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A Taste for Dim Sum: Analysing the Financial Diffusion in the New Offshore Renminbi Debt Securities Market*

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Abstract

Periodically a major financial innovation creates a new product class that changes the financial landscape. Examples include junk bonds that enabled leveraged buyouts, securitization that stimulated off balance sheet growth in banks, and credit default swaps that offered pure trading in credit risk. Now new renminbi financial products are emerging as China opens its capital account, providing new opportunities for innovation in corporate finance that will promote financial stability and sustainable growth in China. This study illustrates the rapid growth in the use of these new products by Chinese and overseas firms. We use diffusion models to explore how participation in this market is influenced by greater depth and liquidity of the market, lower costs of issuance and greater expected appreciation of the renminbi against the US dollar. Understanding these offshore developments will help support smoother innovation in the onshore corporate bond market.

Keywords: financial innovation, offshore bond markets, dim sum, Hong Kong

JEL classification: F32, F34, G32, O16

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1. *Introduction*

Major financial innovations in new product types create new opportunities. Remolona (1990) notes that the growth of the sub-investment grade 'junk' bond market supported the rise in corporate leveraged buyouts among non-financial firms during the 1980s. Berger and Udell (1993) recognise that the development of securitized products (loan sales, standby letters of credit, and loan commitments) led to an increase in the off-balance sheet growth in financial firms. Blanco et al. (2005) document that emerging credit default swap (CDS) contracts with better liquidity than bonds supported the development of a market specifically for trading credit risk by financial and non-financial firms. The same story could be told for many 'back end' and 'front end' financial innovations (see Tufano, 1989, 2003; Frame and White, 2004; and Lerner, 2006).

In 2007 a new 'dim sum' bond market emerged when the China Development Bank issued its first renminbi (RMB) bond, then other Mainland banks and government enterprises began issuing offshore RMB securities. Figure 1 shows that new issuance was dominated by private Mainland and Mainland government bond issues until 2010, but the market was small with just 16 issuers and market size of RMB 35.7 billion in 2010. The offshore bond market for Hong Kong grew with the entry of large multinational companies such as McDonald's and Caterpillar of the United States, America Movil of Mexico and Volkswagen of Germany.[2] The market was dominated by issuers in Hong Kong and overseas by 2013, and by 2016 Mainland issuers had all but disappeared, partly due to the lower cost of issuing in the onshore market. As Figure 2 shows, from 2011 – 2015 the offshore RMB bonds outstanding grew to more than RMB 368 billion before contracting slightly in 2016 and 2017, following a similar pattern to outstanding RMB loans. Hong Kong has the largest market for RMB offshore debt securities, with a substantial range of issuers and banks that facilitate the issuance and sale of these financial products to investors. Data from the Society for Worldwide Interbank Financial Telecommunication (SWIFT) shows Hong Kong has around 70% of the share of worldwide RMB payments (Figure 3) and this trend is also reflected in the growth in other indicators, such as the outstanding volume of offshore bonds, issuance of RMB bonds and daily foreign exchange turnover of offshore RMB reported in Figure 4.[3]

[2] McDonald's was the first foreign company to issue (200 million RMB bond) in August 2010.

[3] Focusing on Hong Kong's 'dim sum' market has particular advantages, as the Hong Kong Monetary Authority (HKMA) Central Moneymarkets Unit (CMU) provides computerised clearing and settlement facilities for a range of Hong Kong debt securities in HKD and RMB. We were given privileged access to firm-level issuance data at a quarterly frequency collected by the Research Department of the Hong Kong Monetary Authority to explore the emergence of this market.

New RMB financial products such as offshore RMB securities have grown in volume since 2011 as China opened its capital account.[4] These securities provide new opportunities for innovation in corporate finance for Mainland companies seeking RMB finance offshore and for multinational firms operating in China. This innovation in RMB financial products from the Mainland is likely to significantly reduce the costs of raising finance for onshore activity, provide diversification benefits for investors seeking exposure to RMB assets.[5] Ultimately, it has allowed the authorities in the Mainland to open up the much larger onshore market in RMB debt securities, a process that has just begun this year and will continue, providing new opportunities for innovation in corporate finance that will promote financial stability and sustainable growth in China.

Research to date on the effects of greater use of RMB offshore has been mostly focused on invoicing patterns of Chinese firms, foreign exchange trading of the RMB, and onshore and offshore financing in Asia (He and Yu, 2014; Lai and Yu, 2014; Shu et al. 2014). However, the determinants of this innovation and the rate of adoption by the market participants of RMB bonds are not well researched. This is somewhat surprising, given the rapid growth in the offshore RMB market.

This paper attempts to fill this gap by identifying major driving factors behind development of the offshore RMB bond market. Mizen and Tsoukas (2015) pioneer a systematic empirical analysis of the drivers that impact financial innovation in the offshore renminbi debt securities market. They focus on how firms' and investors' decisions to engage in the offshore RMB debt securities market are affected by firms' financial health and market conditions, using novel quarterly data on offshore RMB securities issuance in Hong Kong from the Hong Kong Monetary Authority. Applying proportional hazard models to explain how participation in this market is affected by corporate financial indicators and various market-level measures, their empirical results provide evidence of an important role of ex-

[4] China began the process of internationalizing the RMB in successive steps (see He and McCauley, 2012). The Chinese government made the RMB fully convertible under the current account in 1996. It has operated a managed floating exchange rate since 2005, but the People's Bank of China imposes a daily trade band and makes regular interventions (Shu, He and Cheng, 2014). Investors were first permitted to hold investment assets on Chinese exchanges with the opening of the Qualified Foreign Institutional Investor (QFII) scheme in 2002. The thresholds for qualification were progressively reduced in 2006, 2007 and 2012, and now the People's Bank of China allows QFIIs substantial access to investment assets including the inter-bank bond market.

[5] Use of RMB offshore has been permitted for a widening range of activities since 2009, but the offshore bond market is separated from the onshore market due the central bank's intervention in the foreign exchange market (She, He and Cheng, 2014). Nevertheless, the offshore market has also been progressively deregulated for investors, which has increased the attraction of issuance in the market. In 2011 a parallel QFII scheme in RMB was established, known as RQFII. Quotas were raised for RQFIIs from RMB 20 billion to RMB 50 billion in April 2012, and to RMB 200 billion in December 2012, and March and May 2013 saw further relaxation of the criteria for RQFII access.

ante balance sheet characteristics determining creditworthiness in influencing firms to innovate in the RMB market. Furthermore, important drivers of this decision are found to be the depth and liquidity of the market, lower costs of issuance versus onshore or foreign currency alternatives, favourable swap rates and exchange rate appreciation.

