HONG KONG MONETARY AUTHORITY

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AN ASSESSMENT ON THE BENEFITS OF BOND TOKENISATION

Key points:

- *By bringing the bond issuance process into a digital platform, tokenisation can automate the issuance process, shorten settlement cycles, enable transactions without intermediaries, and fractionalise bond ownership. Given these unique features, bond tokenisation has the potential to boost issuance efficiency and market liquidity. However, possibly due to a lack of comprehensive data on this evolving market, to what extent tokenisation can deliver the benefits to bond issuers and investors have not been studied empirically.*

- *Using novel data on tokenised bonds issued globally since 2018, we provide fresh analysis on this evolving market. We reveal that some Asian and European issuers have already embraced tokenisation by testing this innovation in their bond issuance and developing related financial infrastructure. By the end of March 2023, the total issuance amount of tokenised bonds globally had reached US$3.9 billion, with seven-tenths of them issued by Asian financial institutions, and most of the rest issued by European counterparts.*

- *On the efficiency gains, we find that tokenised bonds benefit from reductions in underwriting fees by an average of 0.22 percentage point (ppt) of the bond's par value and in borrowing costs by an average of 0.78 ppt compared to similar conventional bonds issued by the same issuers. On the liquidity gains, our estimates show that tokenised bonds exhibit higher liquidity, as their bid-ask spreads are found to be lower than the similar conventional bonds by 5.3%, with the improvement doubled to 10.8% if the tokenised bonds are open to retail investors. In addition, tokenised bonds may facilitate price discovery of the similar conventional bonds, as the latter's bid-ask spreads are found to be reduced by 8.5% after the issuance of the former.*

- *Our findings have two policy implications. First, a wider usage of tokenisation in bond issuance may be considered to enhance the efficiency and liquidity of bond markets. Second, policies to broaden the investor base of the tokenised* *bond market would pave the way for unlocking the potential benefits of tokenisation. As the tokenised bond market is still developing, the sample used in this study is small, albeit already representative of the market position. Readers should interpret our results with caution.*

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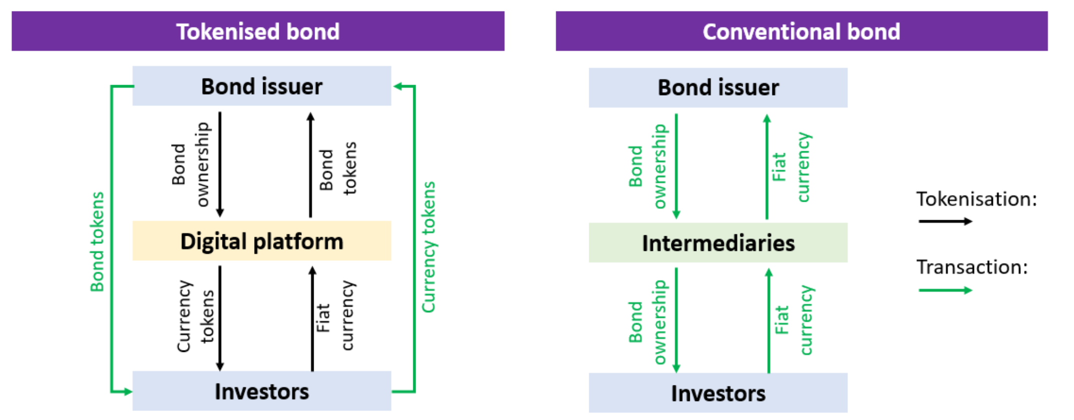
1. INTRODUCTION

Tokenising a bond means recording the beneficial interests in a bond as a multiple of tokens on a digital platform, rather than in traditional computerised book entries. In tokenised bond issuances, issuers and investors can convert their bonds and fiat currencies to tokens on digital platforms respectively. Once tokenised, their bonds and fiat currencies can be exchanged wallet-to-wallet, without the need for financial intermediaries. In contrast, when issuing a conventional bond, issuers and investors have to go through brokers as intermediaries. Chart 1 illustrates the process of issuing tokenised and conventional bonds respectively.

