster 2019). Recent crypto exchange relocations suggest a pattern of moving from jurisdictions with heavier tax burdens to jurisdictions where cryptocurrency transactions are tax free or the applied tax rate is low. Anecdotally, Binance, the world's largest cryptocurrency exchange, was lured by the tax incentives and moved to Malta in 2018, and OKEx, Bleutrade, and BeQuant followed suits. India's recent move towards heavy crypto taxation prompted a couple of dozens crypto companies, including WazirX (India's largest crypto exchange), Polygon, ZebPay and CoinDCX, to shut down their

operations in India and move to tax-friendlier Singapore and Dubai.[2] Aside from regulatory arbitrage by exchange service providers on the supply side, investors can adopt strategies to reduce *reported* income from cryptocurrencies by either moving trades from markets with heavier tax burdens to markets with lighter or no tax burdens or changing tax residency on the demand side. Cong et al. (2022) find that a campaign targeted solely at US-based crypto exchanges drives traders away from US to non-US exchanges. The relocations of crypto exchanges and investors' moving trades across exchanges and jurisdictions potentially affect the cross-jurisdiction allocation of trading volume and price deviations of the same underlying cryptocurrency.[3] Thus, the effect of taxation is unlikely to be confined to its own jurisdiction.

Fourth, the crypto markets are characterized by high uncertainty about the application and enforcement of tax laws. Generally speaking, the tax implications depend on the type of transactions and whether cryptocurrency is used as a form of payment, speculative investment, and mining activities. However, substantial uncertainty remains as to both the principle underlying taxation of cryptocurrency and the application of tax laws to a specific transaction, such as the tax treatment of staking and decentralized-financing (Defi) products in the United States. While some tax authorities have provided guidance and issued warnings in an attempt to improve compliance of crypto tax laws, direct enforcement actions against violations of crypto tax laws did not occur until very recently and are rather limited.[4] The only notable example is that a Japanese court sentenced a person to one year in prison and the payment of tax arrears of $680,000 for deliberately evading Bitcoin taxes in March 2021. If enforcement of crypto tax laws is not a credible threat, it casts doubt on the potential effect of taxation on crypto pricing.

Last, investors in crypto markets face more short-sale constraints so that they cannot rebalance their portfolio without triggering capital gains taxes liability. The most relevant income tax treatment for investors in exchanges of cryptocurrency is capital gain taxes. A few jurisdictions enacted or proposed

[2] Aside from Dubai, Singapore, and Malta as tax heavens for cryptocurrency, the Cayman Islands and Bermuda also have no capital gains or income taxes (https://coinledger.io/blog/crypto-tax-free-countries).
[3] The crypto tax laws in India resulted in a reduction of crypto trading volume by 30% in 2021 (Chainanlysis, 2021).
[4] The IRS stepped up crypto tax reporting by including a question at the top of the Form 1040 asking if taxpayers had any cryptocurrency activity during the year starting 2020 and is building hundreds of crypto tax evasion cases (https://fortune.com/2021/11/18/irs-may-seize-crypto-valued-at-billions-of-dollars-in-2022-according-to-official/).

crypto tax laws that make no distinction between short-term and long-term capital gains from cryptocurrency trading. For instance, all capital gains from crypto trading are taxed at a 30% flat rate in India. The rise of Defi lending platforms offer potential opportunities to defer taxes and convert otherwise short-term capital gains to long-term capital gains.[5] The lack of distinction between short-term versus long-term gains coupled with the rise of Defi lending platforms implies *less* pronounced discontinuity effect of taxation on crypto prices compared with that on stock prices as modelled in Shackelford and Verrecchia (2002). To summarize, given those unique institutional features, ex ante it is uncertain whether cross-jurisdictional variation in taxation of cryptocurrencies influences the cross-jurisdictional variation in prices of the same underlying cryptocurrency, and if so, whether the tax capitalization effect (demand side) or the lock-in effect (supply side) dominates. This leads to the first hypothesis:

H1: Ceteris paribus, cryptocurrency prices vary with jurisdictional tax burdens on cryptocurrencies.

Second, we hypothesize that price deviations are more sensitive to tax laws when the crypto tax reporting system is more transparent. The two major impediments to compliance with reporting income from cryptocurrency activities is the challenge for tax authorities to identify who is active on the crypto market and the lack of information flowing from third parties to tax authorities regarding crypto traders' gains and losses. For instance, Binance, the largest exchange in the world, did not require KYC until 2021. While most exchanges that operate within the United States are required by law to implement KYC procedures to verify the user's identity, Kraken, one of the largest exchanges in the jurisdiction, requires some customer information, but users can start trading without providing information such as social security number and proof of residence. Kucoin and Bybit allow users to get started with trading on the platform with no KYC. All decentralized exchanges, such as Uniswap and ShushiSwap, do not collect customer information and allow users to start trading once the customer plugs in Ethereum wallets. While trading in crypto markets takes place largely outside this third-party reporting system (e.g., Cong et al., 2022), there

[5] For instance, when considering selling cryptocurrencies that are held less than one year but have appreciated in value, an investor could stake the cryptocurrency for a period of time until it qualifies for the long-term capital gain treatment, which defers the taxable event and results in long-term capital gains.

are a few exceptions. For instance, Coinbase started to issue 1099 forms to the IRS since 2017. IRS issued John Doe Summons to receive customer information from Kraken and Canada Revenue Agency won its first crypto-related customer data request involving Coinsquare in 2021. A couple jurisdictions, such as Japan and Australia, require crypto exchanges provide information about customer crypto activities to tax authorities once the value exceeds certain thresholds.

To summarize, the crypto tax reporting system is more transparent when KYC procedures are in place to verify users' identities and when third parties, especially crypto exchanges, provide information about crypto traders' identities and trading activities to tax authorities. More transparent crypto tax reporting system improves tax compliance, especially compliance with reporting income from cryptocurrency activities. Comparatively, price deviations are expected to be more sensitive to tax laws when the crypto tax reporting system is more transparent. This leads to the second hypothesis:

H2: Price differentials are more sensitive to tax laws when the tax reporting system is more transparent.

Third, jurisdictional gaps in crypto regulation, conceptually another form of friction, are likely to influence the cross-jurisdictional variation in prices of the same underlying cryptocurrency. Forty eight percent of survey respondents rank *regulatory uncertainty* as a top barrier to crypto adoption (PwC 2018), whereas 25% of professional investors cite *lack of regulation* as an appealing aspect of cryptocurrency as an asset class (Fidelity 2020). Therefore, this study differentiates between regulatory uncertainty and the receptiveness of specific cryptocurrency polices and develops two broad predictions. The regulatory uncertainty hypothesis contends that uncertainty in the regulatory framework substantially increases regulatory risks for investors and impairs the ease of doing business for institutions who want to participate in the crypto market as service providers. The increased regulatory risk dampens the demand for cryptocurrencies and the supply of crypto-related services, which negatively influences prices. A *fundamental* question in the regulatory framework is what function cryptocurrencies perform and whether cryptocurrencies satisfy the formal definition of "virtual money." To satisfy the formal definition of money, cryptocurrencies must meet three criteria: unit of account, store of value, and medium of exchange.

Regulators' answer to this fundamental question underscores some major differences in crypto policies across jurisdictions.[6] Without a clearly communicated position by regulators on whether cryptocurrencies satisfy the criteria of money, substantial uncertainty remains on the regulatory framework for cryptocurrencies. The resolution of uncertainty, on the other hand, lowers the inherent risk and increases the asset price (e.g., Kreps and Porteus 1978).

An effective crypto regulation should strike a balance between fostering innovation and protecting investors by putting safeguards in place. The regulatory receptiveness hypothesis contends that more receptive regulatory climates are likely to attract more investors as well as crypto businesses, which increases the demand for and supply of cryptocurrencies and positively influences prices. First, we gauge the receptiveness of the legal standing of cryptocurrencies. The vast majority of jurisdictions consider crypto assets and in particular cryptocurrencies to be "legal" to the extent that those jurisdictions do not prohibit the purchase and sale of crypto assets or their use for the purchase of goods and services. In contrast, many jurisdictions have imposed full or partial bans on cryptocurrencies, which could dampen the demand for cryptocurrencies and/or the supply of crypto-related services and lead to lower crypto prices. Second, crypto exchanges, which are centralized gateways that facilitate money flow between fiat currency and decentralized crypto systems, hold a large number of cryptocurrencies for liquidity demand and as custody for customers. They play a critical and dominant role in the crypto ecosystem (Griffin and Shams 2020; Amiram, Lyandres, and Rabetti 2021). The total volume of cryptocurrencies traded on exchanges (likely for investment and speculation purpose) is much higher than the total volume of on-chain transactions (likely actual usage) (e.g., Cong et al. 2021). For instance, during the first quarter of 2020 alone, the total trading volume was $8.8 trillion (Helms 2020). Regulatory requirements for cryptocurrency exchanges aim primarily at protecting market integrity and investors and fighting illegal activities such as

[6] If regulators formally define cryptocurrencies as virtual money, entities involved in crypto activities, such as crypto exchanges, are money transmitters or money service businesses (MSBs), a status that entails the broad know-your-customer (KYC) compliance obligations common to the banking industry. Moreover, the tax treatment of cryptocurrencies also depends critically on whether regulators define cryptocurrencies as virtual money.

money laundering. The most salient aspect of exchange-based regulation is whether AML and CTF laws apply directly to cryptocurrency exchanges. Cryptocurrency remains appealing for illicit activities, primarily due to its pseudo anonymity and the ease with which it allows users to send funds anywhere in the world (e.g., Foley, Karlsen, and Putniņš 2019; Härdle, Harvey, and Reule 2020; Amiram, Jorgensen, and Rabetti 2022). A lack of mandatory AML/CTF programs is likely to encourage the use of cryptocurrencies for illicit activities. For instance, Foley, Karlsen, and Putniņš (2019) find that approximately one-quarter of Bitcoin users were involved in illegal activities during the period from 2014 to 2017. When a government imposes AML/CTF laws explicitly directed toward crypto exchanges, it dampens the demand for Bitcoins from the *illegal* sector of the economy in the jurisdiction. However, the applicability of AML/CTF laws to crypto exchanges, and the related registration, reporting, and transaction monitoring obligations, improve the overall governance of crypto exchanges and enhance overall investor protection. The enhanced investor protection could attract more mainstream adoption of Bitcoin, which is likely to increase the demand from a broader base of market participants for *legitimate* transactions. The net pricing effect of the applicability of AML/CTF laws ultimately depends on which effect dominates. This leads to the third hypothesis:

H3a: Ceteris paribus, prices are lower in jurisdictions with higher regulatory uncertainty.
H3b: Ceteris paribus, prices are higher in jurisdictions with more receptive regulation.

Last, we hypothesize that the influence of cryptocurrency taxation and regulation on price differences varies with capital controls and market segmentation. Market segmentation is a *necessary* condition for the existence of the large price differences for seemingly identical assets in different markets (e.g., Cochrane, 2008). Empirically, Borri and Shakhnov (2022) find that the price differences in bitcoin pairs (against different fiat or cryptocurrencies) traded in exchanges located in countries with *limited or no* capital controls are significant lower. Accordingly, the influence of cryptocurrency taxation and regulation on price differences is likely to be only confined to jurisdictions with tighter capital controls. Furthermore, an exchange whose server is located in one country can operate and market to investors in many jurisdictions. Yet taxation and regulation are different across jurisdictions. As anecdotal evidence, when

Germany passed stricter requirements for crypto businesses relative to other EU members, many crypto businesses stopped operations in Germany and moved to other EU countries. The presence of regulatory arbitrage and cross-border tax arbitrage implies that, comparatively, the influence of one jurisdiction's crypto regulation and taxation is more pronounced for crypto exchanges that predominately serve domestic investors than those that largely serve the global market. This leads to the fourth hypothesis:

H4: Comparatively, the effect of taxation and regulation on price differentials is more pronounced for jurisdictions with tighter capital controls and for exchanges that predominantly serve domestic markets.

3. Data and descriptive statistics

3.1. Data, characterization of taxation and regulation, and empirical design

The panel dataset is a comprehensive collection of Bitcoin prices against fiat currencies from January 2017 to December 2021. We only include bitcoin-to-fiat pairs because investors in different countries trade different bitcoin pairs, for example, U.S. investors trading bitcoin-to-dollar while Japanese investors trading bitcoin-to-yen. We exclude bitcoin-to-crypto pairs because capital flow restrictions ae less binding for the bitcoin-to-crypto pairs (Makarov and Schoar, 2020). We source the Bitcoin price data series from exchanges' orderbooks through the application programming interfaces (APIs) provided by the crypto exchanges. Using the platform-oriented approach, this study uses the URL of the exchange to classify the jurisdiction in which the exchange's server is located as the impacted jurisdiction.[7] The server location is not necessarily a good indicator of the client location, and therefore we use the clientele-oriented approach as an alternative. Under the clientele-oriented approach, this study uses web traffic tools, such as SimilarWeb, to identify the jurisdiction that hosts the largest customer base of the exchange and use this jurisdiction as the affected jurisdiction. Figure 2 illustrates the traffic breakdown of users by geography on Gemini.com as an example. Given that 58% of the IP addresses of users are located in the U.S., the

[7] The jurisdiction in which a crypto exchange's servers are located is not necessarily identical as the registration jurisdiction. For instance, Bitfinex is registered in the British Virgin Islands, but its servers are located in Switzerland (https://docs.tardis.dev/historical-data-details/bitfinex). Kucoin is based in Hong Kong, but its servers are located in Japan as indicated by https://github.com/Kucoin-academy/best-practice/blob/master/README_EN.md. Results are similar when we use the registration jurisdiction.

jurisdiction that hosts the largest customer base is the United States. Thus, under the clientele-oriented approach, US is classified as the affected jurisdiction for Gemini. A relevant feature of the cryptocurrency market is that trading occurs 24 hours a day, 7 days a week, and can occur in multiple crypto exchanges. Accordingly, daily Bitcoin prices against fiat currencies are observed at 12:00 a.m. Coordinated Universal Time (UTC) of the day to ensure that there are no time lags or leads in cryptocurrency prices across all exchanges. To facilitate consistent comparisons, Bitcoin prices quoted in local fiat currencies are converted to U.S. dollars using official exchange rates. To ensure minimum liquidity, we delete observations where the exchange's daily transaction value is less than $10,000. The final sample consists of 40,048 exchange-day observations across forty-two crypto exchanges whose servers are located in twenty-one jurisdictions and whose largest customer bases are located in thirty-one jurisdictions.