Unlike Mizen and Tsoukas (2015), this paper models the diffusion of the offshore RMB bonds as a financial innovation by firms in the bond markets. The decision on adopting the offshore RMB bond by one firm and the timing of adoption are likely to have an impact on other firms' adoption decisions. However, these inter-relationships and dynamics of how the adoption of the offshore RMB bonds by firms diffuses through the market are not well understood in the literature.[6] The aim of this paper is to fill this gap by modelling the number of issuers and amount of issuance in the offshore RMB bond market. More specifically, our study aims to assess how fast the RMB bond is adopted by firms as a financial product in the offshore bond markets. This "speed" of adoption (or "the speed of diffusion") can be the proportion of new adopters (i.e., the increases in issuers or issuance of RMB in this study) out of all adopters in a period, or more rigorously, measured by the coefficient of the proportion of all adopters in the bond market in a regression of the proportion of new adopters in the period given conditions of market development.

There are three main findings. First, we document that the RMB bonds issued in Hong Kong, Singapore and Taiwan are diffused very quickly as a financial innovation. Compared with the high-yield bond markets in the UK and the euro area during the 1990s and the junk bond market in the US during the 1970s and 1980s, the diffusion speed of the offshore RMB bond market during the past decade is found to be faster. Second, the diffusion process can be significantly explained by major variables of market development including (i) market depth indicated by the amounts of offshore bonds outstanding (LN_OFF), the volume of offshore bonds issued (ISSUE_OFF), and the turnover in the secondary market for offshore bonds (TNVR), and (ii) financial advantages indicated by interest differentials (OFF_ON_ID), cross currency swap rate for RMB-USD (SWP-USD), and the expected appreciation of the RMB versus the dollar (MAX_APP). This implies that deepening the market and added financial advantages of bond issuance could allow rapid diffusion in the offshore RMB bond market. Finally, comparing Hong Kong, Singapore and Taiwan, the diffusion speed for Hong Kong is the lowest during the sample period, which is consistent with literature on financial

[6] The diffusion process is not new in the literature. The applications of diffusion models are also common to banks' relative innovations (e.g., Jagtiani et al., 1995; and Frame and White, 2014) and to corporate securities innovations (e.g., Finnerty and Emery, 2002). More recently, Acharya and Xu (2017) take a more general diffusion approach to study financial dependence and innovation for the case of public and private firms.

innovation and diffusion processes that the diffusion of a financial innovation in a mature market tends to be lower.

Our paper adds to the literature in three main ways. First, our analysis contributes to the understanding of firms' decisions to participate in bond markets, following the emerging and developed market literature (see Datta et al., 2000; Munro and Wooldridge, 2010; Mizen and Tsoukas, 2012, 2014, 2015; and Mizen et al., 2012). We add to this literature by documenting the factors at the macro level that affect a firm's decision to innovate by issuing an offshore RMB bond. Second, our paper relates to the literature on financial innovation (see Molyneux and Shamroukh, 1996, 1999; de Bondt and Marques-Ibanez, 2005), which explores the adoption of high-yield bonds in the US, UK, and the euro area. Our paper examines the diffusion processes in the RMB market considering variables of market development. A third related contribution arises from the literature on the emerging economies' financial development. It is expected there will be further expansion of the onshore RMB bond market and importance attached to the RMB in currency markets (Eichengreen and Lombardi, 2015). By showing that the dim sum market has expanded rapidly due to the growth in market depth and expected appreciation of the RMB versus the dollar we help inform policy makers about how to manage the expansion of the onshore market to promote financial stability and growth.

The rest of the paper is organised as follows. In Sections 2 and 3 we describe our empirical methodology and our data. Section 4 reports the results and Section 5 concludes the paper.

2. Empirical methodology

In this analysis, we use the diffusion model to assess how quickly the RMB bond is adopted as a new financial product in the offshore RMB bond market over time.[7] As financial innovation occurs, firms have to decide whether to 'pitch in' to the new market or 'hold back' to see whether the new financial product is adopted by other firms. In other words, the decision on adopting a new financial product by one firm and the timing of adoption are likely to have an impact on other firms' adoption decision. This strategic aspect of innovation adoption by firms can be distinguished into two categories of adopters in the diffusion model. One is 'external adopters' that pioneer new products and services (David, 1969) with this

[7] Major papers of the technique include Mansfield (1961), Bass (1969), Molyneux and Shamroukh (1996), and de Bondt and Marques-Ibanez (2005). See Meade and Islam (2006) for an overview of forecasting the diffusion of innovations.

initial stimulus regarded as "external influence". The other is 'internal adopters' that are persuaded by the rational case for adoption or face competitive pressures that drive them towards adoption at a later stage (in short, due to "internal influence"). Thus, the basic premise of the diffusion model is that the speed and timing of adoption depends on their degree of innovativeness and the degree of imitation among adopters.

Specifically, we consider three diffusion models in this analysis. The first one is introduced by the Mansfield (1961) which is specified as follows

$$\Delta N(t) = [b \cdot N(t)/M] \cdot [M - N(t)] \quad (1)$$

where *N(t)* as the cumulative number of adopters at time *t*; $\Delta N(t)$ indicates changes on the cumulative numbers of adopters or the number of adopters at any time *t*; and *M* is defined as the market potential or maximum number of total adopters. We can express Equation (1) as follows for easier interpretation:

$$\frac{\Delta N(t)}{M - N(t)} = b\frac{N(t)}{M} \quad (2)$$

Equation (2) hypothesizes that the proportion of new adopters in each period is determined by the proportion of all adopters in a constant way, with the constant *b* estimating the rate at which adoption or product diffusion takes place. Thus, the model postulates that the larger the speed of diffusion, the more the number of adopters, and hence, the more rapid the product takes place.