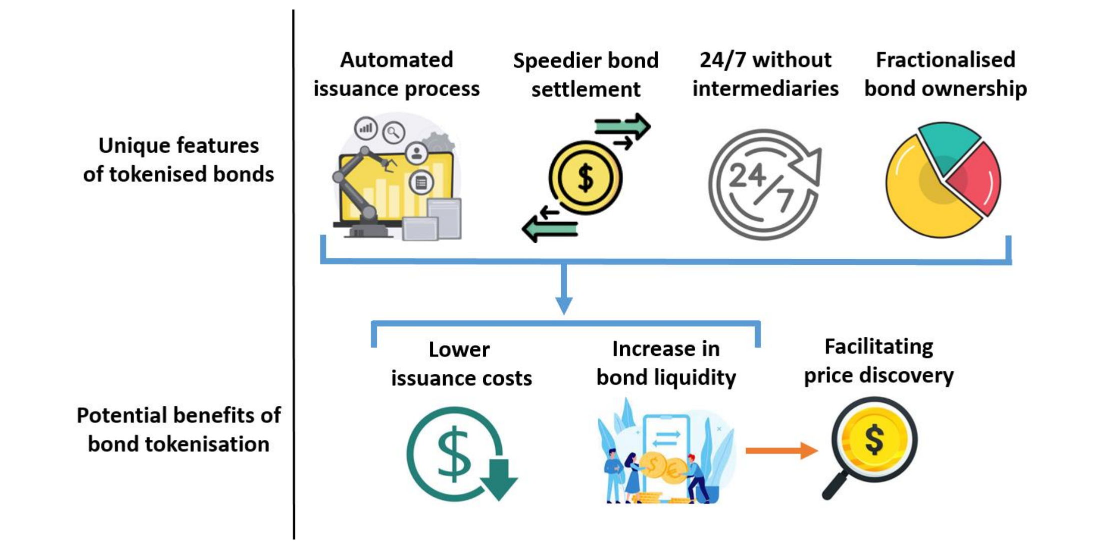
Chart 1: Illustration of tokenised and conventional bond issuances



Tokenised bonds are different from conventional bonds not only in the form where bond ownership is represented, but also in their potentials to improve issuance efficiency and bond liquidity. Theoretically, tokenisation may enhance issuance efficiency by automating the multi-step process for issuance, interest payment and principal repayment through the use of smart contracts. The issuers may also be able to issue tokenised bonds at lower yields, as investors may favour their unique features, such as speedier settlement cycles, round-the-clock trading without intermediaries, and fractionalised bond ownership which allows for an unrestrictedly small amount in transactions. Besides, tokenisation may improve market liquidity, given that the aforementioned features of tokenised bonds may reduce the transaction costs and broaden the investor base. As theoretically tokenised bonds can be traded with greater liquidity, this may also facilitate the price discovery of conventional bonds issued by the same issuers. Chart 2 illustrates these unique features and potential benefits of tokenised bonds. However, possibly due to a lack of comprehensive data on this evolving market, to what extent tokenisation can deliver these benefits to bond issuers and investors have not been studied empirically.[1]

[1] These benefits are widely discussed in academic literature, such as OECD (2020) and ASIFMA (2021). Similar empirical studies include Liu, Shim and Zheng (2023), which examines the difference in yield spreads between blockchain-based asset-backed securities (ABSs) and plain vanilla ABSs in China.

Chart 2: Illustration of unique features and potential benefits of tokenised bonds



Against this backdrop, our study provides fresh analysis on this growing global market. Sourcing data on the tokenised bonds issued globally since 2018, we investigate the following four questions:

1. What are the recent developments in the tokenised bond market in terms of issuance activities and infrastructure development?
2. Does tokenisation deliver efficiency gains to bond issuers by lowering their issuance costs?
3. Does tokenisation improve bond liquidity? Does the liquidity improvement depend on any conditions?
4. Do tokenised bonds facilitate price discovery of the conventional bonds issued by the same issuers?