Panel A of table 1 provides a list of the exchanges and the jurisdictions in which their servers are located. According to www.CoinMarketCap.com, there were over 300 crypto exchanges specializing in spot markets as of March 2021. However, the vast majority of those exchanges have rather limited or low trading activity (less than 100 Bitcoins traded per trading day). Although our dataset covers only forty-two exchanges, the combined Bitcoin trading volume of all exchanges in the sample accounts for 96% of the world's total Bitcoin trading volume during the five-year sample period, confirming their economic significance. For instance, Binance, the largest exchange by trading volume, accounts for about 49% of the total Bitcoin trading volume in 2020 and 69% in 2021. Academic studies find evidence of fake trading volumes reported by crypto exchanges (e.g., Aloosh and Li 2021; Cong et al. 2021; Amiram, Lyandres, and Rabetti 2021). Crypto exchanges have strong economic incentives to inflate reported trading volumes to increase brand awareness and ranks on third-party aggregator websites such as CoinMarketCap and CoinGecko. This is because exchanges with larger self-reported trading volumes are likely to attract more new users, which in turn increases the exchanges' profits from transaction fees. The quality of trading volume data is of less concern for our dataset because all ten exchanges that are identified by Bitwise Asset Management as having real Bitcoin trading volume are included in the sample. Furthermore, six exchanges in the sample rank among the top ten exchanges by Nomics, a data provider that claims to be less likely to

include wash trading volume in exchange ranking criteria. Compared with the issue in reported trading volumes, the quality issue in prices quoted in exchange orderbooks is expected to be less severe. Crypto exchanges have less financial incentive to fake prices because exchange-owned accounts (possibly using algorithm trading robots) have to execute Bitcoin trades at the quoted price.

We use equation (1) to examine whether and how cryptocurrency taxation and regulation explain Bitcoin price deviations in various jurisdictions:

$$BTCPRICEDEVIATIONipt = \alpha + \boldsymbol{\beta 1} * \boldsymbol{INCOMETAXit} + \boldsymbol{\beta 2} * \boldsymbol{VATit} + \boldsymbol{\beta 3} * \boldsymbol{PROPERTYTAXit} + \boldsymbol{\beta 4} * \boldsymbol{INCOMETAXit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 5} * \boldsymbol{VATit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 6} * \boldsymbol{PROPERTYTAXit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 7} * \boldsymbol{REGCLARITYit} + \boldsymbol{\beta 8} * \boldsymbol{LEGALITYit} + \boldsymbol{\beta 9} * \boldsymbol{AMLCTFit} + \boldsymbol{\beta 10} * \boldsymbol{ENFORCEMENTit} + \boldsymbol{\beta 11} * \boldsymbol{REGCLARITYit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 12} * \boldsymbol{LEGALITYit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 13} * \boldsymbol{AMLCTFit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 14} * \boldsymbol{ENFORCEMENTit} * \boldsymbol{CAPITALCONTROLit} + \beta 15 * CAPITALCONTROLit + \beta 16 * Ln(EXCHANGETRADEVOLUMEipt) + \beta 17 * ATTENTIONit + \beta 18 * Ln(GDPpercapita)it + \beta 19 * GDPGROWTHit + \beta 20 * INFLATIONit + \beta 21 * STOCKRETURNit + \beta 22 * Ln(HACKDAMAGEit) + YEARt + \varepsilon \qquad \textit{Equation (1)}$$

where *i* indexes jurisdiction, *p* indexes exchange platform, and *t* indexes day. The dependent variable is the daily Bitcoin price deviation relative to the world market price (*BTCPRICEDEVIATION*). The world market price is defined as the average Bitcoin price across all exchanges included in the sample that have an active price quote on day *t*. Accordingly, $BTCPRICEDEVIATION_{ipt}$ is measured as the quoted price of Bitcoin on exchange platform *p* that is located in country *i* minus the average price across all exchanges normalized by the average price at day *t*. As capital controls and market segmentation are the necessary condition for the price deviation to persist, *CAPITALCONTROL* is included to interact with taxation and regulation of cryptocurrency. *CAPITALCONTROL* measures the restrictions to capital flows imposed by each jurisdiction, which is obtained from Fernández et al. (2016) and is the same measure as that used by Makarov and Schoar (2020).

We use the following three sources to systematically characterize the income tax, VAT, and property tax burdens of crypto transactions and businesses. The primary source is the OECD report entitled "*Taxing Virtual Currencies: An Overview of Tax Treatments and Emerging Tax Policy Issues*" (OECD, 2020). The OECD report summarizes the responses from 50 countries to a questionnaire, which covered guidance provided by each country in relation to the definitions of virtual currencies for tax purposes, and key taxable

events under income taxes and VAT. The second source is *PwC Annual Global Crypto Tax Report* (PwC, 2020, 2021), which sought inputs from tax specialists working at various international offices on the development of digital tax regulations in their respective jurisdictions. The third source is the book entitled "*Taxation of Crypto Assets*" (Schmidt et al. 2021).

Specifically, we measure the receptiveness of the income tax treatment of crypto transactions by the income tax burden on both exchanges of cryptocurrencies (*EXCHANGEINCOMETAX*) and the creation (mining) of cryptocurrencies (*MININGINCOMETAX*). In particular, the receptiveness of the income tax treatment decreases with the number of income tax burdens and decreases with the range of its applicability to distinct groups of market participants. First, *EXCHANGEINCOMETAX* captures the income tax burdens on exchanges of cryptocurrencies. Broadly speaking, there are three types of exchanges of cryptocurrencies: (1) the exchange of cryptocurrencies for fiat currencies; (2) the exchange of cryptocurrencies for other types of cryptocurrencies; (3) the exchange of cryptocurrencies for goods and services. *TAXABLEEXCHANGES* is the number of the types of exchanges that are subject to income taxes, which could take a value of between 0 and 3. Among jurisdictions that impose income taxes on any type of exchange of cryptocurrencies, some jurisdictions apply the same income tax treatment for personal and business exchanges, whereas others apply lower income tax rates or more income tax exemptions to personal exchanges than business exchanges. *TAXAPPLICABILITY* is 2 if the income tax treatment of crypto exchanges is identical for the two group of users, 1 if the income tax imposed on personal entities for exchanges is lower than business exchanges and 0 if income taxes are applicable to neither personal nor business exchanges. Accordingly, *EXCHANGEINCOMETAX* is equal to the number of types of exchanges that are subject to income taxes multiplied by the indicator variable for the lower tax rates or more exemptions for personal exchanges. *EXCHANGEINCOMETAX* is most favorable and takes the value of 0 when no income taxes apply to any type of exchange and *EXCHANGEINCOMETAX* is least favorable and takes the value of 6 if all three types of exchanges are subject to income tax and the income tax treatment of exchanges is the same for personal trading as for business purposes. For instance, in the United States, *TAXABLEEXCHANGES* is 3 because the following three types of exchanges are subject to income taxes:

(1) the exchange of cryptocurrencies for fiat currencies; (2) the exchange of cryptocurrencies for other types of cryptocurrencies; and (3) the exchange of cryptocurrencies for goods and services. *TAXAPPLICABILITY* is 1 because the income tax imposed on personal entities for exchanges is lower than business exchanges. Accordingly, *EXCHANGEINCOMETAX* takes the value of 3 (3 multiplied by 1) in the United States.

Second, *MININGINCOMETAX* captures the income tax burdens on mined cryptocurrencies. *MININGINCOMETAX* is least favorable and takes the value of 4 if the first taxable event for mined crypto is the receipt of a new token from mining. *MININGINCOMETAX* takes the value of 3 if the first taxable event for mined crypto depends on whether mining takes place for business rather than personal purposes. *MININGINCOMETAX* takes the value of 2 if the first taxable event for mined crypto is disposal of mined tokens. *MININGINCOMETAX* takes the value of 1 if the income tax treatment of mined cryptocurrencies is not clear. *MININGINCOMETAX* is most favorable and takes the value of 0 if there is explicitly no income tax for mining. For instance, in the United States, the first taxable event for mined cryptocurrency is the receipt of a new token from mining, and therefore, *MININGINCOMETAX* is 4.

As *INCOMETAX* is a composite measure of the income tax burdens, *INCOMETAX* is measured as *EXCHANGEINCOMETAX* scaled by maximum value of 6 and *MININGINCOMETAX* scaled by maximum value of 4. The maximum (minimum) value for *INCOMETAX* is 2 (0), which implies the least (most) receptive income tax treatment. In the United States, given that the first component is one-half (3 divided by 6) and the second component is one (4 divided by 4), *INCOMETAX* takes the value of 1.5. The maximum (minimum) value for *INCOMETAX* is 2 (0), which implies the least (most) receptive income tax treatment.

VAT is a composite measure of the VAT burdens of crypto transactions, which measures VAT burdens on various types of crypto transactions and crypto service platforms. *VAT* takes the value of 0 when there is no VAT in the country's existing tax system or the tax authorities have explicitly stated that crypto transactions are not subject to VAT. For instance, in the United States, there is no VAT in the existing tax system, *VAT* is 0. The value of *VAT* increases by one additional point from the baseline of 0 if VAT is applicable to one of the following transactions or crypto business entities: the mining of cryptocurrencies; the exchange of cryptocurrency for other virtual or fiat currencies; the supply of goods and services paid

for using cryptocurrencies; exchange platforms; and digital wallets. For instance, Germany applies VAT to the supply of goods and services paid for in cryptocurrency, to intermediation supplied by exchange platforms, and to services provided by digital wallets, its score for *VAT* is 3. The maximum score for *VAT* is 5, which implies the highest VAT burden and least favorable VAT treatment.

PROPERTYTAX measures the receptiveness of the property tax treatment of cryptocurrency. *PROPERTYTAX* takes the value of 0 when there is no property tax in the country's existing tax system or the tax authorities have explicitly stated that crypto transactions are not subject to property tax. *PROPERTYTAX* takes the value of 1 when cryptocurrencies are subject to either inheritance or wealth tax and takes the value of 2 when cryptocurrencies are subject to both inheritance and wealth taxes. For instance, in Switzerland, cryptocurrencies held by individuals are taxable under movable capital assets and are subject to wealth taxes, and thus, *PROPERTYTAX* is 1. The maximum (minimum) score for *PROPERTYTAX* is 2 (0). A higher score for *PROPERTYTAX* implies a higher property tax burden on cryptocurrency and less receptive property tax treatment.

Table 1 summarizes the regulatory framework and the receptiveness of specific crypto policies for the sample jurisdictions and figure 1 depicts the world map of the regulatory landscape. We define the regulatory variables as follows. *REGCLARITY* is an indicator variable that takes the value of 1 when regulators have clearly communicated their position on whether cryptocurrencies satisfy the criteria of virtual money, and 0 otherwise. *LEGALITY* is the legal standing of cryptocurrencies that takes a value ranging from 0 to 5 depending on the number of restrictions imposed on cryptocurrencies or businesses engaged in crypto transactions. *LEGALITY* takes the value of 0 if the legal status is most favorable, that is, jurisdictions do not prohibit the purchase and sale of crypto assets or their use for the purchase of goods and services. The value of *LEGALITY* increases by 1 from the baseline value of 0 for each additional restriction on cryptocurrencies or businesses engaged in crypto transactions. For instance, Indonesia has banned the use of cryptocurrencies as a means of payment; *LEGALITY* is 1 for Indonesia. In 2017, China banned commercial cryptocurrency trading platforms and ICOs, and prohibited regulated financial institutions from engaging directly or indirectly facilitating other parties engaged in crypto-related

activities. Accordingly, *LEGALITY* is 3 for China. *LEGALITY* takes the value of 5 if the legal status is least favorable, that is, a general ban is imposed on cryptocurrencies. For instance, in 2018, Saudi Arabia banned the use of cryptocurrencies and any transaction involving cryptocurrencies. A higher value of *LEGALITY* implies more restrictions on cryptocurrencies and thus a less receptive legal framework for cryptocurrencies. The receptiveness of exchange-based regulation is measured by whether AML/CTF laws apply directly to cryptocurrency exchanges. *AMLCTF* is an indicator variable that takes the value of 1 when the AML/CTF laws apply to cryptocurrency exchanges, and 0 otherwise. *ENFORCEMENT* is the number of enforcement actions against violations of exchange-based regulations. Enforcement actions are hand collected from various sources, including enforcement announcements made by regulatory agencies.[8]

In equation (1), we include a set of control variables. The first control variable is for the daily Bitcoin trading volume (in U.S. dollars) on the specific crypto exchange platform (*EXCHANGETRADEVOLUME)*, which controls for the liquidity at the *exchange* level. The next two control variables capture the level and growth of economic development and activity, which include both gross domestic product (GDP) per capita (*GDPpercapita*) and its growth rate (*GDPGROWTH*). To be consistent with the denomination for Bitcoin prices, *GDPpercapita* in local fiat currency is converted into U.S. dollars using purchasing power parity. The fourth control variable is the aggregate stock return (*STOCKRETURN*), which is included to account for correlation with other asset classes as a vehicle for investment or speculation. The fifth control variable is the inflation rate (*INFLATION*). As pundits in Bitcoin claim, Bitcoin could serve as a store value and hedge against debasement of fiat currencies and inflation. If so, the higher the inflation rate, the higher the value of Bitcoin as a store of value, the higher the Bitcoin price. *HACKDAMAGE* is measured as the damage in U.S. dollars caused by hacks on exchanges located in a given country or region, which is included to control for the technology risk of crypto exchanges. As Liu and Tsyvinski (2021) find that investor attention strongly predicts future cryptocurrency cumulative returns, we include investor attention (*ATTENTION*) as

[8] For instance, CipherTrace.com provides updates on enforcement actions against violations of AML/CTF laws and Cornerstone Research summarizes SEC cryptocurrency enforcement actions at https://www.cornerstone.com/wp-content/uploads/2022/01/SEC-Cryptocurrency-Enforcement-2021-Update.pdf.

the last control variable. *ATTENTION* is measured as the daily Google search statistics for "Bitcoin" or "BTC" in a country. Google trends provide the relative search volume for a keyword indexed between 0 and 100 for a given period. Zero indicates the lowest relative search interest for the given keyword, whereas 100 indicates the maximum search interest within the selected time range.

3.2. Descriptive statistics

Panel A of table 2 presents the descriptive statistics of the sample. The mean (median) daily Bitcoin return is 0.28% (0.22%) and the standard deviation is 3.53%. By construction, the mean price deviation relative to the world market price is zero. However, the median price deviation is -0.14% with a standard deviation of 2.55%. The maximum (minimum) price deviation is 42.58% (-20.99%). On average, regulators have clearly communicated their position on whether cryptocurrencies satisfy the criteria of money and have imposed some legal restrictions on cryptocurrencies. For a representative jurisdiction, income taxes and VAT are applicable to crypto transactions, AML/CTF laws are directly applicable to crypto exchanges, and no regulatory actions have been taken against violations of crypto-related laws. On average, income tax burdens on the creation (mining) of cryptocurrencies (*MININGINCOMETAX*) is 1.91 out of 4 and income tax burdens on exchanges of cryptocurrencies (*EXCHANGEINCOMETAX*) is 2.08 out of 6.