The second model is the Bass (1969) model which extends the Mansfield (1961) model to the following specification:

$$\Delta N(t) = n(t) = [a + b \cdot N(t)/M] \cdot [M - N(t)] \quad (3)$$

or alternatively,

$$\Delta N(t) = a \cdot [M - N(t)] + b \cdot N(t)/M \cdot [M - N(t)]. \quad (4)$$

The left-hand side of equation (4) represents the increase in the cumulative number of adopters over time, which is equal to the number of first-time adopters in each period. The first term on the right-hand side of equation (4) represents the number of adopters due to external influence, while the second term represents the number of first-time adopters due to internal influence at time *t*. Thus, the intercept coefficient *a* captures the initial proportion of

adopters (or namely, the "pioneer effect", in this study), while the coefficient b captures the rate of adoption (or namely, the "diffusion speed", in this study) with the pioneer effect being controlled for.

The third model is a modified Bass (1969) model which extends the Bass (1969) model in equation (3) in various ways[8]: (i) making the maximum number of total adopters $M(t)$ dependent on time (Mahajan and Peterson, 1978); (ii) introducing a long-term term market penetration ceiling on total adopters c to allow for non-adoption for a percentage of the market potential; (iii) introducing independent variables $X(t)$ with an estimated coefficient β to capture these variables' influence on the diffusion process. These variables can be macro-economic and financial related (de Bondt and Marques-Ibanez, 2005) or market development conditions (Mizen and Tsoukas, 2015). Specifically, the model can be written as follows:

$$\Delta N(t) = [a + b(N(t)/cM(t))] \cdot [cM(t) - N(t)] \quad \cdot t \cdot [1 - \beta X(t)] \tag{5}$$

where a, b and β are parameters to be estimated, while c is a pre-determined value approximated by an estimate of maximum market share of adopters.

3. Data

Our data of bond issuance includes all currency bonds issued in Hong Kong, Singapore, and Taiwan, covering the sample period from 2008Q4 to 2015Q4 in quarterly frequency. All the bond issuance are downloaded from Bloomberg. During the period, RMB bond issuances in these economies share around 40% out of 21 countries that issues RMB bonds (Table 1), with the majority of issue numbers found in Hong Kong (553 issues and 25.6% of the sample) followed by Mainland China (419 issues and 19.4% of the sample), after which Taiwan, Singapore, France, the United Kingdom and the United States comprise between 5-7% of the sample each, which amounts to 693 issues and 32.2% of the sample in total.

For independent variables in Equation (3), we consider two main kinds of market development variables identified in the literature on bond financing, namely (i) market depth and (ii) financial advantages for the bond issuers and holders. On our chosen variables of

[8] The extension can also include: (i) nonlinearity in the diffusion curve, by raising the first term in equation (3) to the power d (Easingwood et al., 1983) or heterogeneity among the adopters, by raising the second term in equation (3) to the power e (Jeuland, 1981). In practice, it may not be necessary or possible (given a short sample) to introduce these two generalizations and only assume a linear form and a time invariant maximum adoption level in equation (3).

market depth, we use the outstanding amount of total offshore debt securities (LN_OFF) to measure the size of the offshore RMB bond market; the total new issuance in the offshore RMB market (ISSUE_OFF) to measure the growth of the offshore market; and the turnover (TNVR) to measure the secondary market liquidity for these securities.

On the variables of financial advantages to issuers of the offshore RMB bonds, we use the offshore-onshore yield differential (OFF_ON_ID) to measure the differences in the yields that RMB issuers must provide to issue in respective markets; and the cross currency swap rate for RMB-USD (SWP-USD) to measure the advantage from swapping the proceeds of a RMB debt issue back into USD. On the variables of financial advantages to the investor from holding offshore RMB bonds, we use the offshore-USD yield differential measured by the difference between the HSBC offshore RMB bond index and the HSBC Asian USD bond index both from Bloomberg (OFF_USD_ID) to gauge the relative return to investors from holding RMB debt securities offshore and from holding the USD debt securities offshore;[9] and the potential RMB appreciation expectation measured by the 3-month expected maximum appreciation of RMB against the USD (MAX_APP) to see if the currency movement in the near term is a factor influencing investors. The variable of MAX_APP is calculated by following the methodology reported in Hui et al. (2008) which captures characteristics of the exchange rate dynamics over the whole time horizon but not at the end of the time interval concerned only based on market data of RMB spot exchange rates, non-deliverable forward rates and currency option prices. A decline (rise) in MAX_APP means an expectation of appreciation (depreciation) in the RMB against USD.

Figures 4 and 5 depict the time series for the variables of market depth and financial advantages respectively. All the time series of market depth and MAX_APP are sourced from the Hong Kong Monetary Authority, while the remaining time series are sourced from Bloomberg.[10] There are several interesting observations. On the variables of market depth, there are upward trends of RMB outstanding (in logarithms) and the new issuance in the offshore RMB market although the growth of issuance slowed notably after 2014. Turnover data takes relatively low values that are lower than the amount of new issuance, and a declining proportion of the amounts outstanding. On the variables of financial advantages, the

[9] This measure is commonly considered in Graham and Harvey (2001), Habib and Joy (2010) and Munro and Wooldridge (2010) to measure returns from interest differentials. It is different from the variable of SWP_USD which measures returns from the expected change in currency appreciation/depreciation. Considering the two return types together, McBrady and Schill (2007) use a covered interest differential plus the expected exchange rate depreciation.

[10] While the onshore RMB bond yield is available in Bloomberg, its primary source is the China Central Depository & Clearing Co. Ltd.'s China Bond New Composite index.

variables of OFF_ON_ID and OFF_USD_ID are negative most of the time, indicating the lower cost of offshore bond issuance versus onshore issuance and versus USD bond issuance. In comparison, the variable of SWAP_USD rises over time while the MAX_APP declines most of the time, which may reflect a decline in the returns of holding the offshore RMB bonds during the sample period.

Table 2 (Panel A) summarises major statistical characteristics of these data. All data are in quarterly frequency. The correlation matrix in Table 2 (Panel B) shows outstanding amounts, issuance and turnover to be highly correlated with each other, and similarly interest differential are also highly correlated. Practically speaking, this means that we cannot include all of these variables in one regression because of collinearity issues.

4. Empirical findings

In this section we report the empirical results obtained using a Mansfield (1961) model (i.e., Equation (1)), a Bass (1969) model (i.e., Equation (3)) and a modified Bass model (i.e., Equation (5)). In the modified Bass model, the variables of market depth and financial advantages are introduced individually for two reasons: (i) it avoids multicollinearity given that many of these variables are highly correlated, and (ii) the number of observations are small. Using the available number of quarterly observations since 2008Q4 in our models, our results are found to be generally consistent with our expectations and with previous studies of diffusion in financial markets.