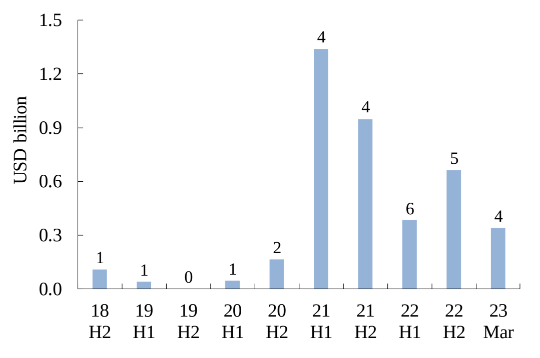
This study is structured as follows. The next section describes the recent developments in the tokenised bond market. Section 3 discusses the empirical findings for the remaining questions. Section 4 concludes.

2. Recent Developments in the Tokenised Bond Market

We retrieved the data on tokenised bond issuance from Bloomberg and Refinitiv Eikon. Our dataset includes 28 tokenised bonds issued by 23 different issuers since 2018. We verify their tokenised nature with reference to a number of news items, press releases, reports, announcements, and other official documents published by the issuers or third-party specialists, such as the International Capital Market Association (2023), which has tracked bond issuances on digital platforms since 2018 and provides detailed information on the issuances, including issue date, issuer name, and often ISIN code, issue amount and coupon rate. A bond is confirmed as tokenised if its information on Bloomberg or Refinitiv Eikon is consistent with the verification materials.

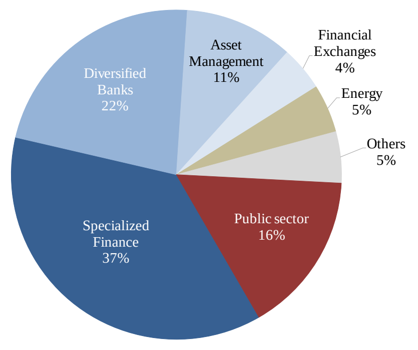
Our final sample is representative of the global position, as the total outstanding amount of the tokenised bonds accounts for a majority of the level reported by Damak et al. (2023) from S&P Global Ratings, which is one of the mainstream rating agencies for tokenised bonds, over the past year. At the end of March 2023, our data reveal that the total issuance amount of tokenised bonds globally had reached US$3.9 billion, with nine-tenths of the issuance occurring in and after 2021 (Chart 3).

Chart 3: Total issuance amount of tokenised bonds in the world



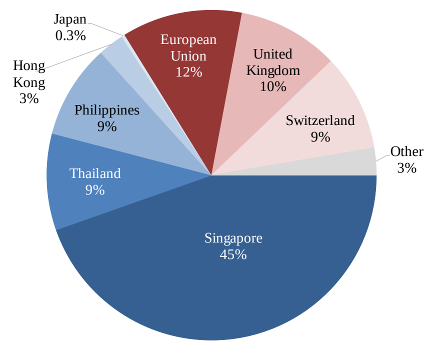
Notes: (i) Y-axis denotes the issuance amount; and (ii) Figures above the bars denote the number of deals.
Sources: Bloomberg, Refinitiv Eikon and HKMA staff estimates.

Chart 4: Share of tokenised bonds in terms of issuance amount, by issuer type



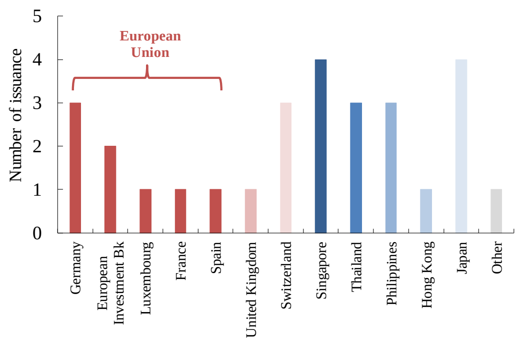
Note: Figures cover the tokenised bonds globally issued since 2018, in terms of the issuance amount.
Sources: Bloomberg, Refinitiv Eikon and HKMA staff estimates.