Panel B of table 2 presents the average of daily Bitcoin price deviations by jurisdiction and by year. The descriptive statistics suggest that the Bitcoin price deviation relative to the world market price is dynamic and varies over time within a jurisdiction. It is worth noting that the daily Bitcoin price series is not a balanced dataset largely due to two factors. First, commercial crypto exchanges are new forms of business entities that started operations in different countries at different times, which results in the varying lengths of daily Bitcoin time series in different countries. Second, when countries, such as China, banned all domestic cryptocurrency exchanges, many exchange platforms withdrew from the market and moved to other jurisdictions. For instance, Okcoin moved from China to Hong Kong in late 2017. As reported in column 2, due to varying time periods that various crypto exchanges are in operation, the number of observations and the average Bitcoin price deviation vary significantly across jurisdictions. Eleven exchanges locate their servers in the United States and the United Kingdom and thus the two countries

account for one third of the total number of exchange-day observations. As reported in column 3, during the entire sample period, the Bitcoin price in the United Kingdom is close to the world market price as evident from the average value of -0.08%. The average Bitcoin price deviation in the United States is -0.55%. Brazil and the Republic of Korea, whose average price deviations are 3.33% and 1.58%, respectively, have the highest Bitcoin premium. Russia and China, whose average price deviations are -2.74% and -2.63%, respectively, have the highest Bitcoin discount. We then report the average of Bitcoin price deviations by year. Consistent with a Bitcoin price premium in the Republic of Korea (a Kimchi *premium*) from December 2017 through February 2018, we find that the average price deviations in the Republic of Korea are 4.13% and 2.35% in 2017 and 2018, respectively. However, Bitcoin prices in the Republic of Korea are slightly lower than the world market price subsequently, as evident from an average price deviation of -0.93% and -0.30% in 2019 and 2020, respectively.

4. Baseline results and comparative statistics

4.1. Baseline cross-jurisdictional results on taxation and price deviations

Panel A of table 3 presents the regression results when the dependent variable is the Bitcoin price deviation relative to the world market price and the variable of interest is taxation of cryptocurrency. As some jurisdictions have more than one cryptocurrency exchanges and macro-economic variables are only available on the annual basis rather than on the daily frequency, standard errors are cluster-adjusted by both exchange and year in all multivariate analyses, which accounts for correlations of the error terms within the same exchange over time (Petersen 2009). We do not include country fixed effect in the baseline analysis because capital control values subsume country-fixed effects without interaction terms between taxation (regulation) variables with capital controls.

First, we use the platform-oriented approach under which the jurisdiction in which the server of the exchange is located is classified as the affected jurisdiction. As shown in column 1, all control variables, including exchange liquidity, macro variables, damage from exchange hacks, investor attention, and capital controls, collectively explain about 3.3% of the variation in cross-jurisdiction in Bitcoin price deviations.

Bitcoin price deviations are lower in jurisdictions with higher GDP growth and are higher in countries with tighter capital controls. Column 2 presents the implications of tax policies on Bitcoin price deviations under the platform-oriented approach. Using the 3.3% explanatory power of the model without tax variables as the benchmark, we find that a combination of tax policies and control variables explains 4.4% of the cross-jurisdiction variation in Bitcoin price deviations. The slope coefficient on *INCOMETAX* is -0.003 and statistically significant with a $t(p)$ value of -1.703 (0.09). The lower Bitcoin prices for jurisdictions that impose heavier income tax burdens on crypto transactions is consistent with the tax capitalization hypothesis. It implies that, despite a number of unique institutional features of crypto markets, investors incorporate the income tax consequences and need to be compensated for income taxes paid on cryptocurrency. The slope coefficient on *VAT* and *PROPERTYTAX* are statistically insignificant.

Second, we use the clientele-oriented approach under which we classify the jurisdiction in which the largest customer base of the exchange is located as the affected jurisdiction. To ensure a material impact of tax laws, we require a minimum level of geographical investor concentration: at least 10% of investors are located in the affected jurisdiction. Accordingly, the number of observations decreases to 23,276 as reported in column 3 and column 4. Column 4 presents the results under the clientele-oriented approach. Using the 6.6% explanatory power of the model without tax variables as the benchmark, we find that a combination of tax policies and control variables explains 10.2% of the cross-jurisdiction variation in Bitcoin price deviations. The slope coefficient on *INCOMETAX* is -0.018 and statistically significant. While the implications of income taxes on crypto pricing are *qualitatively* similar under the two approaches, the magnitude of the slope coefficient on *INCOMETAX* under the clientele-oriented approach is about six times of that under the platform-oriented approach. The significant difference in the economic magnitude under the two approaches indicates that the tax residency of investors on the exchange matters more for the tax capitalization effect than the exchange's location, which is consistent with the institutional feature that income tax is levied in the investor's county of tax residency.

Panel B of table 3 presents the implications of income tax burdens on the mining of cryptocurrencies and income tax burdens on the exchanges of cryptocurrencies respectively. As shown in column 1, without

VAT in the regression, the slope coefficient on *INCOMETAX* is -0.003 and statistically significant with a *p*-value of 0.09, suggesting that the Bitcoin price is lower in jurisdictions that apply heavier income tax burdens on crypto transactions. We next examine whether the two components of the income tax burden, namely *MININGINCOMETAX* and *EXCHANGEINCOMETAX*, are associated with the jurisdictional gap in Bitcoin prices. Per column 2, the slope coefficient on *MININGINCOMETAX* is statistically insignificant. In contrast, as shown in column 3, the slope coefficient on *EXCHANGEINCOMETAX* is -0.001 and statistically significant, suggesting that the Bitcoin price deviation is lower in jurisdictions that apply heavier income tax burdens on the exchange of cryptocurrencies. We further break down the income tax treatment of exchanges of cryptocurrencies into the number of taxable exchanges and the applicability of taxable exchanges to distinct groups of market participants. As shown in column 4(5), the Bitcoin price deviation decreases with *TAXABLEEXCHANGES* (*TAXAPPLICABILITY)*.

4.2. The tax capitalization effect and transparency of the crypto tax reporting system

Table 4 presents the regression result on whether Bitcoin price deviations are more sensitive to tax laws when the tax reporting system is more transparent. We capture two aspects of transparency in the tax reporting system. The first dimension is whether the KYC procedure is in place. *KYC* is an indicator variable that takes the value of 1 when the exchange implements KYC procedures to verify a user's identity before the user can start trading either voluntarily or mandated by laws, and 0 otherwise. 87% of observations have KYC procedure in place. As reported in panel A of table 4, Bitcoin price deviations are more sensitive to tax laws when KYC procedure is in place to verify a user's identity. For instance, the slope coefficient on *INCOME*KYC* is -0.002 and statistically significant with a t(p)-value of 2.873(0.001). The slope coefficients on *VAT*KYC* and *EXCHANGEINCOMETAX*KYC* are negative and statistically significant.

The second dimension is the information flow from third parties, in this case, crypto exchanges, to tax authorities. When crypto exchanges provide information on traders' identities and crypto trading activities, tax authorities are able to compare the specific information against filed tax returns, which ensures better compliance in reporting income from crypto trading. *INFOFLOW* is an indicator variable that takes the value of 1 when the exchange provides information about customer identities and customer

trading activities to tax authorities either ordered by court ruling or mandated by the jurisdiction's exchange reporting rules, and 0 otherwise. The average *INFOFLOW* is 0.06, suggesting that the overall the information flow from third parties to tax authorities is rather limited. As reported in panel B of table 4, Bitcoin price deviations are more sensitive to tax laws, especially income tax laws, when more information about trading activities flows from crypto exchanges to tax authorities. For instance, the slope coefficient on *INCOME*INFOFLOW* is -0.021 and statistically significant with a t(p)-value of 3.333(0.001). The slope coefficients on the interaction between *INFOFLOW* and income tax burdens on exchanges of cryptocurrency (and its component) are also negative and statistically significant. To summarize, more transparent crypto tax reporting system enhances compliance in reporting income from crypto activities, and thus, the tax capitalization effect is more pronounced.

4.3. Baseline cross-jurisdictional results on regulation and price deviations

Table 5 presents the regression results when the variable of interest is cryptocurrency regulation. Because specific regulatory policies depend on the regulators' stance on whether cryptocurrencies satisfy the criteria of money, different dimensions of crypto regulation are highly correlated, as evident from panel C of table 2. Therefore, we examine the influence of the various dimensions of regulation on a stand-alone basis. As shown in column 1 of table 5, the slope coefficient on *REGCLARITY* is 0.006 and statistically significant with a *p*-value of 0.08. As shown in column 2, the slope coefficient on *LEGALITY* is negative but not statistically significant. Column 3 presents the implications of exchange-based regulation on Bitcoin prices. The Bitcoin price is lower in countries where the AML/CTF laws apply directly to crypto exchanges. The net *negative* effect suggests that the applicability of AML/CTF laws to cryptocurrency exchanges dampens the demand for Bitcoin from the *illegal* sector of the economy. Furthermore, the decline in *illicit* use of Bitcoin is, on average, more than the potential increase in demand for Bitcoin from a broader base of market participants for *legitimate* transactions as a result of enhanced investor (consumer) protection. As shown in column 4, the slope coefficient on *ENFORCEMENT* is statistically insignificant.

4.4. Comparative statistics on taxation, regulation, and crypto pricing by market segmentation

The first two panels of table 6 report the comparative statistics on taxation and the Bitcoin price deviation. As shown in column 1 of panel A, the slope coefficient on *INCOMETAX*CAPITALCONTROL* is -0.017 and statistically significant with a *t(p)*-value of -1.794 (0.07), suggesting that the price deviation is more sensitive to the income tax burden in jurisdictions with tighter capital controls. As shown in column 2, the slope coefficient on *VAT*CAPITALCONTROL* is -0.012 and statistically significant with a *t*(*p)*-value of -2.646 (0.01), suggesting that the price deviation is more sensitive to the VAT burden in jurisdictions with tighter capital controls. The comparative statistics are largely consistent with the hypothesis that the tax capitalization effect is more pronounced in jurisdictions with tighter capital controls.

Panel B of table 6 presents the results on whether the relation between taxation and the Bitcoin price deviation varies with an exchange's customer base. An exchange is classified either as dominated by domestic investors or as dominated by global investors. Domestic investors are defined as those from the jurisdiction in which an exchange's server is located and dominance is defined as accounting for more than 50% of the customer base of the exchange. *LOCALEXCHANGE* is defined as 1 if an exchange's customer base is dominated by domestic investors and 0 otherwise. As we cannot identify the geographical distributions of customer bases for six exchanges, the number of exchange-day observations reduces to 36,209. The main effect on *LOCALEXCHANGE* is consistently positive and statistically significant. As shown in column 1, the slope coefficient on *INCOMETAX*LOCALEXCHANGE* is -0.008 and statistically significant with a *t(p)*-value of -2.056 (0.04), suggesting that the negative relation between the price deviation and the income tax burden is more pronounced for exchanges that predominantly serve local investors. As shown in column 2, the slope coefficient on *VAT*LOCALEXCHANGE* is -0.006 and statistically significant with a *t*(*p)*-value of -2.048 (0.03), suggesting that the negative relation between the price deviation and the VAT burden is more pronounced for exchanges that predominantly serve domestic investors. The comparative statistics are largely consistent with the hypothesis that the Bitcoin price deviation is more sensitive to the income tax treatment and the VAT treatment of crypto transactions for exchanges that predominantly serve the domestic market. To summarize, panel A and panel B collectively

suggest that, when there are less opportunities for cross-border tax arbitrage, jurisdictional gaps in taxation of cryptocurrency have a more pronounced effect on Bitcoin price deviations.

The last two panels of table 6 report comparative statistics on the relation between the Bitcoin price deviation and the receptiveness of cryptocurrency regulation. As shown in column 2 of panel C, the slope coefficient on *LEGALITY*CAPITALCONTROL* is -0.020 and statistically significant with a *t(p)*-value of -1.908 (0.06), suggesting that the negative relation between the price deviation and the number of legal restrictions on cryptocurrency is more pronounced in jurisdictions with tighter capital controls. As shown in column 3, the slope coefficient on *AMLCTF*CAPITALCONTROL* is -0.045 and statistically significant with a *t* (*p)*-value of -3.364 (0.01), suggesting that the negative relation between the price deviation and the applicability of AML laws is more pronounced in jurisdictions with tighter capital controls. As shown in column 2 of panel D, the slope coefficient on *LEGALITY*LOCALEXCHANGE* is -0.012 and statistically significant with a *t*(*p*)-value of -3.246 (0.001), suggesting that the negative relation is more pronounced for exchanges whose customer bases are predominantly domestic investors. Furthermore, the explanatory power of the model with the interaction term increases to 11%, more than triple that of the benchmark model without regulatory variables. As shown in column 3, the slope coefficient on *AMLCTF*LOCALEXCHANGE* is -0.016 and statistically significant with *t*(*p*)-value of -2.869 (0.001), suggesting that the negative relation between the price deviation and the applicability of AML laws is more pronounced for exchanges that predominantly serve domestic investors. To summarize, the comparative statistics as reported in panel C and panel D are largely consistent with the hypothesis that the Bitcoin price deviation is more sensitive to the receptiveness of cryptocurrency regulation for jurisdictions with tighter capital controls and for exchanges that predominantly serve the domestic market. The comparative statistics is largely consistent with the market segmentation framework.

5. Identification strategies for the effect of regulation on crypto pricing

5.1. Difference-in-differences analysis before and after the passage of cryptocurrency laws

Some may argue that certain country-level differences not considered in equation (1) could drive the baseline association between jurisdictional differences in regulation and price differentials in Bitcoin. For instance, a country's existing banking system matters to the marginal investor or user of cryptocurrencies because a payment system using cryptocurrencies challenges the traditional roles that banks have always played. The existing banking system also matters because using cryptocurrencies could enable a large portion of the unbanked population to join the modern world of internet commerce (e.g., Howell, Niessner, and Yermack 2020). As Bertrand, Duflo, and Mullainathan (2004) discuss, the differences-in-differences approach has become an increasingly popular research design for identifying causal effects. To address the endogeneity of regulation adopted by different jurisdictions (an omitted correlated variable problem) and identify the effect of taxation and regulation on cryptocurrency prices, the first identification strategy is the use of a difference-in-differences design that includes country-specific and time-specific fixed effects and compares Bitcoin price deviations before and after major regulatory updates on cryptocurrencies within a specific country or region.