4.1 Main results

Table 3 reports estimation results of offshore RMB bond diffusion models based on the amounts of RMB bond issued. The first set of estimated results (M1) is based on the Mansfield model specified in Equation (1), which assumes no pioneer effects (i.e., a = 0). The second set (M2) is based on the Bass model specified in Equation (3), which includes a pioneer effect in addition to the speed of diffusion. The remaining sets (M3-M9) are based on the modified Bass models specified in Equation (5) in which the variables of market depth and financial advantages are added individually and the parameter *c* is set to be 0.0561. Note that, following de Bondt and Marques-Ibanez (2005)'s approach, the parameter *c* is determined by the current maximum market share of RMB bonds among the market for all bonds (which is equal to a value of 0.0337 in our case) plus two standard deviations (which is

equal to a value of 0.0224 in total).[11] To ensure the robustness of our findings, Table 4 reports the results when we use number of bonds issued rather than their RMB amounts. Our main results are largely unchanged which suggests that our main findings are robust to different measures of market diffusion based on the volume as well as their value, but since using the amounts captures the size of the issue we prefer to use results reported in Table 3.

There are several interesting findings that emerge from Table 3. First, the majority of the estimates of the pioneer effect are positive, regardless of controlling for the effects of driving factors (i.e., M3-M9) or not (i.e., M2) in the specification. A diffusion process with a positive pioneer effect (intercept) tends to reach the peak market share faster than a process with a non-positive intercept. The only exception is the process with the control variable of total issuance in the specification (i.e., M3). That said, the magnitude appears to be small compared with other significant estimates and may have resulted from data scarcity of smaller outstanding issuance in estimation.

The diffusion speeds are found to be positively significant under M1-M5, and M9. This implies that the larger the autonomous speed of diffusion, the more rapid the dim sum bond diffusion. The value of the diffusion estimate falls dramatically after we add controls, which implies that the diffusion rate is substantially related to the market depth and financial advantages.

Considering the effects of market depth, we observe that changes in the size of offshore RMB bond outstanding amounts (LN_OFF) and new issuances (ISSUE_OFF), and turnover in the RMB market (TNVR) have a positive impact on the RMB bond diffusion process. In other words, more issuances in the offshore market, and more trading in secondary market would speed up the diffusion process. This is entirely consistent with a market depth theory, supported in Asian emerging bond markets by Allayannis et al.. (2003), Chan et al.. (2011) and Mizen et al. (2012).

Considering the effects of financial advantages, we find that changes in offshore-onshore interest rate differentials (OFF_ON_ID), USD-CNY cross currency swap (USD_SWAP), RMB appreciation expectation (MAX_APP) has a negative impact on the diffusion process, which means that a smaller difference between the offshore and onshore interest rates, lower cost for swapping RMB proceeds into USD funding (i.e. USD_SWAP decreases), and higher RMB appreciation expectation (i.e. MAX_APP decreases) would

[11] When we explore the sensitivity of the diffusion estimate to the setting of the ceiling, we find the diffusion rate declines as we allow the ceiling to increase from 2 standard deviations to 4 standard deviations or 8 standard deviations from the market penetration level, which is consistent with De Bondt and Marques-Ibanez (2005) .

increase the speed of the diffusion process. This result is consistent with the findings of Graham and Harvey (2001), McBrady and Schill (2007) and Munro and Wooldridge (2010) who register advantages of issuing in an offshore market when short-term interest rates differ. Gczy et al. (1997) and Mizen et al. (2012) show that derivatives (i.e. swaps) can be utilised in conjunction with offshore markets.

The maximum expected deprecation seems to have a much larger effect than the interest differentials,[12] and this is consistent with the argument that an appreciation of the RMB represents an additional return to the investor, over and above the yield on the bond. While this was expected to increase the yield it spurred the adoption of RMB bonds, which had a ready market among investors, but when it was expected to decrease the yield it had the opposite effect.

4.2 Discussion about the main results

There are two major conclusions drawn from the main results. First, greater market depth measured by the RMB amounts of offshore bonds outstanding, the volume of offshore bonds issued, and the turnover in the secondary market for offshore bonds are major drivers of diffusion. As volumes have increased with regulatory changes that permitted greater participation in the market by Mainland and multinational issuers on the one hand, and international investors on the other, so the dim sum bond market has expanded. A further major influence on the decision to issue in the offshore market has been the expected maximum appreciation of the RMB versus the dollar, which has had the effect of increasing the return to investors if appreciation is expected, and decreasing returns if depreciation is expected.

Second, following deregulation, favourable market conditions allowed rapid diffusion of the dim sum bonds, making the bonds the fastest financial innovation in bond markets even including the very rapid growth of the junk bond market during the 1980s in the US. Specifically, we observe similar pioneer and diffusion rates when comparing our estimated results in the dim sum bond market over the sample period with those from the same model reported in de Bondt and Marques-Ibanez (2005) for high yield bond innovations in the US in the 1980s, and in the UK and euro area in the 1990s. The estimated cumulative distributions are illustrated in Figure 6. Molyneux and Shamroukh (1996) identify the junk bond market as

[12] The larger effect of RMB appreciation expectation is based on comparing the standardised coefficients (or beta coefficients in terms of statistics) estimated in a regression of dependent variable on normalised independent variables. Since significance and sign of these coefficients are consistent with those reported in Tables 3 and 4, these results are not reported in the paper but available upon request.

one of the fastest growing segments of the US bond market in the 1980s. Comparing results from de Bondt and Marques-Ibanez (2005) with our own, the US market initially expanded faster than the dim sum bond market (a stronger pioneer effect), but according to our data the Hong Kong market grew very fast once established, which we also know from earlier results is related to growth in market depth and expected appreciation of the RMB versus the US dollar. The growth of high yield markets in the UK and the euro area was much slower.

Taking these results together with the estimated diffusion rate after adding controls for market depth, interest differentials and expected exchange rate appreciation the results are consistent with our expectations and previous literature on financial innovation and diffusion processes.