Chart 5: Share of tokenised bonds in terms of issuance amount, by issuer domicile



Note: Figures cover the tokenised bonds globally issued since 2018, in terms of the issuance amount.
Sources: Bloomberg, Refinitiv Eikon and HKMA staff estimates.

Chart 6: Number of tokenised bond issuance, by issuer domicile

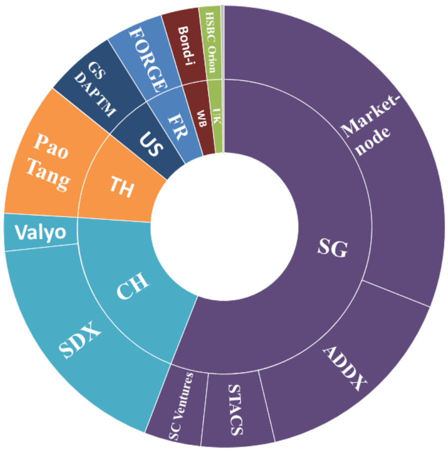


Note: Figures cover the tokenised bonds globally issued since 2018, in terms of the number of deals.
Sources: Bloomberg, Refinitiv Eikon and HKMA staff estimates.

Among these tokenised bond issuances, financial industries were the leading issuers in terms of the issuance amount, with most of them being banks, asset managers, financial exchanges or specialised finance service providers (Chart 4). The public sector has also embraced the trend of tokenisation, with our novel data encompassing the world's first tokenised bond launched by the World Bank and the world's first government-issued tokenised green bond launched by the Hong Kong Government.[2] For geographic distribution, a majority (around 70%) were issued by Asian institutions, while European issuers accounted for most of the rest (Chart 5). As for the number of deals, no jurisdiction had a significant numeric advantage, with the number of deals ranging from 1 to 4 across jurisdictions (Chart 6).

Digital platforms for bond tokenisation have also emerged in Asia and Europe in recent years (Chart 7), with many of them being backed by traditional financial institutions. The footprint of financial exchanges is widely seen in these digital platforms. For instance, Singapore Exchange Group is one of the co-owners of Marketnode and financed ADDX in a series A round in early 2021. ADDX also received investment from the Stock Exchange of Thailand in a series B round in 2022. Japan Exchange Group also embraced the trend by investing in Nomura-affiliated Boostry in early 2023. In addition, some banks have also launched their own digital platforms.[3]

Chart 7: Share of tokenised bonds, by digital platform and domicile



Notes: (i) Figures cover the tokenised bonds globally issued since 2018, in terms of the issuance amount; (ii) The outer circle denotes the digital platforms in our sample and the inner circle denotes where they are based; and (iii) SG stands for Singapore; CH stands for Switzerland; TH stands for Thailand; US stands for the United States; FR stands for France; WB stands for the World Bank; and UK stands for the United Kingdom.
Sources: Bloomberg, Refinitiv Eikon and HKMA staff estimates.

In summary, tokenisation is still in its early stage of development. Nevertheless, some Asian and European institutions have already taken an early step to embrace this wave of technological advancement, by applying tokenisation to their bond issuance and developing digital platforms for this purpose. In the next section, we empirically

[2] https://www.hkma.gov.hk/eng/news-and-media/press-releases/2023/02/20230216-3/
[3] In our sample, Goldman Sachs, HSBC, Krungthai Bank, Raiffeisen Switzerland, Nomura, Societe Generale and Standard Chartered launched GS DAPTM, HSBC Orion, Pao Tang, Valyo, Boostry, Forge and SC Ventures, respectively.

examine to what extent tokenisation can deliver efficiency and liquidity gains for these institutions.