We utilize the staged adoptions of specific cryptocurrency policies in the difference-in-differences design. Table 7 summarizes major regulatory updates on cryptocurrencies during the sample period. Specifically, to control for omitted correlated variables (both observable and unobservable), we use the following difference-in-differences design to identify the effect of regulation on cryptocurrency prices:

$$BTCPRICEDEVIATIONipt = \alpha + \boldsymbol{\beta 1} * \boldsymbol{POSTINCOMETAX}it + \boldsymbol{\beta 2} * \boldsymbol{POSTINCOMETAXit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 3} * \boldsymbol{POSTFRAMEWORKit} + \boldsymbol{\beta 4} * \boldsymbol{POSTFRAMEWORKit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 5} * \boldsymbol{POSTBAN}it + \boldsymbol{\beta 6} * \boldsymbol{POSTBANit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 7} * \boldsymbol{POSTAMLit} + \boldsymbol{\beta 8} * \boldsymbol{POSTAMLit} * \boldsymbol{CAPITALCONTROLit} + \boldsymbol{\beta 9} * \boldsymbol{POSTENFORCEMENTit} + \boldsymbol{\beta 10} * \boldsymbol{POSTENFORCEMENTit} * \boldsymbol{CAPITALCONTROLit} + \beta 11 * Ln(EXCHANGETRADEVOLUME)ipt + \beta 12 * CAPITALCONTROLit + YEARt + COUNTRYi + \varepsilon \qquad \textit{Equation (2)}$$

where *i* indexes countries, *p* indexes exchange platform, and *t* indexes time. *COUNTRY* is the country fixed effect and *YEAR* is the time fixed effect. *POSTINCOMETAX* is an indicator variable set equal to 1 after income taxes are imposed on cryptocurrency transactions, and 0 otherwise. *POSTFRAMEWORK* is an indicator variable set to 1 after the country has established a regulatory framework for cryptocurrency, and 0 otherwise. *POSTBAN* is an indicator variable set to 1 after the regulator imposes at least one restriction

on cryptocurrency or crypto-related businesses, and 0 otherwise. *POSTAML* is an indicator variable that takes the value of 1 after the application of AML/CTF laws to cryptocurrency exchange platforms, and 0 otherwise. *POSTENFORCEMENT* is an indicator variable that takes the value of 1 after a jurisdiction takes enforcement actions against exchange-based or tax-related crypto regulation, and 0 otherwise. As capital controls and market segmentation are the necessary condition for persistent price deviations, *CAPITALCONTROL* is included to interact with the before-and-after indicator for specific crypto policies.

The identifying assumption in this research design is that the daily price deviation relative to the world market price would have been the same absent the passage of cryptocurrency rules and laws. Accordingly, the difference-in-differences design identifies the causal effect of regulation and taxation on cryptocurrency prices by using the trend in the Bitcoin price deviation in jurisdictions that did not have a specific policy on cryptocurrencies in effect during a given period as the counterfactual outcome. As discussed in Armstrong, Balakrishnan, and Cohen (2012), estimating equation (2) allows for different jurisdictions that passed different laws on cryptocurrencies at different times. The staggered passage of the crypto-related laws means that our control group is not restricted to jurisdictions that never passed laws on cryptocurrencies. Instead, the control group includes all countries without a cryptocurrency law at time *t*, even if the jurisdiction has since passed, or will pass (sometime after time *t*), cryptocurrency-related laws. Following Bertrand, Duflo, and Mullainathan (2004) and Armstrong, Balakrishan, and Cohen (2012), we add country and year indicators to control for time and country fixed effects. Furthermore, we include the daily trading volume at the exchange (*EXCHANGETRADEVOLUME*) to control for *exchange-level* liquidity.

Table 8 presents the results on the difference-in-differences design for daily Bitcoin deviations from the world market price. The difference-in-differences results are largely consistent with the baseline results. The difference-in-differences design with country and year fixed effects explains about 13% of cross-jurisdictional variation in price deviations. As shown in column 1 of table 8, while the slope coefficient on *POSTINCOMETAX* is not statistically significant, the slope coefficient on the interaction term between *POSTINCOMETAX* and *CAPITALCONTROL* is negative and statistically significant, suggesting that the decline in the Bitcoin price deviation is more pronounced for jurisdictions with tighter capital controls after

the jurisdiction imposes income taxes on crypto transactions. As shown in column 2, the slope coefficient on *POSTFRAMEWORK* is 0.01 and statistically significant with a *p*-value of 0.03, suggesting that Bitcoin trades at a higher price relative to the world market price after the jurisdiction establishes a regulatory framework for cryptocurrency and thus reduces regulatory uncertainty. As shown in column 3, while the slope coefficient on *POSTBAN* is not statistically significant, the slope coefficient on the interaction term between *POSTBAN* and *CAPITALCONTROL* is negative and statistically significant, suggesting that the decline in the Bitcoin price deviation is more pronounced for jurisdictions with tighter capital controls after the jurisdiction imposes some legal ban on cryptocurrencies. The more pronounced difference-in-differences results for jurisdictions with tighter capital controls further mitigate the concern that some omitted and unobservable country-level factors drive both the changes in taxation and regulation and cryptocurrency pricing. To summarize, utilizing the staggered adoption of specific cryptocurrency polices, the results from the difference-in-differences design for Bitcoin price deviations are consistent with the baseline cross-sectional results, which helps identify the effect of jurisdictional gaps in crypto taxation and regulation on the cross-jurisdictional variation in Bitcoin prices.

5.2. Regulatory event studies around major regulatory changes on cryptocurrencies

As an alternative way to identify the effect of taxation and regulation on cryptocurrency prices, we use regulatory event study methodology (e.g., Schipper and Thompson 1983; Binder 1985). Specifically, we identify the economic impact of regulation and taxation on cryptocurrencies by examining the changes in cryptocurrency prices in jurisdictions that have material changes in taxation and regulation of cryptocurrencies relative to those that are yet to enact those changes. We use the word regulation in a general sense to mean an enforceable rule or standard for which noncompliance is costly, in particular laws and quasi-legal rules such as SEC requirements. Auer and Claessens (2018) and Liu and Tsyvinski (2021) find that the *world* market cryptocurrency price reacts to regulatory news. For instance, Auer and Claessens (2018) identify 151 regulatory news events for the period between January 2015 and June 2018 and find that the world cryptocurrency price, on average, reacts negatively to regulative events. Liu and Tsyvinski

(2021) categorize the same regulatory events into positive and negative events and find that the world cryptocurrency price responds to negative regulatory events but not to positive regulatory events.

This study takes a regulatory event study approach that is distinct from Auer and Claessens (2018) and Liu and Tsyvinski (2021) in three aspects. First, in terms of scope, while they are interested in the pricing effect of *regulatory* news, this study is also interested in the pricing effect of *taxation* news. Second, in terms of variable of interest, while they are interested in assessing how the *average* world market price responds to regulatory news, this study is interested in how investors located in the jurisdiction that implements a particular regulatory or taxation change respond to the change *compared with* those located in other jurisdictions that are yet to implement the particular change. Third, in terms of time period, Auer and Claessens (2018) identify all changes in the policy formation process that significantly altered expectations either about the effects of possible outcomes or about the likelihood of a given outcome as regulatory events from January 2015 to June 2018. Therefore, there could be multiple announcement events for a given policy change. In contrast, given the rapidly changing regulatory landscape on the cryptocurrency market starting in 2018, this study extends the time period to 2021. To be consistent across all jurisdictions, we consider the day of the enactment of a new crypto-related rule or law itself as a day of material change. The enactment date is hand collected from various sources, among which the most comprehensive one is the report entitled "*Regulation of Cryptocurrency around the World: November 2021 Update"* (Library of Congress, 2021).

If market agents expect the regulations to increase (reduce) the estimated net benefits associated with cryptocurrencies, Bitcoin prices would increase (decline) if the regulations had not already been fully anticipated in the pricing process. We identify jurisdiction-days where a major regulatory update occurs in a jurisdiction and delineate days as either "positive" or "negative" event days. For the "treated" jurisdiction, a positive event day is one during which a policy update is expected to increase the price of cryptocurrency, and a negative event day is one in which a policy update is expected to decrease the price of cryptocurrency. For instance, based on the cross-sectional results, we view a day as a negative event day when a country imposes additional income taxes on crypto transactions. In contrast, we view a day as a positive event day

when the jurisdiction clarifies its position on whether cryptocurrencies satisfy the criteria to be defined as "money." All other jurisdictions that have not made the corresponding change in the taxation and regulation of cryptocurrencies in the same event day are considered "non-treated" jurisdictions. Bitcoin prices in "non-treated" jurisdictions are used to calculate the benchmark bitcoin returns for the corresponding event window. The excess Bitcoin return is calculated as the difference in event-window returns for the "treated" jurisdiction and "non-treated" jurisdictions. Only a limited number of days during the sample period contained material changes in the taxation and regulation of cryptocurrencies. Each "treated" jurisdiction has about two or three key events. Specifically, we compare the event day return (the three-day cumulative return starting from the event day) for the "treated" jurisdiction with the corresponding daily (three-day) returns for "non-treated" jurisdictions.

The regulatory event study has one caveat, however. Some rules may be anticipated leading up to the actual enactment date, which could reduce the power of the event study, therefore biasing against findings of statistically significant price changes to major regulatory updates. Panel A of table 9 presents the Bitcoin returns, both the event day return and the three-day cumulative return starting from the event day by jurisdiction. For virtually every jurisdiction with days of material regulatory updates, the event-day return is consistent with the expected sign and is statistically significant. For instance, when China imposed bans on domestic trading platforms in September 2017, the event-day return is -6.18% and the three-day cumulative return is -19.80%, both of which are statistically significant with a *p*-value of 0.01. When Japan officially imposed income taxes on cryptocurrency transactions in December 2017, the event-day return is -6.54% and the three-day cumulative return is -13.83%, both of which are statistically significant.

Panel B of table 9 presents the summary statistics of the event-window returns. Overall, for Bitcoin, the mean negative-event-day return is -4.76% for "treated" jurisdictions, which is 5.04% lower than the mean corresponding-day return of 0.28% for "non-treated" jurisdictions, and the excess return (difference) is statistically significant with a *p*-value of 0.05. Similarly, the mean three-day cumulative return starting from the negative-event-day is -7.62%, which is 8.61% lower than the mean corresponding three-day return of 0.89% for "non-treated" jurisdictions, and the excess return (difference) is statistically significant with a *p*-

value of 0.07. Furthermore, among all negative event days, the event-day return is -3.41% and the three-day cumulative return is -4.67% for "treated" jurisdictions with fewer capital controls (as defined as the capital control index is lower than the median value), both of which are not statistically different from those for "non-treated" jurisdictions. In contrast, among all negative event days, the event-day return is -6.11% and the three-day cumulative return is -10.56% for jurisdictions with tighter capital controls (as defined as the capital control index is greater than or equal to the median value), both of which are statistically lower than those for "non-treated" jurisdictions with a *p*-value of 0.04. The regulatory event study results suggest that the pricing effect of less receptive regulatory updates are concentrated in jurisdictions with tighter capital controls, which is again consistent with the comparative statistics on the cross-sectional results. As reported in the remaining rows of panel B, the mean positive-event-day return and the mean three-day cumulative return starting from the positive-event-day for "treated" jurisdictions are *not* statistically different from those for "non-treated" jurisdictions, which is consistent with Liu and Tsyvinski (2021).

Panel C of table 9 quantifies the excess event-window return for treated jurisdictions in response to the changes in cryptocurrency taxation, the legal standing of cryptocurrencies, and the applicability of anti–money laundering laws to crypto exchanges respectively. The average excess event-day return for "treated" jurisdictions that impose additional income tax burdens on crypto transactions is -3.90%, which is statistically significant with a *p*-value of 0.09. The corresponding average excess three-day cumulative return is -5.46%. The average excess event-day return for "treated" jurisdictions that impose some legal restrictions on cryptocurrencies is -11.11%, which is statistically significant with a *p*-value of 0.05. The corresponding average excess three-day cumulative return is -19.59%, which is statistically significant with a *p*-value of 0.01. The average excess event-day return for "treated" jurisdictions that apply or strengthen AML/CTF laws to cryptocurrency exchanges is 0.03% and the corresponding three-day return is -0.12%, neither of which is statistically significant. The insignificant excess return to AML/CTF laws is largely consistent with Makarov and Schoar (2021) that the fraction bitcoin trading in illegal activity is smaller than that reported in Foley et al. (2019) and that much of the AML/CTF regulation can be easily by-passed.

6. Identifying the underlying channels and robustness checks

We argue that jurisdictional gaps in crypto regulation influence the relative demand and supply of crypto-based activities and could result in varied crypto prices across jurisdictions. The Bitcoin price captures the equilibrium derived from demand and supply sides, and the explanatory power of regulation for cross-jurisdictional variation in Bitcoin prices could derive from either the demand side or from the supply side or both. In this section, we use distinct measures for investor demand for Bitcoin and for the supply of goods and services and provide some preliminary evidence on the channels underlying the incremental explanatory power of crypto regulation and taxation for cross-jurisdictional gaps in Bitcoin prices. On the demand side, this study uses daily Google search statistics for "Bitcoin" or "BTC" in a country as the proxy for demand from investors. Panel A of table 10 presents the results on the association between taxation and regulatory variables and investor demand for Bitcoin. Daily search interest does not vary with tax-related and exchange-based regulations, but investor demand is lower in jurisdictions that take a tough stance on enforcement of crypto-related regulations. In terms of the regulatory and legal framework, regulatory clarity is associated with a higher search interest for Bitcoin, and more legal restrictions on cryptocurrencies are associated with a lower search interest for Bitcoin.

On the supply of goods and services, Statista (2021) estimates that, as of March 2021, close to 20,000 businesses entities accept crypto payments across 145 jurisdictions, among which Tesla, Coca-Cola, Microsoft, and BMW are notable examples. An interesting question is to what extent crypto-related regulation and taxation in the jurisdiction affects the operation of business that offers a cryptocurrency option in the supply of goods services. Accordingly, we use the number of business entities that either have a cryptocurrency ATM or offer crypto as an in-store payment method as published by Statista (2021) to proxy for the supply side. As shown in panel B of table 10, the number of observations is 61 because we are only able to obtain information on control variables and regulatory variables for 61 jurisdictions. The number of business entities that offer a cryptocurrency option is lower in jurisdictions that impose heavier

VAT burdens on cryptocurrency.[9] Regulatory clarity is associated with a greater number of business entities. More legal restrictions on cryptocurrencies and the applicability of AML/CTF laws to crypto platforms are associated with a lower number of goods and service providers. Taxation or regulation together with control variables explain more than 60% of the cross-jurisdictional variation in the number of business entities that offer a cryptocurrency option. To summarize, the supplementary analyses identify both the demand and supply sides as two channels underlying the incremental explanatory power of taxation and regulation of cryptocurrency for Bitcoin price differentials.

In un-tabulated results, as robustness checks, we find that the results are similar if the world market price is defined as the price in the United States as in Makarov and Schoar (2020) or as the median price across all crypto exchanges that have an active price quote. Given that one third of exchanges are located in US and UK, when we use the jurisdiction-level average price deviations as the alternative dependent variable, the results are also similar. We find that the effect of taxation on cryptocurrency pricing in the period during which Bitcoin prices trended up differs from that in the period during which Bitcoin prices trended down. Because many decentralized-finance (Defi) applications are built on Ethereum, we apply the same methodology to the prices of Ethereum, another dominant cryptocurrency. The median Ethereum price deviation from the world market price is -1.21% with a standard deviation of 2.33%. As reported in table 11, using 20,395 daily Ethereum prices from eighteen exchanges, we find a similar relation between crypto taxation and regulation and Ethereum price deviations.