4.3. Further results on diffusion rates

(i) Relative diffusion rates for Hong Kong, Singapore and Taiwan

The empirical results in Tables 3 and 4 are based on issuance in Hong Kong, Singapore and Taiwan in estimation. We repeat the estimation for each of the economies individuals (unreported) and then compare their diffusion rates. Figure 7 depicts the estimated diffusion rates based on the Bass models which have significant factors of market depth and financial advantages (i.e. M3-M7, &M9). Two results emerge from Figure 7. First, the diffusion rate for Taiwan is the largest in all specifications. One possible reason is that, unlike the other two economies, Taiwan has yet to be granted any RQFII quota or stock-connect scheme that allows Taiwanese investors to invest in domestic Chinese bonds. That means Taiwanese investors who hold RMB have few investment options and invest mainly in Formosa bonds (e.g., offshore bonds in RMB),[13] which yield more than domestic Taiwanese bonds and offer potential foreign exchange gains. Given this strong demand, the yield of RMB bonds in Taiwan is lower than Hong Kong peers, which attracts more issuers of RMB bonds.

Second, the diffusion rate in Hong Kong, although very fast by international standards, was reduced when controlling for the size of the market and even negative when controlling for interest differentials. This could be explained by the fact that market conditions were major drivers of diffusion, and therefore the reported diffusion after controlling for these effects is small.

(ii) Recursive estimates of diffusion rates

[13] A Formosa bond is a bond issued in Taiwan but denominated in a currency other than the New Taiwan Dollar.

Given that the RMB bond markets were in a transition stage during our sample we explore whether there has been a change in the diffusion rate over time. To do this we use an expanding window approach, using the Bass model, M2, first estimated using the 20 observations starting from 2008Q4 (i.e. our first observation) to estimate the initial diffusion speed. We then expand the window one quarter at a time to compute successive estimate of the diffusion rate. We repeat this process until we have used all observations up to 2015Q4.

Figure 8 depicts the diffusion rate estimated from the outstanding amount of RMB bonds issued in Hong Kong, Singapore, and Taiwan. As can be seen, the rate is the highest at the launch date in 2008Q4 when the diffusion rate is 3.49 (in the window period from 2008Q4 to 2011Q4). It subsequently declines steadily as we add more data over the sample. The tendency to decline can be interpreted as evidence that the diffusion of a financial innovation only has a limited time span. This pattern is also observed by de Bondt and Marques-Ibanez (2005) in the high yield bond market.

5. Conclusions

Financial innovation can create new products that have significant implications for the firms that make use of them. Examples of these products include 'junk' bonds, securitized products, and CDS contracts, where each new product has had a significant impact on the financial arrangements of firms as they have embraced them. In this paper we explore the adoption of offshore corporate debt securities as the market for renminbi (RMB) financial products was liberalized. The opening up of a new 'dim sum' market for offshore RMB debt securities marked a critical step in capital account liberalization in China and provided a new source of RMB finance for firms engaged with the Mainland.

We investigate the rate at which firms adopt this financial innovation in this study. Our results show that market depth measures such as amounts of offshore bonds outstanding, the volume of offshore bonds issued, and the turnover in the secondary market for offshore bonds are major drivers of diffusion. As volumes have increased with regulatory changes that have permitted greater participation in the market by Mainland and multinational issuers on the one hand, and international investors on the other, so the dim sum bond market has expanded. A further major influence on issuance has been financial advantages, particularly, the effects of the expected appreciation of the RMB versus the dollar, where greater expected appreciation leads to greater issuance and the opposite reduces it. These influences are likely to give indications to the government about how to manage the expansion of the onshore market to promote financial stability and growth. Dim sum bonds have been adopted very

quickly, and the market has seen the fastest diffusion rate of any bond market, including the US junk bond experience in the 1970s and 1980s.

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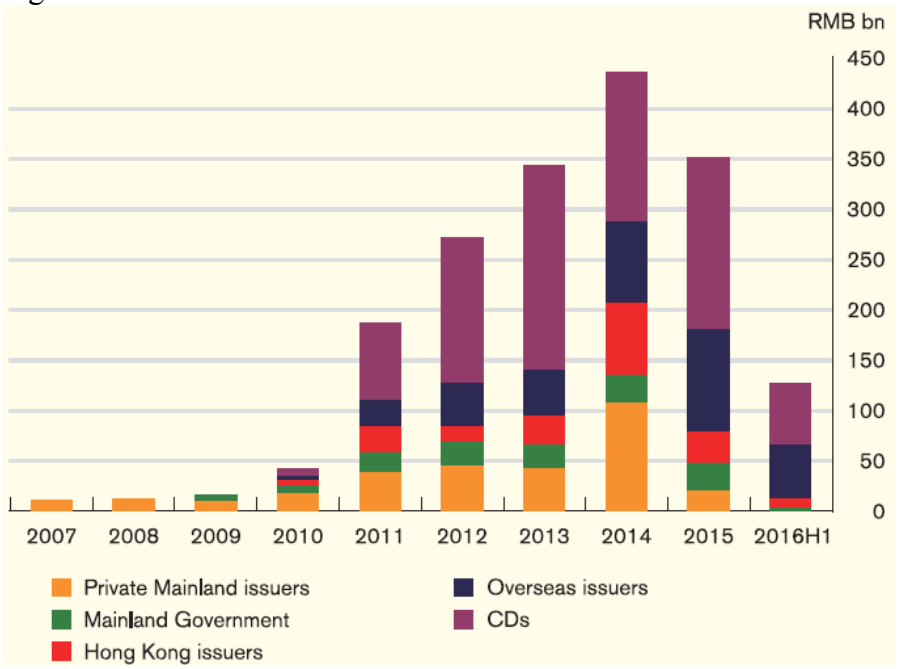
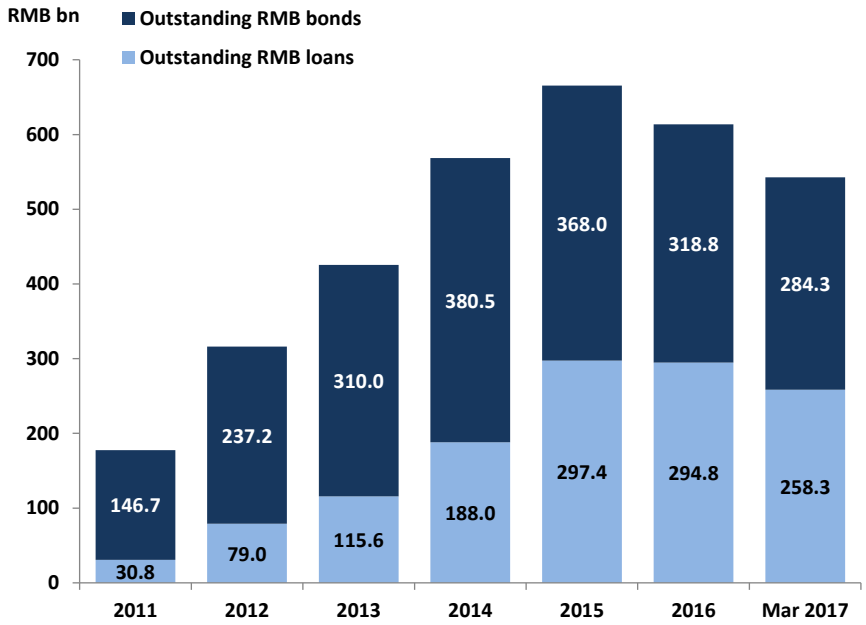
Figure 1: New Issuance of offshore renminbi debt securities