3. BENEFITS OF BOND TOKENISATION

To identify the benefits of bond tokenisation, we need to compare tokenised bonds with their conventional counterparts issued by the same issuers. To this end, we further download data on 6,090 conventional bonds issued by the issuers of tokenised bonds from Bloomberg. However, a direct comparison of tokenised and conventional bonds is challenging due to the high degree of dissimilarity across various bond characteristics, such as issue amount, issue date, maturity and currency denomination, which could bias any observed differences in issuance costs or liquidity between the two bond types. For a fair comparison, we match each tokenised bond with the most similar conventional bond. For each tokenised bond, we filter out conventional bonds which did not have the same issuer, currency, credit rating and coupon type. We then measure the similarity of the remaining conventional bonds to the tokenised bond, based on various bond characteristics, including differences in issue date, maturity and issue amount.[4] Finally, we can identify the most similar conventional bond to match with the tokenised bond. By matching the bonds in this way, we significantly reduce the heterogeneity between the two bond types to the level widely acceptable in academic literature.[5,6]

3a. Does tokenisation deliver efficiency gains to bond issuers?

Conventional bond issuance involves multiple intermediaries such as underwriters, who charge fees for their services. In contrast, tokenisation streamlines the bond issuance process by automating the manual process and eliminating paper trails. These may reduce the operational cost of bond issuance, including the underwriting fees.

We confirm this conjecture by estimating the mean difference in the underwriting fees of bond issuance between the matched tokenised and conventional bonds. In the matched sample, we find that underwriting fees for issuing a tokenised

[4] The similarity measurement is equivalent to a propensity score of being tokenised, estimated by a logit function where the dependent variable is a dummy variable equal to one for the tokenised bond, or zero for the conventional bonds; and the independent variables include the differences in issue date, maturity and issue amount between the conventional bonds and the tokenised bond. The detailed description of the matching procedure can be found in Annex A1.

[5] The heterogeneity between tokenised and conventional bonds before and after matching can be found in Annex Table A2.

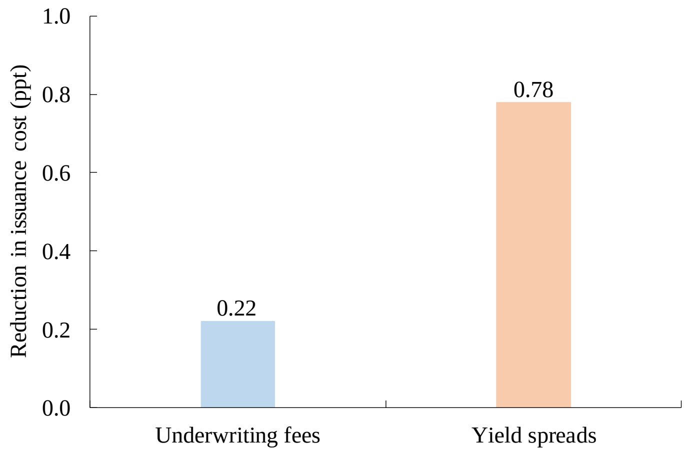
[6] We have also matched the bonds under a looser and stricter set of criteria. The empirical results remain robust across matching criteria. Full results can also be found in the HKIMR Working Paper series (forthcoming).

bond were lower than those of a conventional bond by an average 0.22 ppt of the bond's par value (blue bar, Chart 8).[7] This result is economically significant, as it represents a 25.8% reduction in the underwriting fees of conventional bonds.

Apart from underwriting fees, an issuer also needs to pay borrowing costs in the form of bond yields to its investors. The issuers may be able to issue tokenised bonds at a lower yield, if the investors favour the unique characteristics of tokenised bonds, such as shorter settlement cycles, round-the-clock trading without intermediaries, or fractionalised bond ownership that may lower the entry barrier of those bonds that were once illiquid to ordinary investors.

To test this hypothesis, we further estimate the mean difference in the yield spreads[8] between the matched tokenised and conventional bonds. Our findings suggest that investors recognised the benefits of tokenisation and were willing to accept a lower yield spread of 0.78 ppt on average when investing in tokenised bonds, compared to their most similar conventional bonds (orange bar, Chart 8).[9] Likewise, the result is economically significant as it is equivalent to lowering the yield spread at issuance by 23.9% from the conventional bonds.

Chart 8: Estimation results of the efficiency gains from bond tokenisation



Note: This chart depicts the estimated reductions in underwriting fees and yield spreads in percentage by tokenisation.
Source: HKMA staff estimates.