7. Conclusion and future research

Using Bitcoin (Ethereum) prices from forty-two (eighteen) crypto exchanges, we find that variations in cryptocurrency regulation and taxation provide incremental explanatory power for the cross-jurisdiction

[9] Convenience-oriented businesses, such as casual dining restaurants, accommodations, and gas stations, account for about 10% of business entities that accept crypto payment, whereas crypto exchanges and wallets account for about 3% of those business entities. VAT are levied in jurisdictions where economic activities actually occur. The seller, such as a crypto exchange, have the VAT collection obligations under which they must charge VAT (if applicable) on the sale and issue a VAT invoice to the customer (if required to do so).

disparity in Bitcoin prices. Bitcoin price deviations relative to the world market price are lower in jurisdictions that apply heavier income tax burdens on crypto transactions. Interestingly, price deviations are more sensitive to tax laws when the crypto tax reporting system is more transparent. Bitcoin price deviations are higher in jurisdictions where regulators have clearly communicated their position on whether cryptocurrencies satisfy the definition of money and are lower in jurisdictions that apply AML/CTF laws directly to crypto exchanges. Consistent with the market segmentation framework, the association between regulation and price deviations is more pronounced for jurisdictions with tighter capital controls and for exchanges whose customer bases are predominantly domestic investors. The incremental explanatory power derives from both the demand and supply sides. As cryptocurrencies gain more mainstream adoption, a promising area for future research might be the accounting and financial reporting implications for crypto businesses.

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Table 1
Summary of the Regulatory Framework and the Receptiveness of Crypto Regulation

Panel A: Regulatory clarity for selected jurisdictions as of 2021

Country/Region	Crypto Exchanges	Clarity on whether cryptocurrency satisfies the definition of money
Australia	Btcmarkets	Yes
Brazil	MercadoBitcoin	No
Canada	Quadrigacx	Yes
China	Okcoin/Lakebtc/Bcchina/Huobi	Yes
Estonia	Coinsbank	Yes
France	Paymium/Bitcoin-central	Yes
Germany	Bitcoin.de	Yes
HongKong (China)	HitBTC/OKcoin/Okex	No
Indonesia	Bitcoin.co.id	No
Israel	Bit2c	Yes
Japan	Bitflyer/Binance/Zaif/Kucoin	No
Luxembourg	Bitstamp	No
Malta	Therocktrading	Yes
Mexico	Bitso	Yes
Poland	Bitbay/Bitcurex/Bitmarketpl	No
Russia	Btce/Yobit	Yes
Singapore	Coinfit	Yes
Republic of Korea	Bithumb/Korbit	No
Switzerland	Bitfinex	Yes
United Kingdom	Bit-X/Cex/Exmo /Coinfloor	Yes
United States	Kraken/Coinbase/Gemini/Poloniex/Itbit /Bittrex/CampBX	Yes

Table 1 (continued)

Panel B: Receptiveness of crypto regulation for selected jurisdictions as of December 2021

Country/Region	Full or partial ban on cryptocurrencies	Taxation of cryptocurrency transactions	Applicability of AML/CTF to cryptocurrency exchanges
Australia	No	Yes	Yes
Brazil	No	Yes	No
Canada	No	Yes	Yes
China	Yes, full ban	Not clear	Yes
Estonia	No	Yes	Yes
France	No	Yes	Yes
Germany	No	Yes	Yes
HongKong (China)	No	Yes	Yes
Indonesia	Yes, partial ban	Yes	Yes
Israel	No	Yes	Yes
Japan	No	Yes	Yes
Luxembourg	No	Yes	Yes
Malta	No	Yes	Yes
Mexico	Yes, partial ban	Not clear	Yes
Poland	No	Yes	Yes
Russia	Yes, partial ban	Yes	Yes
Singapore	No	Yes	Yes
Republic of Korea	Yes, partial ban	No	Yes
Switzerland	No	Yes	Yes
United Kingdom	No	Yes	Yes
United States	No	Yes	Yes

Table 2
Descriptive Statistics and Correlation Table

Panel A: Descriptive statistics for the sample period from January 2017 to December 2021

Variables	N	Mean	Median	Std. dev.	Min	Max
BTCPRICE	40,048	13,342.4	7,914.4	15,612.3	761.6	72,245.9
BTCPRICEDEVIATION	40,048	0.00%	-0.14%	2.55%	-20.99%	42.58%
DAILYRETURN	40,048	0.28%	0.22%	3.53%	-41.30%	31.69%
EXCHANGETRADEVOLUME	40,048	221,935,178	6,272,269	1,820,702,337	10,022	52,959,873,009
REGCLARITY	40,048	0.73	1.00	0.45	0	1
LEGALITY	40,048	0.40	0.00	0.78	0	3
INCOMETAX	40,048	0.83	1.00	0.73	0	2
MININGINCOMETAX	40,048	1.91	2.00	1.82	0	4
EXCHANGEINCOMETAX	40,048	2.08	3.00	2.13	0	6
TAXABLEEXCHANGES	40,048	1.56	2.00	1.45	0	3
TAXAPPLICABILITY	40,048	0.76	1.00	0.75	0	2
VAT	40,048	1.58	2.00	1.40	0	5
PROPERTYTAX	40,048	0.44	0	0.83	0	2
AMLCTF	40,048	0.52	1.00	0.50	0	1
ENFORCEMENT	40,048	2.53	0	6.322	0	22
GDPpercapita	40,048	49,526	46,569	21,915	10,935	120,962
INFLATION	40,048	1.95%	1.81%	1.26%	-0.54%	6.04%
GDPGROWTH	40,048	0.11%	1.51%	4.20%	-9.79%	8.12%
STOCKMARKETRETURN	40,048	7.35%	9.71%	18.14%	-21.89%	50.21%
HACKDAMAGE	40,048	38.47	0.00	129.98	0	495.00
ATTENTION	40,048	42.27	15.61	25.94	0	97.26
CAPITALCONTROL	40,048	0.29	0.23	0.24	0	0.85
KYC	40,048	0.87	1.00	0.34	0	1
INFOFLOW	40,048	0.06	0	0.23	0	1
LOCALEXCHANGE	36,209	0.42	0	0.49	0	1.00

Table 2
(continued)
Panel B: Average Bitcoin price deviations by jurisdiction and by year

Jurisdiction	N	Average daily price deviations	Average price deviations (2017)	Average price deviations (2018)	Average price deviations (2019)	Average price deviations (2020)	Average price deviations (2021)
Australia	1824	0.23%	1.73%	-0.38%	-0.14%	0.17%	-0.25%
Brazil	821	3.33%	6.12%	1.10%	1.05%	N/A	N/A
Canada	728	2.03%	0.83%	2.63%	N/A	N/A	N/A
China	732	-2.63%	-2.63%	N/A	N/A	N/A	N/A
Estonia	360	-0.41%	N/A	-1.38%	-0.09%	N/A	N/A
France	2753	-0.46%	-1.00%	-.1.01%	-0.22%	-0.11%	-0.48%
Germany	1584	0.14%	-0.45%	-0.19%	0.69%	0.60%	-0.06%
HongKong (China)	500	-0.93%	-1.71%	-0.08%	N/A	N/A	N/A
Indonesia	1820	0.72%	1.06%	0.91%	0.84%	0.21%	0.55%
Israel	186	0.36%	0.37%	N/A	N/A	N/A	N/A
Japan	2047	-0.21%	0.50%	-0.61%	-0.30%	-0.09%	-0.42%
Luxembourg	1826	-0.64%	-1.26%	-1.01%	-0.32%	-0.13%	-0.45%
Malta	289	0.27%	0.29%	-5.08%	N/A	N/A	N/A
Mexico	1777	0.12%	1.55%	-0.26%	-0.29%	-0.17%	-0.10%
Poland	2831	-0.21%	-0.05%	-0.69%	-0.09%	0.27%	-0.26%
Russia	206	-2.74%	-2.74%	N/A	N/A	N/A	N/A
Singapore	360	0.99%	N/A	1.44%	0.84%	N/A	N/A
Republic of Korea	3109	1.58%	4.13%	2.35%	-0.93%	-0.75%	3.10%
Switzerland	1826	-0.27%	-1.08%	-0.41%	0.68%	-0.07%	-0.46%
United Kingdom	6763	-0.08%	-0.86%	-0.07%	0.39%	0.22%	-0.13%
United States	7706	-0.55%	-0.91%	-0.93%	-0.30%	-0.17%	-0.46%
Sum	40,048	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 2
(continued)

Panel C: Pearson correlation (upper diagonal) and Spearman correlation (lower diagonal) between prices and regulation

	BTCPRICE DEVIATION	REGCLARITY	LEGALITY	INCOMETAX	VAT	PROPERTY TAX	AMLCTF	ENFORCEMENT
BTCPRICE DEVIATION	1	-0.117**	0.096**	-0.095**	-0.087**	0.095**	-0.082**	-0.045**
REGCLARITY	-0.089**	1	-0.263**	0.448**	0.001	-0.093**	0.521**	0.228**
LEGALITY	0.154**	-0.224**	1	-0.345**	-0.339**	0.398**	-0.120**	-0.204**
INCOMETAX	-0.091**	0.466*	-0.248**	1	-0.028**	0.097**	0.570**	0.349**
VAT	-0.041**	-0.006	-0.318***	-0.070**	1	0.030**	0.165**	-0.378**
PROPERTYTAX	0.067**	-0.093**	0.471**	0.107**	0.039**	1	0.177**	-0.210**
AMLCTF	-0.033**	0.521**	-0.115**	0.562**	0.179**	0.177**	1	0.360**
ENFORCEMENT	-0.040**	0.221**	-0.356**	0.380**	-0.056**	-0.294**	0.417**	1

* *p*-value is significant at 0.05 level; ***p*-value is significant at 0.01 level.

Table 3

Baseline Cross-Jurisdictional Results on Taxation and Bitcoin Price Deviations

Panel A: Tax Treatment of Cryptocurrency and Bitcoin Price Deviations

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$			
		Platform-oriented approach: the impacted jurisdiction is the jurisdiction in which the exchange's server is located		**Clientele-oriented approach:** the impacted jurisdiction is the jurisdiction in which the largest customer base of the exchange is located	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-0.511)	-0.001 (-0.630)	-0.001 (-0.596)	-0.001 (-0.296)
Ln (GDPpercapita)$_{it}$		0.001 (0.336)	0.002 (0.563)	0.003 (0.745)	0.003 (0.742)
GDPGROWTH$_{it}$		-0.001** (-2.133)	-0.002 (-1.423)	-0.001 (-0.416)	-0.001 (-0.433)
INFLATION$_{it}$		0.001 (0.665)	0.001 (1.451)	0.002 (1.607)	0.002 (1.267)
STOCKRETURN$_{it}$		0.001 (1.171)	0.001 (1.163)	-0.002** (-2.340)	-0.001* (-1.847)
Ln(HACKDAMAGE)$_{it}$		-0.001 (-0.016)	-0.001 (-0.543)	0.001 (0.869)	0.001 (0.993)
ATTENTION$_{it}$		0.001 (1.226)	0.001 (1.530)	0.001 (1.508)	0.001 (1.448)
CAPITALCONTROL$_{it}$		0.020* (1.961)	0.010 (0.047)	0.024** (2.040)	0.026** (2.178)
INCOMETAX$_{it}$	**(-)**		**-0.003* (-1.703)**		**-0.018* (-2.407)**
VAT$_{it}$	**(-)**		**-0.002 (-1.429)**		**0.003 (1.144)**
PROPERTYTAX$_{it}$	**(-)**		**0.004 (1.086)**		**-0.010 (-1.307)**
Year fixed effects		Included	Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year	By exchange and year
N		40,048	40,048	23,276	23,276
Adjusted *R*-squared		3.3%	4.4%	6.6%	10.2%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$.

Table 3

(continued)

Panel B: Income Tax Burdens and Bitcoin Price Deviations

		Dependent variable = $BTCPRICEDEVIATION_{ipt}$				
		Column 1	Column 2	Column 3	Column 4	Column 5
Explanatory variables	Predicted sign	coefficient (*t-value*)	Coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		0.001 (0.037)	0.001 (0.136)	-0.001 (-0.163)	0.001 (0.079)	-0.001 (-0.095)
Ln (GDPpercapita)$_{it}$		0.001 (0.411)	0.001 (0.444)	0.001 (0.255)	0.001 (0.288)	0.001 (0.238)
Ln (HACKDAMAGE)$_{it}$		0.011 (0.122)	0.011 (0.281)	-0.011 (-0.168)	0.011 (0.101)	-0.011 (-0.257)
INFLATION$_{it}$		-0.001 (-0.051)	-0.001 (-0.539)	-0.001 (-0.051)	-0.001 (-0.495)	-0.001 (-0.361)
GDPGROWTH$_{it}$		-0.001 (-1.327)	-0.001 (-0.971)	-0.001 (-1.623)	-0.001 (-1.291)	-0.001 (-1.395)
STOCKRETURN$_{it}$		0.001 (0.258)	0.001 (0.275)	0.001 (0.295)	0.001 (0.340)	0.001 (0.201)
ATTENTION$_{it}$		0.012 (0.185)	0.012 (0.120)	0.012 (0.134)	0.012 (0.259)	0.012 (0.103)
CAPITALCONTROL$_{it}$		0.001 (1.169)	0.001 (1.093)	0.001 (1.289)	0.001 (1.009)	0.001 (1.294)
INCOMETAX$_{it}$	***(-)***	***-0.003* (-1.743)***				
MININGINCOMETAX$_{it}$	***(-)***		***-0.001 (-1.462)***			
EXCHANGEINCOMETAX$_{it}$	***(-)***			***-0.001** (1.975)***		
TAXABLEEXCHANGES$_{it}$	***(-)***				***-0.002** (-2.346)***	
TAXAPPLICABILITY$_{it}$	***(-)***					***-0.003** (-2.129)***
Year fixed effects		Included	Included	Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year	By exchange and year	By exchange and year
N		40,048	40,048	40,048	40,048	40,048
Adjusted *R*-squared		3.9%	3.8%	3.9%	4.2%	4.0%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$.