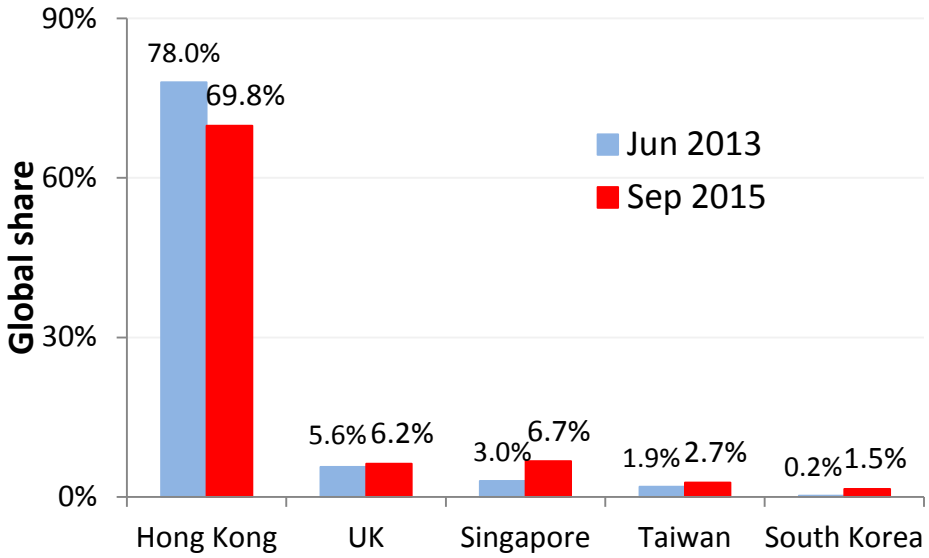
Source: Half-yearly Monetary and Financial Stability Report September 2016, Hong Kong Monetary Authority

Figure 2: RMB financing activities



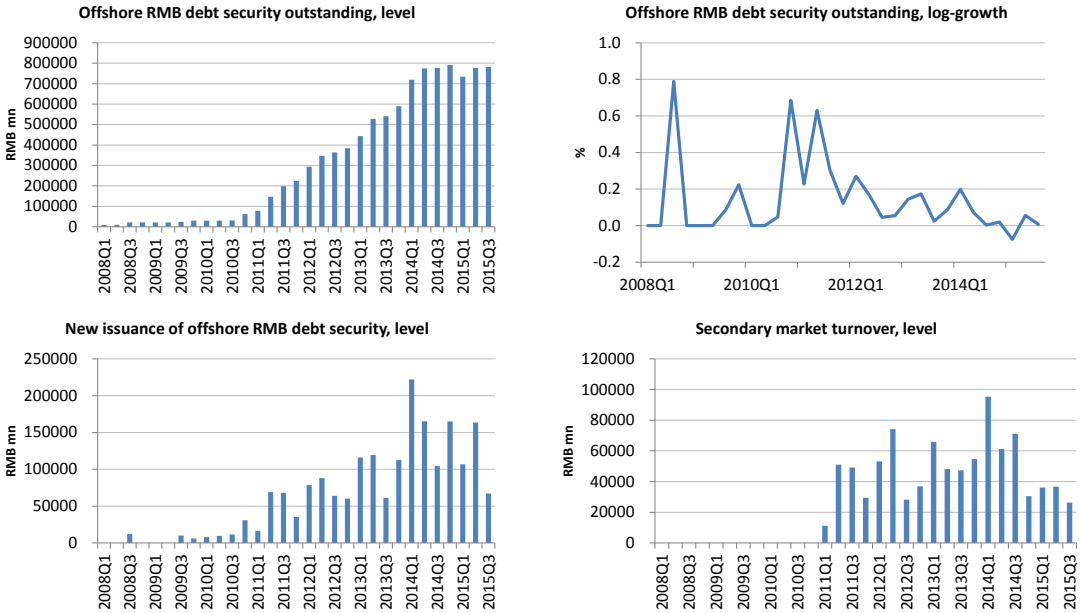
Source: Hong Kong Monetary Authority

Figure 3: Global share of selected offshore renminbi centres in terms of RMB payment