Taking the underwriting fees and borrowing costs together, our findings suggest that tokenisation could lower these costs by a combined 1 ppt of the bond's par value. It should be noted that tokenisation may also have implication for other cost items of

[7] The estimate is statistically significant at the 10% level.
[8] Bond yield spread is equivalent to bond yield minus a benchmark rate, which is 1-year interbank or deposit rate of the bond currency capturing the impact of the interest rate cycle. We use bond yield spreads instead of bond yields because the observed mean difference in bond yields could be driven by the interest rate cycle. The mean difference in bond yield spreads provides a more accurate estimate of the impact of tokenisation on the borrowing costs of the issuers.
[9] The estimate is statistically significant at the 10% level.

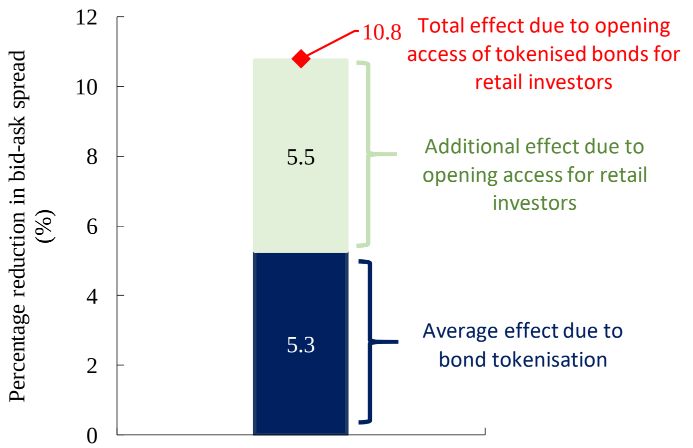
bond issuance such as reducing legal fees or accounting fees (OECD, 2020). However, these are unavailable in mainstream data sources. Therefore, our estimates may have only accounted for part of the efficiency gains of tokenisation.

3b. Does tokenisation improve bond liquidity?

As argued previously, tokenised bonds may exhibit greater liquidity than conventional bonds in the secondary markets, as the former can be settled faster, traded without intermediaries, and fractionalised into an unrestrictedly small amount in transactions, thereby lowering the entry barrier. In addition, the magnitude of liquidity improvement is likely to be greater for those bonds that are open to retail investors, as they are more likely to benefit from the lower entry barrier and increased access to the market.

We proxy bond liquidity with its bid-ask spread. The lower the spread is, the higher is the liquidity, and vice versa. We test the hypothesises with a fixed effect regression model.[10] Our estimates suggest that tokenised bonds exhibited a higher liquidity than the matched conventional bonds. Regardless of retail investor access, our regression estimations suggest that the bid-ask spread of tokenised bonds was lower than that of the conventional bonds by 0.035 ppt on average. It represents a 5.3% decrease in the average bid-ask spread of those conventional bonds (blue bar, Chart 9). If the bonds are open to retail investors, our estimation results find that the reduction could double to 0.072 ppt, denoting a 10.8% drop in the average bid-ask spread of those conventional bonds (red dot, Chart 9).[11]

Chart 9: Estimation results of the liquidity gains from bond tokenisation



Note: This chart depicts the estimated reductions in bid-ask spreads of bonds in percentage by tokenisation, by investor base of the bonds.
Source: HKMA staff estimates.

[10] Detailed description of the regression model can be found in Annex A2.
[11] All of these estimates are statistically significant at the 1% level.

3c. Do tokenised bonds facilitate price discovery of conventional bonds?

Tokenisation may improve the liquidity of conventional bonds by facilitating their price discovery process. In theory, as tokenised bonds are traded with greater liquidity, they are more conducive to more informative prices. This information can then help facilitate the discovery of the fair value of the less liquid conventional bonds issued by the same issuers, thereby improving the liquidity of the latter.

Likewise, we test this hypothesis with a fixed effect regression model.[12] We find that the liquidity of conventional bonds would improve after their issuers issue a similar tokenised bond. Our regression results suggest that the average bid-ask spread of conventional bonds would be reduced by 0.049 ppt, after their issuers issued a tokenised bond.[13] The reduction is equivalent to 8.5% of the average bid-ask spread of the conventional bonds.