Table 4

The Tax Capitalization Effect and Transparency of the Tax Reporting System

Panel A: Transparency of the Tax Reporting System is Proxied by KYC Procedures

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$				
		Column 1	Column 2	Column 3	Column 4	Column 5
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-0.596)	-0.001 (-0.296)	-0.001 (-1.006)	-0.001 (-1.006)	-0.001 (-1.006)
KYC$_{it}$		0.006** (5.967)	0.005*** (6.432)	0.007*** (9.021)	0.006*** (6.001)	0.006*** (6.234)
INCOMETAX$_{it}$		-0.001 (-0.810)				
INCOMETAX$_{it}$*KYC$_{it}$	**(-)**	**-0.002*** (-2.851)**				
VAT$_{it}$			0.001 (0.002)			
VAT$_{it}$*KYC$_{it}$	**(-)**		**-0.002*** (-5.164)**			
EXCHANGEINCOMETAX$_{it}$				-0.001 (-0.034)		
EXCHANGEINCOMETAX$_{it}$*KYC$_{it}$	**(-)**			**-0.002*** (-4.326)**		
TAXABLEEXCHANGES$_{it}$					-0.001 (-0.682)	
TAXABLEEXCHANGES$_{it}$*KYC$_{it}$	**(-)**				**-0.002*** (-4.866)**	
TAXAPPLICABILITY$_{it}$						0.002** (2.941)
TAXAPPLICABILITY$_{it}$*KYC$_{it}$	**(-)**					**-0.005*** (-6.530)**
Country level controls in the baseline model		Included	Included	Included	Included	Included
Year fixed effects		Included	Included	Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year	By exchange and year	By exchange and year
N		40,048	40,048	40,048	40,048	40,048
Adjusted *R*-squared		5.5%	5.4%	4.9%	3.9%	3.8%

*** p<0.01, ** p<0.05, * p<0.10.

Table 4

(continued)

Panel B: Transparency of the Tax Reporting System is Proxied by Third-party Information Flows to Tax Authorities

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$				
		Column 1	Column 2	Column 3	Column 4	Column 5
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-0.596)	-0.001 (-0.296)	-0.001 (-1.006)	-0.001 (-1.006)	-0.001 (-1.006)
INFOFLOW$_{it}$		0.031*** (3.379)	-0.002** (-2.676)	0.001 (0.006)	0.001 (0.003)	0.001 (0.004)
INCOMETAX$_{it}$		-0.002*** (-3.810)				
INCOMETAX$_{it}$*INFOFLOW$_{it}$	**(-)**	**-0.021*** (-3.333)**				
VAT$_{it}$			-0.001*** (-3.516)			
VAT$_{it}$*INFOFLOW$_{it}$	**(-)**		**0.002** (3.392)**			
EXCHANGEINCOMETAX$_{it}$				-0.001*** (-4.699)		
EXCHANGEINCOMETAX$_{it}$*INFOFLOW$_{it}$	**(-)**			**-0.001*** (-3.924)**		
TAXABLEEXCHANGES$_{it}$					-0.002*** (-5.873)	
TAXABLEEXCHANGES$_{it}$*INFOFLOW$_{it}$	**(-)**				**-0.001* (-1.690)**	
TAXAPPLICABILITY$_{it}$						-0.003*** (-5.827)
TAXAPPLICABILITY$_{it}$*INFOFLOW$_{it}$	**(-)**					**-0.002*** (-3.272)**
Country-level controls in the baseline model		Included	Included	Included	Included	Included
Year fixed effects		Included	Included	Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year	By exchange and year	By exchange and year
N		40,048	40,048	40,048	40,048	40,048
Adjusted *R*-squared		5.4%	5.3%	3.9%	3.8%	3.9%

*** p<0.01, ** p<0.05, * p<0.10.

Table 5

Baseline Cross-Jurisdictional Results on Regulation and Bitcoin Price Deviations

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$			
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-0.367)	-0.001 (-0.512)	-0.001 (-0.184)	-0.001 (-0.511)
Ln (GDPpercapita)$_{it}$		0.002 (0.387)	0.001 (0.307)	0.002 (0.448)	0.001 (0.318)
GDPGROWTH$_{it}$		-0.002** (-2.146)	-0.001* (-1.957)	-0.002** (-2.291)	-0.001** (-2.114)
INFLATION$_{it}$		0.001 (0.928)	0.001 (0.613)	0.001 (0.697)	0.001 (0.668)
STOCKRETURN$_{it}$		0.001 (1.517)	0.001 (1.177)	0.001 (1.545)	0.001 (1.174)
Ln(HACKDAMAGE)$_{it}$		-0.001 (-0.086)	0.001 (0.033)	-0.001 (-0.066)	0.001 (0.145)
ATTENTION$_{it}$		0.001 (1.353)	0.001 (1.297)	0.001 (1.530)	0.001 (1.203)
CAPITALCONTROL$_{it}$		0.015 (1.424)	0.022* (1.878)	0.019* (1.914)	0.020* (1.922)
REGCLARITY$_{it}$	**(+)**	**0.006* (1.913)**			
LEGALITY$_{it}$	**(-)**		**-0.001 (-0.220)**		
AMLCTF$_{it}$	**(?)**			**-0.006* (-1.707)**	
ENFORCEMENT$_{it}$	**(?)**				**-0.001 (-0.184)**
Year fixed effects		Included	Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year	By exchange and year
N		40,048	40,048	40,048	40,048
Adjusted *R*-squared		3.2%	4.3%	3.8%	4.2%

*** p<0.01, ** p<0.05, * p<0.10.

Table 6

Comparative Statistics on Bitcoin Price Deviations by Market Segmentation

Panel A: ***Cryptocurrency taxation and Bitcoin price deviations by capital controls***

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$		
		Column 1	Column 2	Column 3
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-0.596)	-0.001 (-0.296)	-0.001 (-1.006)
Ln (GDPpercapita)$_{it}$		0.003 (0.745)	0.003 (0.742)	0.008** (-2.539)
GDPGROWTH$_{it}$		-0.001 (-0.416)	-0.001 (-0.433)	-0.001 (-0.471)
INFLATION$_{it}$		0.002 (1.607)	0.002 (1.267)	0.003** (2.035)
STOCKRETURN$_{it}$		-0.002** (-2.340)	-0.001* (-1.847)	0.001 (0.102)
Ln(HACKDAMAGE)$_{it}$		0.001 (0.869)	0.001 (0.993)	0.001 (0.102)
ATTENTION$_{it}$		0.001 (1.508)	0.001 (1.448)	0.001 (1.371)
CAPITALCONTROL$_{it}$		0.024** (2.040)	0.026** (2.178)	-0.016** (-1.130)
INCOMETAX$_{it}$	**(-)**	**0.001 (0.550)**		
INCOMETAX$_{it}$*CAPITALCONTROL$_{it}$		**-0.017* (-1.794)**		
VAT$_{it}$	**(-)**		**0.002 (1.224)**	
VAT$_{it}$*CAPITALCONTROL$_{it}$			**-0.012*** (-2.646)**	
PROPERTYTAX$_{it}$	**(-)**			**-0.002 (-0.827)**
PROPERTYTAX$_{it}$*CAPITALCONTROL$_{it}$				**0.021 (1.231)**
Year fixed effects		Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year
N		40,048	40,048	40,048
Adjusted *R*-squared		4.0%	4.9%	5.4%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$.

Table 6 (Continued)

Panel B: Cryptocurrency taxation and Bitcoin price deviations by exchange-level customer base

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$		
		Column 1	Column 2	Column 3
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-0.366)	-0.001 (-0.485)	-0.001 (-0.475)
Ln (GDPpercapita)$_{it}$		0.004 (0.791)	0.004 (0.798)	0.004 (0.771)
GDPGROWTH$_{it}$		-0.001 (-0.032)	-0.001 (-0.587)	-0.001 (-0.721)
INFLATION$_{it}$		0.003** (2.005)	0.001 (1.035)	0.001 (1.227)
STOCKRETURN$_{it}$		-0.002** (-2.439)	-0.001** (-2.083)	-0.002** (-2.518)
Ln(HACKDAMAGE)$_{it}$		0.001 (1.060)	0.001 (1.096)	0.001* (2.014)
ATTENTION$_{it}$		0.001 (1.331)	0.001* (1.742)	0.001 (1.341)
CAPITALCONTROL$_{it}$		0.011 (1.005)	0.011 (0.944)	0.012 (1.029)
LOCALEXCHANGE$_{ipt}$		0.013** (2.525)	0.012** (2.768)	0.015*** (3.172)
INCOMETAX$_{it}$		**-0.001 (-0.054)**		
INCOMETAX$_{it}$* LOCALEXCHANGE$_{ipt}$	**(-)**	**-0.008* (-2.056)**		
VAT$_{it}$			**0.001 (0.274)**	
VAT$_{it}$* LOCALEXCHANGE$_{ipt}$	**(-)**		**-0.006** (-2.048)**	
PROPERTYTAX$_{it}$				**0.004** (2.022)**
PROPERTYTAX$_{it}$*LOCALEXCHANGE$_{ipt}$	**(-)**			**0.005 (1.192)**
Year fixed effects		Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year
N		36,209	36,209	36,209
Adjusted *R*-squared		6.0%	6.0%	5.7%

*** p<0.01, ** p<0.05, * p<0.10.

Table 6 (Continued)

Panel C: ***Cryptocurrency regulation and Bitcoin price deviations by capital controls***

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$			
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-1.416)	-0.001 (-0.331)	-0.001 (-1.281)	-0.001 (-0.505)
Ln (GDPpercapita)$_{it}$		0.004 (1.240)	0.001 (0.193)	0.004 (1.077)	0.001 (0.300)
GDPGROWTH$_{it}$		-0.001 (-1.610)	0.001 (0.320)	-0.001 (-1.283)	0.001 (0.145)
INFLATION$_{it}$		0.002* (1.835)	0.001 (0.015)	0.002* (1.678)	0.002 (0.672)
STOCKRETURN$_{it}$		-0.002** (-2.594)	-0.002 (-1.209)	-0.002** (-2.751)	-0.001** (-2.053)
Ln(HACKDAMAGE)$_{it}$		0.001** (2.483)	0.001 (1.412)	0.001** (2.457)	0.001 (1.035)
ATTENTION$_{it}$		0.001 (1.107)	0.001 (0.783)	0.001 (1.155)	0.001 (1.203)
CAPITALCONTROL$_{it}$		0.048*** (3.661)	0.027*** (2.236)	0.037*** (3.206)	0.020* (1.826)
REGCLARITY$_{it}$	**(+)**	**0.016*** (3.350)**			
REGCLARITY$_{it}$*CAPITALCONTROL$_{it}$		**-0.055 (-0.881)**			
LEGALITY$_{it}$			**0.012** (2.173)**		
LEGALITY$_{it}$*CAPITALCONTROL$_{it}$	**(-)**		**-0.020** (-1.908)**		
AMLCTF$_{it}$				**0.009** (2.222)**	
AMLCTF$_{it}$*CAPITALCONTROL$_{it}$	**(-)**			**-0.045*** (-3.364)**	
ENFORCEMENT$_{it}$					**-0.001 (-0.061)**
ENFORCEMENT$_{it}$*CAPITALCONTROL$_{it}$					**-0.001 (-0.028)**
Year fixed effects		Included	Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year	By exchange and year
N		40,048	40,048	40,048	40,048
Adjusted *R*-squared		7.1%	3.8%	7.0%	3.1%

Table 6 (Continued)

Panel D: Cryptocurrency regulation and Bitcoin price deviations by exchange-level customer base

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$			
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-1.119)	-0.001 (-1.239)	-0.001 (-0.475)	-0.001 (-0.909)
Ln (GDPpercapita)$_{it}$		0.007 (1.486)	0.009** (2.123)	0.004 (0.771)	0.005 (1.015)
GDPGROWTH$_{it}$		-0.001 (-1.233)	-0.001 (-1.282)	-0.001 (-0.721)	0.001 (0.133)
INFLATION$_{it}$		0.003* (1.906)	0.003** (2.005)	0.001 (1.227)	0.001 (0.608)
STOCKRETURN$_{it}$		-0.001** (-2.314)	-0.001** (-2.006)	-0.002** (-2.518)	-0.001** (-2.063)
Ln(HACKDAMAGE)$_{it}$		0.001** (2.048)	0.001** (2.131)	0.001* (2.014)	0.001 (0.841)
ATTENTION$_{it}$		0.001 (0.880)	0.001 (0.203)	0.001 (1.341)	0.001 (0.657)
CAPITALCONTROL$_{it}$		-0.001 (-0.089)	0.008 (0.858)	0.012 (1.029)	0.023* (1.969)
LOCALEXCHANGE		0.028*** (4.426)	0.037*** (4.566)	0.015*** (3.172)	0.007** (2.418)
REGCLARITY$_{it}$	**(+)**	**0.001** (2.371)**			
REGCLARITY$_{it}$*LOCALEXCHANGE$_{it}$		**-0.027 (-0.931)**			
LEGALITY$_{it}$			**0.005** (2.119)**		
LEGALITY$_{it}$*LOCALEXCHANGE$_{it}$	**(-)**		**-0.012*** (-3.246)**		
AMLCTF$_{it}$				**0.001 (0.079)**	
AMLCTF$_{it}$*LOCALEXCHANGE$_{it}$	**(-)**			**-0.016*** (-2.869)**	
ENFORCEMENT$_{it}$					**0.001 (0.211)**
ENFORCEMENT$_{it}$*LOCALEXCHANGE$_{it}$					**-0.001** (-2.222)**
Year fixed effects		Included	Included	Included	Included
Cluster-adjusted standard deviation		By exchange and year	By exchange and year	By exchange and year	By exchange and year
N		36,209	36,209	36,209	36,209
Adjusted *R*-squared		9.2%	11.0%	7.4%	4.7%

*** p<0.01, ** p<0.05, * p<0.10.

Table 7

Key Regulatory Updates on Cryptocurrencies for Sample Jurisdictions from January 2017 to December 2021

Jurisdiction	Date	Key update summary	Expected sign of price reaction
Australia	08/20/2014	The Australia Taxation Office issued guidance on the tax treatment for Bitcoin and concluded that Bitcoin is neither money nor a foreign currency, but is an asset for capital gains tax purposes.	Negative (tax)
	12/18/2017	Australia approved legislation on goods and services taxes (GST) and digital currency, which removes the double taxation on digital currency and ensures no GST) on purchases of digital currency.	Positive (tax)
	12/07/2017	Amendments to the Anti-Money Laundering and Counter-Terrorism Financing Act of 2006 were passed, which require digital currency exchanges to comply with AML laws.	Uncertain (AML)
Brazil	07/05/2019	Cryptocurrencies are subject to capital gain taxes.	Negative (tax)
Canada	06/25/2019	Amended AML laws impose additional compliance and reporting obligations on crypto exchanges.	Uncertain (AML)
	06/26/2019	Canada Revenue Agency issued guidance on the tax rules on cryptocurrency	Negative (tax)
China	09/03/2017	Bans domestic commercial crypto trading platforms.	Negative (tax)
	05/24/2021	China's Financial Stability and Development Committee cracks down on Bitcoin mining and trading.	Negative(legal)
	09/15/2021	People's Bank of China issued a circular on further preventing and disposing of speculative risks in virtual currency trading, which effectively imposed a full ban on cryptocurrencies.	Negative (legal)
Estonia	10/26/2017	Money Laundering and Terrorism Financing Prevention Act was enacted, applying AML/CTF laws to crypto exchanges.	Uncertain (AML)
France	05/22/ 2019	Under the Action Plan for Business Growth and Transformation Law, cryptocurrencies are legally classified as a medium of exchange and are considered movable investments for tax purposes. Article 150 of the French General Tax Code stipulates tax treatment of cryptocurrency.	Negative (tax)
	12/09/2020	New AML/CFT rules were imposed on crypto-to-crypto exchanges, which are the same as those currently imposed on digital asset to legal tender service providers (crypto-to-fiat) exchanges. The AML/CTF requirements also include a prohibition on the use of anonymous accounts for trading on crypto-to-crypto exchanges.	Uncertain (AML)