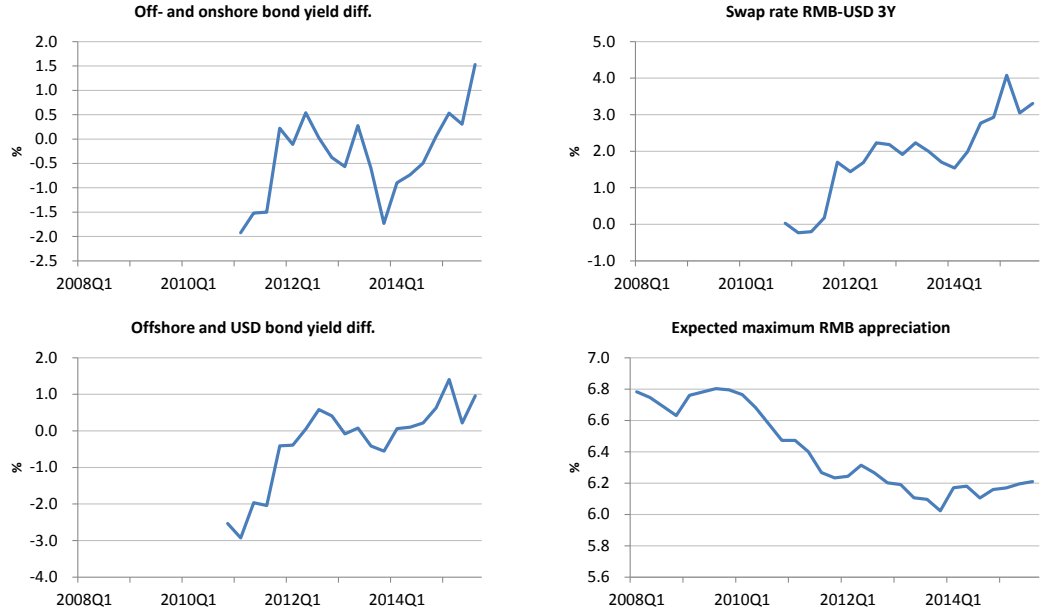
Source: http://www.legco.gov.hk/research-publications/english/essentials-1516ise08-competitiveness-of-hong-kong-in-offshore-renminbi-business.htm

Figure 4: Market Depth



Source: Hong Kong Monetary Authority

Figure 5: Financial advantages to the RMB bond issuers and holders



Sources: Hong Kong Monetary Authority, China Central Depository & Clearing Co. Ltd., and Bloomberg

Figure 6: Cumulative distribution functions for financial innovations in the US, UK, Euro area and Hong Kong.

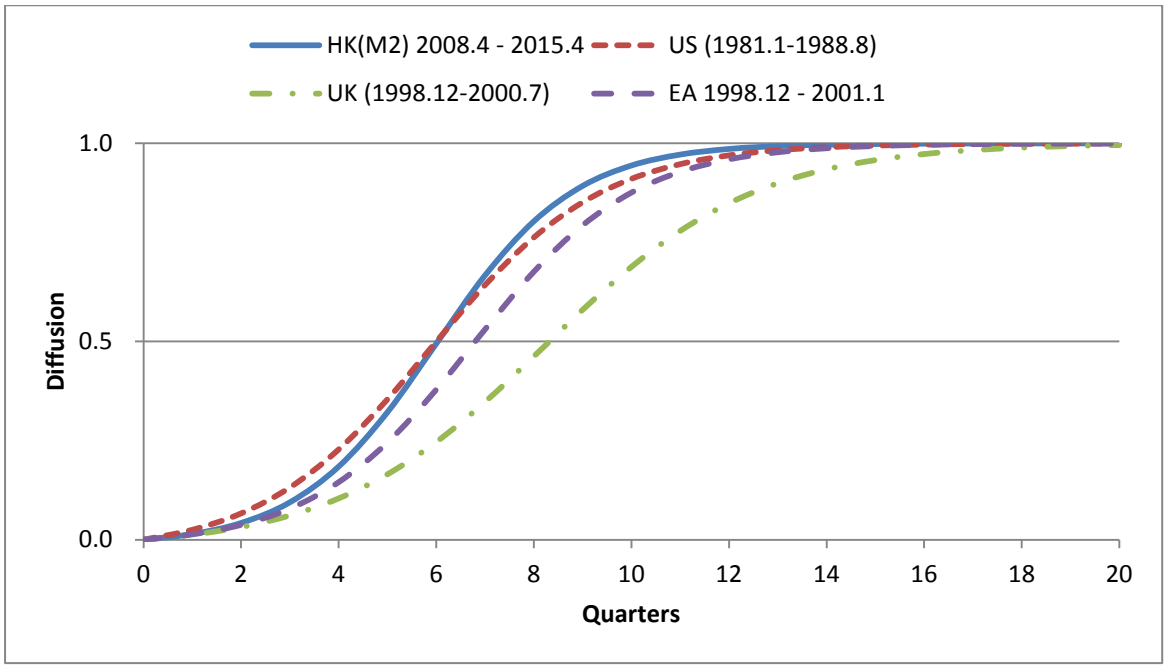


Figure 7: Estimates of diffusion rates across offshore RMB markets

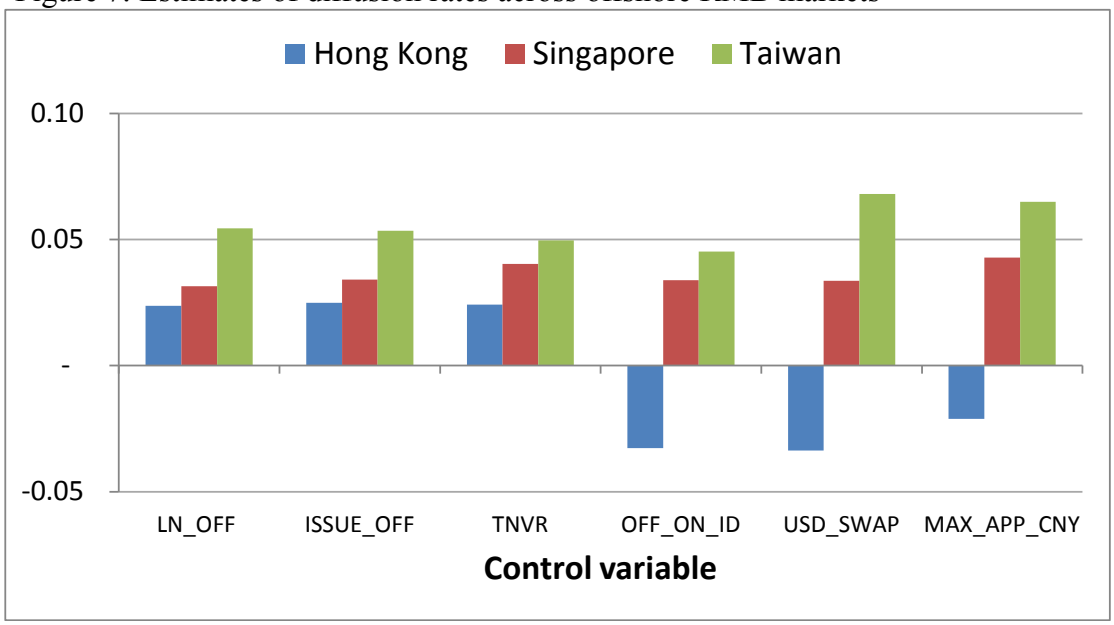


Figure 8: Recursive estimates of diffusion rates (expanding window approach)