4. CONCLUSION

Tokenisation has huge potential to be unlocked. Our novel data reveal that some Asian and European issuers are embracing this wave of technological advancement by testing tokenisation in their bond issuance and developing digital platforms for this purpose. While tokenisation has yet to be commonly used in financial practices, many of us are curious about its potential, and more importantly, to what extent such an innovation can benefit us in financial markets.

Against this backdrop, this study has provided answers to two critical questions. First, tokenisation has significant operational benefits for bond issuers as it can lower their underwriting fees and borrowing costs. Specifically, tokenisation could reduce underwriting fees for bond issuance by an average of 0.22 ppt of the bond's par value. As investors may also prefer tokenised bonds to conventional ones, issuers can issue a tokenised bond at a yield level lower than what they would offer for issuing a conventional bond by 0.78 ppt on average. Second, tokenisation can enhance the liquidity of bonds in the secondary market. We find that tokenised bonds exhibited higher liquidity than the conventional ones by 5.3%. Given the liquidity advantage, secondary trading of the tokenised bonds may be able to facilitate price discovery of the conventional bonds, as we find the latter's bid-ask spread becomes tighter by 8.5% after the issuance of the former.

These findings offer two important implications for the development of the global bond market. First, a wider usage of tokenisation in bond issuance may be considered to enhance the efficiency and liquidity of bond markets. Second, policies to

[12] Detailed description of the regression model can be found in Annex A3.
[13] The estimate is statistically significant at the 1% level.

broaden the investor base of the tokenised bond market would pave the way for unlocking the potential benefits of tokenisation. However, as the tokenised bond market is still evolving, the sample used in this study is small, albeit already representative of the market position. Readers should interpret our results with caution.

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ANNEX

A1: Bond matching procedure

Table A1 summarises our two-step approach to match each tokenised bond with the most similar conventional bonds. For each tokenised bond, we filter out those conventional bonds not fulfilling some criteria widely applied in academic literature (Zerbib, 2019; Lau et al., 2020; Wu, 2022; Bachelet et al., 2019). Among the remaining conventional bonds, we measure their propensity scores of being tokenised bonds following the approach adopted in the literature (Gianfrate et al., 2019; Fatica et al., 2021; Lacker et al., 2020). The conventional bond with the highest propensity score would be matched with the tokenised bond.

Table A1: Two-step approach to match tokenised and conventional bonds

Step	Description
1	For each tokenised bond i, we restrict the conventional bonds j which can satisfy the following exact matching criteria: • Same issuer; • Same currency; • Same rating; • Same coupon type as tokenised bond i
2	In the sample of tokenised bond i and the selected conventional bonds j, we estimate their propensity scores with the following logit function and match tokenised bond i with the conventional bond with the highest propensity score. $\phi(T_k) = \beta_1 + \beta_2 Issue_{k,i} + \beta_3 Maturity_{k,i} + \beta_4 Size_{k,i} + \varepsilon_k$ where T_k is a dummy variable if bond k is tokenised; $Issue_{k,i}$ is the difference in issue date between bond k and tokenised bond i; $Maturity_{k,i}$ is the difference in maturity between bond k and tokenised bond i; $Size_{k,i}$ is the percentage difference in bond size between bond k and tokenised bond i; and ε_k is the residual term of bond k.

The bond matching procedure significantly reduces the heterogeneity in bond characteristics between tokenised and conventional bonds. Table A2 furnishes the changes in their differences.

The difference in the issue date is reduced to 1.64 years from 2.01 years. The difference in bond maturity is nearly eliminated. The difference in bond size is also reduced by about one-third. All of these differences in the matched sample are statistically insignificant and within the threshold widely acceptable in academic literature (Zerbib, 2019; Lau et al., 2020; Wu, 2022; Bachelet et al., 2019).