Jurisdiction	Date	Key update summary	Expected sign of price reaction
Germany	06/23/2017	A new German Money Laundering Act came into effect as part of the implementation of EU Directive 2015/849, which provides for the beneficial ownership register.	Uncertain (AML)
	02/27/2018	The Federal Ministry of Finance addressed individual taxation and regarded Bitcoin as equivalent to legal tender when used as a means of payment and, thus, not subject to VAT.	Positive (tax)
	09/24/2021	KryptoWTransverV (the Crypto Asset Transfer Regulations) passed, which makes Germany one of the first European countries to require crypto businesses to comply with the Financial Action Task Force (FATF) Travel Rule. German virtual-asset-service providers must collect, store, and verify the name and address of noncustodial beneficiaries and principals.	Uncertain (AML)
Hong Kong (China)	09/06/2019	The Securities and Futures Commission confirmed its willing to license and regulate virtual asset trading platforms on an opt-in basis, including a detailed framework for the regulation.	Positive (clarity in framework)
	03/27/2020	Inland Revenue Department issued Departmental Interpretation and Practice Notes No. 39, which sets out the taxation principles on electronic commerce transactions and digital assets and states that it will look beyond the location of the server and examine the location where the core operations take place.	Negative (tax)
Indonesia	02/18/2019	Regulation No. 5/2019 was approved, which legally recognizes and regulates bitcoin and other cryptocurrencies as trading commodities and legalizes cryptocurrency exchanges.	Positive (legal)
	12/17/2020	Regulation No. 7/2020 was issued, which clearly stipulates definitive clarifications as to the specific guidelines and criteria required for crypto assets to be approved by the Commodity Futures Trading Regulatory Agency. It provides an official list of 229 cryptocurrencies that are allowed to be traded within the territory of Indonesia.	Positive (legal)
Israel	01/12/2017	Israel's government applies capital gains tax to Bitcoin sales, categorizing digital currencies as a type of property. The Israel Tax Authority said that it would consider Bitcoin and other digital currencies as a kind of intangible asset rather than a foreign currency. Any commercial sales of Bitcoin or transactions involved with trading are subject to VAT.	Negative (tax)
	11/14/2021	Anti-Money Laundering Order (Credit Service Providers' Duties of Identification, Reporting and Registration for the Prevention of Money Laundering and Terrorist Financing) 5781–2021 went into effect, which imposes an AML order regulating cryptocurrency transactions.	Uncertain (AML)
Japan	4/1/2017	The Virtual Currency Act became effective, imposing registration requirements, AML laws, and additional cybersecurity and reporting requirements on crypto exchanges.	Uncertain (AML)
	12/27/2017	The National Tax Agency ruled that gains on cryptocurrencies should be categorized as "miscellaneous income" and taxed.	Negative (tax)
	05/01/2020	An amendment to the Payment Services Act and the Financial Instruments and Exchange Act become effective. Crypto custodian services are subject to licensing.	Positive (clarity in framework)

Jurisdiction	Date	Key update summary	Expected sign of price reaction
Luxembourg	02/08/2018	The Luxembourg AML Amending Law passed, which sets out new requirements relating to the due diligence obligations for professionals.	Uncertain (AML)
	07/26/2018	Circulaire du directeur des Contributions passed, which specifies that cryptocurrencies should be considered as intangible assets for Luxembourg income tax, business tax, and net wealth tax purposes. Any profit or expense denominated in a cryptocurrency should be converted to euros.	Negative (tax)
Malta	07/04/2018	The Maltese Parliament enacted three bills into law to create a regulatory framework for blockchain, cryptocurrency, and blockchain technology (DLT).	Positive (clarity in framework)
	11/01/2018	Guidelines on the Income Tax Treatment of Transactions or Arrangements Involving DLT Assets were issued	Negative (tax)
	11/01/2018	Virtual Financial Assets Act, cap. 590, passed, stipulating that license requirements apply to the provision by any person of a virtual financial asset service in or from within Malta.	Uncertain (AML)
Mexico	03/01/2018	Mexico's lower house of Congress approved a bill to regulate the fast-growing financial technology sector, including crowdfunding and cryptocurrency firms. The bill seeks to promote financial stability and prevent money laundering.	Uncertain (AML)
Poland	04/04/2018	Gains on digital assets are deemed subject to capital gain taxes and VAT.	Negative (tax)
	03/30/2021	Act on Combating Money Laundering and the Financing of Terrorism and Certain Other Acts passed, which implements the Fifth EU Anti–Money Laundering Directive (AMLD5) in Poland.	Uncertain (AML)
Republic of Korea	12/07/2017	Financial Services Commission (FSC) issued a ban on the trading of Bitcoin futures.	Negative (legal)
	01/23/2018	FSC formally mandated a real-name verification system for cryptocurrency accounts and trading.	Negative (legal)
	03/06/2020	A broad framework for regulation of cryptocurrencies and crypto exchanges passed. Cryptocurrency companies are subject to equivalent AML measures and tax obligations. It requires crypto service providers to use real-name verification systems and comply with FATF requirements.	Negative (tax and AML)
Singapore	01/28/2020	The Payment Service Act of 2019 becomes effective, which establishes a comprehensive framework for all crypto-related enterprises and expands the scope of payment services to include digital payments. It offers regulatory clarity and requires licenses to provide specified payment services.	Positive (clarity in framework)
	05/26/2020	A Guide to Digital Token Offerings was issued, which outlines AML and CTF concerns in relation to digital token offerings and highlights the applicable requirements.	Uncertain (AML)
	04/17/2020	Inland Revenue Authority of Singapore published guidance on the tax treatment of income from transactions involving digital tokens. Virtual currencies are treated as exempt supplies if exchanged for fiat or other virtual currencies and are an excluded transaction if used as payment for goods and services.	Positive (tax)

Jurisdiction	Date	Key update summary	Expected sign of price reaction
Russia	02/26/2020	The Russian Supreme Court added the *illicit* use of cryptocurrencies to the list of criminal offenses related to money laundering, which effectively imposes a full ban on cryptocurrency in Russia.	Negative (legal)
	07/31/2020	President Putin signed federal law No. 259-FZ on Digital Financial Assets, Digital Currency and Amendments to Certain Legislative Acts of the Russian Federation. Digital currencies are recognized as a payment means and investment, but cannot be used to pay for goods and services.	Negative(legal)
Switzerland	12/14/2018	AML/CTF applicability to crypto business entities.	Uncertain (AML)
	08/27/2019	The Swiss Federal Tax Administration issued a statement that cryptocurrency is regarded as similar to foreign exchange; no capital gains tax for profits from sale for individuals but taxable for business.	Negative (tax)
United Kingdom	12/19/2019	Her Majesty's Revenue & Customs issued a policy paper on the taxation of crypto assets for individuals.	Negative (tax)
	01/10/2020	The Money Laundering and Terrorist Financing (Amendment) Regulations 2019 came into force. These regulations implement the AMLD5 in the United Kingdom, including an expansion of the scope of the regulated sector and changes to aspects of regulated firms' customer due diligence and enhanced due diligence. obligations.	Uncertain (AML)
	03/06/2020	Her Majesty's Treasury implemented the AMLD5 through amending the Money Laundering Regulations. The AML regime extends to specific activities, such as exchange, custody, ICOs, and crypto-ATMs.	Uncertain (AML)
	03/30/2021	Her Majesty's Revenue & Customs issued Cryptoassets Manual, which provides a comprehensive explanation of the tax treatment of crypto assets.	Negative (tax)
United States	04/14/2014	Cryptocurrency transactions are subject to taxes under Internal Revenue Service Notice 2014-21 and Notice 2014-16.	Negative (tax)
	06/04/2021	Internal Revenue Service updates on tax-related questions on virtual currency transactions.	Negative (tax)
	06/30/2021	Countering money laundering and the financing of terrorism designated national priorities: The Financial Crimes Enforcement Network issues regulations specifying how financial institutions should incorporate "cybercrime, including relevant cybersecurity and virtual currency considerations" into their AML programs.	Uncertain (AML)

Table 8

Identifying the Effect of Regulation on Price Deviations Using Difference-in-Differences Design

		Dependent variable = BTCPRICEDEVIATION$_{ipt}$				
		Column 1	Column 2	Column 3	Column 4	Column 5
Explanatory variables	Predicted sign	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)	coefficient (*t-value*)
Intercept		Included	Included	Included	Included	Included
Ln (EXCHANGETRADEVOLUME)$_{ipt}$		-0.001 (-0.296)	0.001 (1.576)	-0.001 (-0.596)	-0.001 (-1.281)	-0.001 (-0.505)
CAPITALCONTROL$_{it}$		0.026** (2.178)	0.014 (0.274)	0.024** (2.040)	0.037*** (3.206)	0.020* (1.826)
POSTINCOMETAX$_{it}$		**0.006 (1.228)**				
POSTINCOMETAX$_{it}$*CAPITALCONTROL$_{it}$		**-0.012* (-1.957)**				
POSTFRAMEWORK$_{it}$			**0.010** (2.189)**			
POSTFRAMEWORK$_{it}$*CAPITALCONTROL$_{it}$			**-0.023 (-1.110)**			
POSTBAN$_{it}$				**0.015 (1.630)**		
POSTBAN$_{it}$*CAPITALCONTROL$_{it}$	**(-)**			**-0.029* (-1.672)**		
POSTAML$_{it}$					**0.008** (2.201)**	
POSTAML$_{it}$*CAPITALCONTROL$_{it}$	**(-)**				**-0.017 (-0.940)**	
POSTENFORCEMENT$_{it}$						**-0.002 (-0.377)**
POSTENFORCEMENT$_{it}$*CAPITALCONTROL$_{it}$						**0.003 (0.267)**
Year fixed effects		Included	Included	Included	Included	Included
Country/region fixed effects		Included	Included	Included	Included	Included
Standard errors		Cluster-adjusted by exchange and year				
N		40,048	40,048	40,048	40,048	40,048
Adjusted *R*-squared		12.7%	12.9%	13.0%	13.0%	12.6%

*** p<0.01, ** p<0.05, * p<0.10.

Table 9

Regulatory Event Study Around Key Cryptocurrency Regulation Updates

Panel A: Regulatory event-window returns by jurisdiction

Jurisdiction	Regulatory update date	Expected sign	Event-day return in the "treated" jurisdiction	Three-day return in the "treated" jurisdiction
Australia[#]	12/07/2017	Uncertain	4.00%*	-8.11%*
	12/18/2017	Positive	-1.84%	3.99%
China	09/03/2017	Negative	-6.18%**	-19.80%***
France[#]	05/22/2019	Negative	-4.32%*	0.05%
	12/09/2020	Uncertain	-1.55%	1.43%
Germany	06/23/2017	Uncertain	0.11%	-9.32%*
	02/27/2018	Positive	1.01%	4.01%
Indonesia	02/18/2019	Positive	2.32%	3.11%
	12/17/2020	Positive	2.11%	5.20%
Japan[#]	4/1/2017	Uncertain	1.02%	6.15%
	12/27/2017	Negative	-6.54%**	-13.83%**
	05/01/2020	Positive	1.64%	0.50%
Luxembourg[#]	02/08/2018	Uncertain	1.11%	0.10%
	07/26/2018	Negative	-2.22%	0.28%
Mexico	03/01/2018	Uncertain	1.85%	4.90%
Poland	04/04/2018	Negative	-4.52%*	-3.16%
	03/30/2021	Uncertain	1.25%	3.20%
Republic of Korea	12/07/2017	Negative	-16.03%***	-19.37%***
	01/23/2018	Negative	0.22%	-3.11%
	03/06/2020	Negative	-9.10%***	-11.73%*
Switzerland	12/14/2018	Uncertain	-1.02%	4.05%
	08/27/2019	Positive	-1.05%	-6.21%
United Kingdom[#]	12/19/2019	Negative	-2.40%	-2.71%
	01/10/2020	Uncertain	-1.70%	-0.80%
	03/06/2020	Uncertain	-2.44%	-12.46%**
	03/30/2021	Negative	-1.33%	-1.30%
United States[#]	06/04/2021	Negative	-3.65%*	-10.51%**
	06/30/2021	Uncertain	-3.91%***	-0.26%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$.

[#]Jurisdictions with low capital control measures (the capital control index is less than the sample median).