Table A2: Mean differences between tokenised and conventional bonds[i]

Mean difference in	Before matching	After matching	Threshold used in the literature
Issue date (in year)[ii]	2.01*	1.64	≥ 6
Maturity (in year)[iii]	4.76	-0.26	≥ 2
Bond size (%)[iv]	-97.7***	-66.7	25 - 400

Notes:

(i) ***, ** and * denote 1%, 5% and 10% level of statistical significance;

(ii) A positive (negative) figure means that the tokenised bond was issued later (earlier) than the matched conventional bond;

(iii) A positive (negative) figure means that the tokenised bond had a longer (shorter) maturity at issue than the matched conventional bond; and

(iv) A positive (negative) percentage means that the tokenised bond was larger (smaller) than the matched conventional bond.

A2: Fixed effect regression model in Section 3b

To test the hypothesis whether tokenised bonds exhibit greater liquidity than similar conventional bonds do, we consider the following fixed effect regression model:

$$Liquidity_{i,t} = \alpha_j + \beta_1 \times T_i + \beta_2 \times R_i + \beta_3 \times T_i \times R_i + Control_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where $Liquidity_{i,t}$ is the daily average bid-ask spread of bond i issued by issuer j on day t. T_i is a dummy variable equal to one for tokenised bonds, or zero otherwise. R_i is a dummy variable equal to one for retail bonds, or zero otherwise. Our data sources do not provide any label for retail bonds. We therefore classify a bond as retail bond by ourselves if its minimum subscription amount is below the sample lower quartile, which is US$5,400. This classification is more stringent than the standard practice of US$100,000 in the literature (deHaan et al., 2023; O'Hara and Zhou, 2021; Cuny et al., 2021; Larcker and Watts, 2020; Bessembinder et al., 2018). We control for issuer-specific fixed effects with α_j. Bond-specific fixed effect (α_i) is not added since the dummy variables are time-invariant for each bond and would thus be crowded out by α_i. $Control_{i,t}$ include (i) the age, (ii) time to maturity (iii) size of the bond; and (iv) MOVE index to capture time-variant market conditions. These control variables are commonly used in academic literature to identify the impacts of various factors on bond liquidity (O'Hara and Zhou, 2021; Kargar et al., 2021; Anderson and Stulz, 2017; Pooter et al., 2018). If the hypothesis is correct, then β_1, which measures the average impact of tokenisation on bond liquidity, should be significantly negative. β_3, which measures the additional impact of tokenisation on bond liquidity if the bond is open to retail investors, should also be significantly negative. The result is shown in Table A3 below.

Table A3: Regression results of Equation (1)[i]

	$Liquidity_{i,j,t}$
T_i (β_1)[ii]	-0.035***
$T_i \times R_i$ (β_3)[ii]	-0.037**
R_i (β_2)	0.003
Pairs of bonds	15
Observations	17,880

Notes:

(i) ***, ** and * denote 1%, 5% and 10% level of statistical significance; and

(ii) A positive (negative) figure means the average bid-ask spread of tokenised bonds is higher (lower) than that of the matched conventional bonds.

Source: HKMA staff estimates.

A3: Fixed effect regression model in Section 3c

Likewise, we test the hypothesis whether the liquidity of conventional bonds is improved after the tokenised bond issuance by their issuers with the following fixed effect regression model:

$$Liquidity_{i,t} = \alpha_j + \beta_1 \times Issue_{i,\,t} + Control_{i,t} + \varepsilon_{i,t} \qquad (2)$$

where the set-up is similar to Equation (1), except $Issue_{i,\,t}$ which is a dummy variable equal to 1 after the tokenised bond was issued, or zero otherwise. For estimation, we draw the observations in times 364 days before and after the issuers issue a tokenised bond. If the hypothesis is true, then β_1 should be significantly negative, and vice versa. The result is shown in Table A4 below.

Table A4: Regression results of Equation (2)[i]

	$Liquidity_{i,j,t}$
$Issue_{i,\,t}$ (β_1)[ii]	-0.049***
No. of bonds	15
Observations	5,966

Notes:

(i) ***, ** and * denote 1%, 5% and 10% level of statistical significance; and

(ii) A positive (negative) figure means the average bid-ask spread of conventional bonds after their issuers issue a tokenised bond is higher (lower) than that before the issuance.

Source: HKMA staff estimates.