Table 9

(continued)

Panel B: Summary statistics of the event-window returns

Summary statistics	***Event-day return***	***Three-day return***
Average event-window returns that are expected to be negative for "treated" jurisdictions	-4.76%*	-7.62%*
Benchmark: Average corresponding returns for "non-treated" jurisdictions	*0.28%*	*0.89%*
Excess Bitcoin return for "treated" jurisdiction that are expected to have negative event-window returns *(p-value)*	-5.04%* *(0.05)*	-8.61%* *(0.07)*
Average event-window returns that are expected to be negative for "treated" jurisdictions with LOW capital controls	-3.41%	-4.67%
Excess Bitcoin return for "treated" jurisdictions that are expected to have negative event-window returns with LOW capital control *(p-value)*	-3.69% *(0.14)*	-5.56% *(0.13)*
Average event-window returns that are expected to be negative for "treated" jurisdictions with HIGH capital controls	-6.11%**	-10.56%**
Excess Bitcoin return for "treated" jurisdictions that are expected to have negative event-window returns with HIGH capital control*(p-value)*	-6.39% *(0.04)*	-11.45% *(0.04)*
Average event-window returns that are expected to be positive for "treated" jurisdictions	*0.78%*	2.55%
Benchmark: Average corresponding returns for "non-treated" jurisdictions	*0.28%*	*0.89%*
Excess Bitcoin return for "treated" jurisdiction that are expected to have positive event-window returns *(p-value)*	0.50% *(0.47)*	1.66% (0.43)
Average event-window returns that are expected to be positive for "treated" jurisdictions with LOW capital controls	-1.84%	3.99%
Excess Bitcoin return for "treated" jurisdictions that are expected to have positive event-window returns with LOW capital control (p-value)	-2.12% *(0.28)*	3.10% *(0.27)*
Average event-window returns that are expected to be positive for "treated" jurisdictions with HIGH capital controls	1.81%	4.11%
Excess Bitcoin return for "treated" jurisdictions that are expected to have positive event-window returns with HIGH capital control *(p-value)*	*1.53%* *(0.41)*	*3.22%* *(0.26)*

Panel C: Event-window excess returns by regulation type

Regulation type	**Expected sign**	**Event-day excess return**	**Three-day excess return**
Average event-window returns for treated jurisdictions that impose heavier income tax burdens on cryptocurrencies	Negative	-3.90%* (0.09)	-5.46% (0.14)
Average event-window excess returns for treated jurisdictions that impose more legal restrictions on cryptocurrencies	Negative	-11.11%*** (0.01)	-19.59%*** (0.01)
Average event-window returns for treated jurisdictions that apply or strengthen AML/CTF laws to cryptocurrency exchanges	Uncertain	0.03% (0.47)	-0.12% (0.42)

*** $p<0.01$, ** $p<0.05$, * $p<0.10$.

Table 10

Supplementary Analysis on the Channels Underlying the Demand Side and the Supply Side

Panel A: Regulation, tax, and investor demand for Bitcoin

		Dependent variable = Daily Google Search Index$_{it}$			
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	Predicted sign	Coefficient (*t-value*)	Coefficient (*t-value*)	Coefficient (*t-value*)	Coefficient (*t-value*)
Intercept		Included	Included	Included	Included
Ln(GDPpercapita)$_{it}$		-10.125 (-1.854)	-10.569 (12.320)	-10.841 (-0.728)	18.328 (0.857)
INFLATION$_{it}$		-10.003 (-1.461)	-10.089 (-1.223)	10.002 (0.409)	-5.858 (-0.514)
GDPGROWTH$_{it}$		10.008 (1.738)	10.004 (0.239)	-10.087 (-1.186)	10.521 (0.998)
STOCKRETURN$_{it}$		-0.619 (-1.210)	-1.089* (-1.781)	-0.992* (-1.679)	-0.685 (-1.247)
CAPITALCONTROL$_{it}$		-13.470 (-0.864)	-11.562 (-0.822)	-10.756 (-0.589)	-17.252 (-0.290)
Ln (HACKDAMAGE)$_{it}$		-10.117 (-1.615)	-10.117 (-1.222)	-10.060 (-0.840)	-6.727 (-0.892)
INCOMETAX$_{it}$	***(-)***	***0.299 (1.354)***			
VAT$_{it}$	***(-)***	***-0.191 (-0.716)***			
REGCLARITY$_{it}$	***(+)***		***1.466* (1.677)***		
LEGALITY$_{it}$	***(-)***		***-0.696* (1.812)***		
AMLCTF$_{it}$	***(?)***			***-0.677 (-0.679)***	
ENFORCEMENT$_{it}$	***(?)***				***-0.244** (-2.215)***
Year fixed effects		Included	Included	Included	Included
Cluster-adjusted standard errors		By country and year	By country and year	By country and year	By country and year
N		40,048	40,048	40,048	40,048
Adjusted *R*-squared		3.1%	3.3%	3.1%	3.2%

Table 10

(continued)

Panel B: Regulation, tax, and supply of Bitcoin-related goods and services

		Dependent variable = Ln (Number of businesses that either have a Bitcoin ATM or accept Bitcoin as in-store payment method)$_i$			
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	Predicted sign	Coefficient (*t-value*)	Coefficient (*t-value*)	Coefficient (*t-value*)	Coefficient (*t-value*)
Intercept		Included	Included	Included	Included
Ln (GDPpercapita)$_i$		-0.397 (-1.029)	-0.534 (-1.425)	-0.379 (-1.084)	-0.466 (-1.186)
INFLATION$_i$		0.018 (0.196)	-0.068 (-0.733)	0.037 (0.471)	0.040 (0.496)
GDPGROWTH$_i$		-0.133** (-2.469)	-0.176*** (-3.332)	-0.200*** (-4.138)	-0.177*** (-3.627)
STOCKRETURN$_i$		0.019** (2.621)	0.016* (1.913)	0.025*** (3.097)	0.021*** (2.801)
CAPITALCONTROL$_i$		-2.323*** (-4.125)	0.057 (0.102)	-1.543*** (-3.459)	-1.491*** (-3.271)
Ln (HACKDAMAGE)$_i$		0.340*** (4.076)	0.622*** (9.165)	0.584*** (8.739)	0.681*** (4.741)
INCOMETAX$_i$	***(-)***	***0.304** (2.402)***			
VAT$_i$	***(-)***	***-0.386*** (-4.701)***			
REGCLARITY$_i$	***(+)***		***0.531* (1.784)***		
LEGALITY$_i$	***(-)***		***-0.380*** (-3.709)***		
AMLCTF$_i$	***(?)***			***-0.598** (-2.461)***	
ENFORCEMENT$_i$	***(?)***				***-0.030 (-0.767)***
N		61	61	61	61
Adjusted *R*-squared		68.6%	62.6%	62.3%	60.1%

Table 11

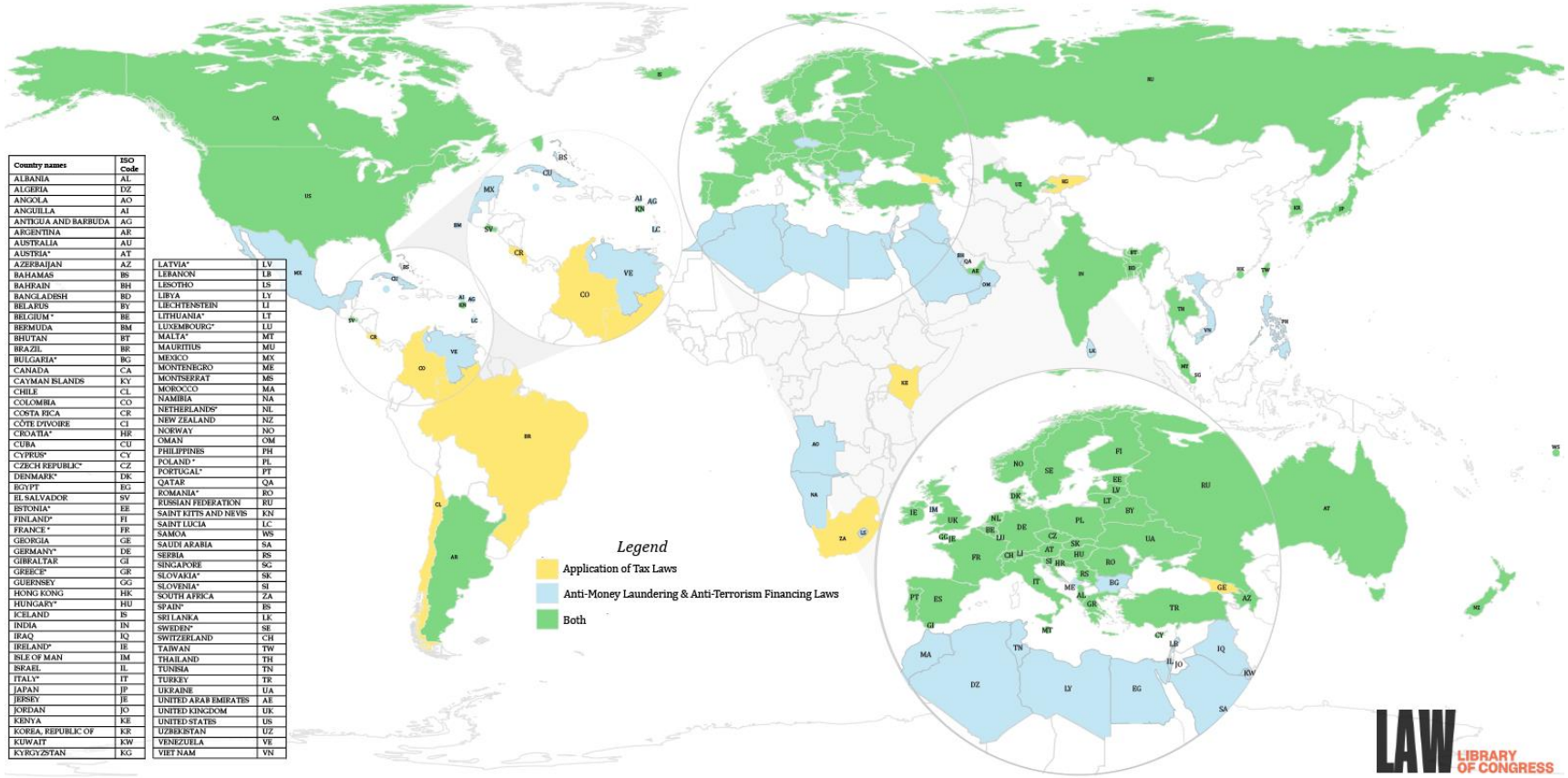
Taxation, Regulation, and Ethereum Price Deviations Relative to the World Market Price

		Dependent variable = ETHPRICEDEVIATION$_{ipt}$					
		Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Explanatory variables	Predicted sign	coefficient (t-value)	coefficient (t-value)	coefficient (t-value)	coefficient (t-value)	coefficient (t-value)	coefficient (t-value)
Ln(EXCHANGETRADEVOLUME)$_{ipt}$		0.001 (0.221)	0.001 (0.756)	0.001 (0.588)	0.001 (0.331)	0.001 (0.813)	0.001 (0.453)
Ln(GDPpercapita)$_{it}$		0.003 (0.745)	0.003 (0.742)	-0.005* (-1.707)	-0.004 (-0.993)	-0.005* (-1.762)	-0.003 (0.300)
GDPGROWTH$_{it}$		-0.001* (-1.718)	-0.002** (-2.505)	-0.001 (-1.421)	-0.001 (-0.320)	-0.001 (-1.283)	-0.001 (-1.145)
INFLATION$_{it}$		0.004*** (3.612)	0.005*** (4.473)	0.002* (1.726)	0.002 (1.015)	0.002* (1.865)	0.002 (1.285)
STOCKRETURN$_{it}$		0.001 (1.081)	0.001 (1.238)	0.001** (2.491)	0.001 (1.634)	0.001** (2.252)	0.001 (0.977)
Ln(HACKDAMAGE)$_{it}$		-0.002** (-2.452)	-0.002** (-2.257)	-0.001* (-1.770)	-0.001 (-1.442)	-0.001* (-1.694)	-0.003 (-3.077)
ATTENTION$_{it}$		0.001* (1.797)	0.001 (1.448)	0.001 (1.107)	0.001 (0.783)	0.001 (1.155)	0.001 (0.203)
CAPITALCONTROL$_{it}$		0.034** (2.293)	0.031* (1.792)	0.054*** (3.632)	0.020* (1.770)	0.051*** (3.636)	0.026** (2.232)
INCOMETAX$_{it}$		**0.005* (1.974)**					
INCOMETAX$_{it}$*CAPITALCONTROL$_{it}$	**(-)**	**-0.039*** (-2.951)**					
VAT$_{it}$			**0.001 (0.504)**				
VAT$_{it}$*CAPITALCONTROL$_{it}$	**(-)**		**-0.002 (-0.314)**				
REGCLARITY$_{it}$	**(+)**			**0.013*** (3.189)**			
REGCLARITY$_{it}$*CAPITALCONTROL$_{it}$				**-0.056 (-1.065)**			
LEGALITY$_{it}$					**0.013** (2.406)**		
LEGALITY$_{it}$*CAPITALCONTROL$_{it}$	**(-)**				**-0.018** (-2.057)**		
AMLCTF$_{it}$						**0.012*** (3.066)**	
AMLCTF$_{it}$*CAPITALCONTROL$_{it}$	**(-)**					**-0.056*** (-4.417)**	
ENFORCEMENT$_{it}$	**(?)**						**0.002 (1.098)**
ENFORCEMENT$_{it}$*CAPITALCONTROL$_{it}$	**(?)**						**-0.007 (-0.727)**
Intercept and year fixed effect		Included					
Standard deviations		Cluster-adjusted by exchange and year					
N		20,395	20,395	20,395	20,395	20,395	20,395
Adjusted R-squared		9.0%	6.9%	11.3%	7.6%	11.7%	7.5%

*** p<0.01, ** p<0.05, * p<0.10.

Figure 1

Application of Tax Laws and AML/CTF Laws or Both to Cryptocurrencies as of November 2021



Country names	ISO Code
ALBANIA	AL
ALGERIA	DZ
ANGOLA	AO
ANGUILLA	AI
ANTIGUA AND BARBUDA	AG
ARGENTINA	AR
AUSTRALIA	AU
AUSTRIA*	AT
AZERBAIJAN	AZ
BAHAMAS	BS
BAHRAIN	BH
BANGLADESH	BD
BELARUS	BY
BELGIUM *	BE
BERMUDA	BM
BHUTAN	BT
BRAZIL	BR
BULGARIA*	BG
CANADA	CA
CAYMAN ISLANDS	KY
CHILE	CL
COLOMBIA	CO
COSTA RICA	CR
CÔTE D'IVOIRE	CI
CROATIA*	HR
CUBA	CU
CYPRUS*	CY
CZECH REPUBLIC*	CZ
DENMARK*	DK
EGYPT	EG
EL SALVADOR	SV
ESTONIA*	EE
FINLAND*	FI
FRANCE *	FR
GEORGIA	GE
GERMANY*	DE
GIBRALTAR	GI
GREECE*	GR
GUERNSEY	GG
HONG KONG	HK
HUNGARY*	HU
ICELAND	IS
INDIA	IN
IRAQ	IQ
IRELAND*	IE
ISLE OF MAN	IM
ISRAEL	IL
ITALY*	IT
JAPAN	JP
JERSEY	JE
JORDAN	JO
KENYA	KE
KOREA, REPUBLIC OF	KR
KUWAIT	KW
KYRGYZSTAN	KG
LATVIA*	LV
LEBANON	LB
LESOTHO	LS
LIBYA	LY
LIECHTENSTEIN	LI
LITHUANIA*	LT
LUXEMBOURG*	LU
MALTA*	MT
MAURITIUS	MU
MEXICO	MX
MONTENEGRO	ME
MONTSERRAT	MS
MOROCCO	MA
NAMIBIA	NA
NETHERLANDS*	NL
NEW ZEALAND	NZ
NORWAY	NO
OMAN	OM
PHILIPPINES	PH
POLAND *	PL
PORTUGAL*	PT
QATAR	QA
ROMANIA*	RO
RUSSIAN FEDERATION	RU
SAINT KITTS AND NEVIS	KN
SAINT LUCIA	LC
SAMOA	WS
SAUDI ARABIA	SA
SERBIA	RS
SINGAPORE	SG
SLOVAKIA*	SK
SLOVENIA*	SI
SOUTH AFRICA	ZA
SPAIN*	ES
SRI LANKA	LK
SWEDEN*	SE
SWITZERLAND	CH
TAIWAN	TW
THAILAND	TH
TUNISIA	TN
TURKEY	TR
UKRAINE	UA
UNITED ARAB EMIRATES	AE
UNITED KINGDOM	UK
UNITED STATES	US
UZBEKISTAN	UZ
VENEZUELA	VE
VIET NAM	VN

Source: Regulation of Cryptocurrency Around the World: November 2021 Update

Figure 2

An Example using SimilarWeb to Identify the Jurisdiction in which a Crypto Exchange's Major Customer Base is Located