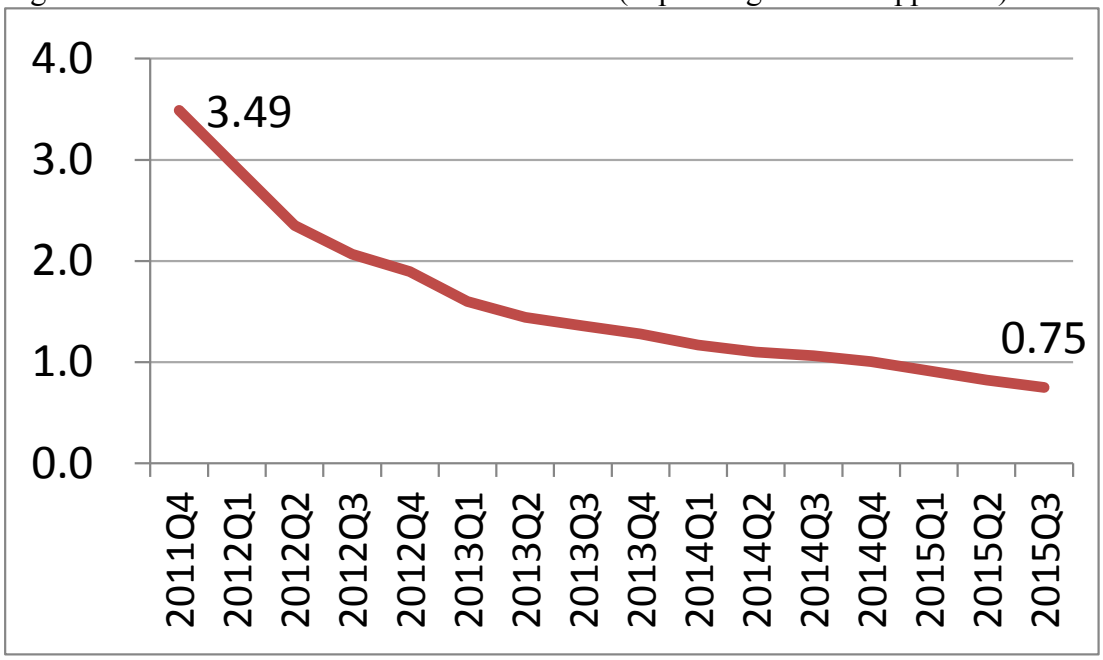


Table 1: RMB Bond issues by country

	Frequency (No)	Percent of sample (%)
AUS	32	1.5
AUT	16	0.7
BRA	71	3.3
CHL	17	0.8
CHN	419	19.4
DEU	76	3.5
FRA	124	5.7
GBR	148	6.9
HKG	553	25.6
IND	28	1.3
JPN	54	2.5
KOR	44	2.0
MEX	18	0.8
NLD	34	1.6
NZL	17	0.8
PHL	17	0.8
RUS	33	1.5
SGP	109	5.1
SWE	36	1.7
TWN	159	7.4
USA	153	7.1
Total	2158	100.0

Note: The table reports the distribution of RMB bond issues by country.
Source: Hong Kong Monetary Authority

Table 2: Summary Statistics

Panel A: Market Development Variables

	LN_OFF	ISSUE_OFF	TNVR	OFF_ON_ID	SWP_USD	OFF_USD_ID	MAX_APP
Count	69349	60158	51625	51625	54070	54070	69349
Mean	12.3215	89.63488	47764.83	-.3288344	1.926504	-.2351458	6.32649
SD	1.307378	55.80419	19602.36	.8647058	1.116805	1.085055	.2347019
Min	9.998797	6	11121.83	-1.9234	-.23	-2.928	6.023284
Max	13.58172	221.973	95318.2	1.5289	4.08	1.405	6.802954

Panel B: Correlation Matrix of Market Development Variables (in first difference)

	LN_OFF	ISSUE_OFF	TNVR	OFF_ON_ID	SWP_USD	OFF_USD_ID	MAX_APP
LN_OFF	1.000000						
ISSUE_OFF	0.869443	1.000000					
TNVR	0.896101	0.934911	1.000000				
OFF_ON_ID	0.229341	0.023366	0.007233	1.000000			
SWP_USD	0.244444	-0.006402	-0.009967	0.811641	1.000000		
OFF_USD_ID	0.546114	0.295922	0.246454	0.782332	0.840870	1.000000	
MAX_APP	-0.563765	-0.489008	-0.586427	0.300800	0.124488	0.141555	1.000000

Notes: The table reports summary statistics. LN_OFF is the logarithm of the amount of total offshore debt securities outstanding in RMB million. ISSUE_OFF is the quarterly volume of total new issuance in the offshore RMB market in RMB. TNVR denotes the turnover in the secondary market for RMB securities using data from the Hong Kong Monetary Authority monthly statistical bulletin. OFF_ON_ID measures the differences in the yields that issuers must provide to issue in respective markets using the HSBC offshore RMB bond index from Bloomberg versus the CCDC's China Bond New Composite Index reported on the official website. SWP-USD is the cross-currency swap rate for RMB-USD. OFF_USD_ID is calculated by taking the HSBC offshore RMB bond index and subtracting the HSBC Asian USD bond index. MAX_APP is the 3-month expected maximum appreciation as a percentage return.

Table 3: Diffusion Model Using Amount Issued (RMB)

Equation number	Eq.(1)	Eq.(3)	Eq.(5)						
Model number	M1	M2	M3	M4	M5	M6	M7	M8	M9
Pioneer effect (a)		0.01	-0.002***	0.00	0.01	0.018***	0.022***	0.022***	0.005**
		(0.277)	(-4.689)	(0.711)	(1.095)	(3.622)	(4.066)	(3.629)	(1.962)
Diffusion speed (b)	0.713***	0.699***	0.021***	0.021***	0.017*	-0.01	-0.02	-0.02	0.017***
	(20.084)	(11.012)	(10.998)	(4.87)	(1.745)	(-0.712)	(-1.403)	(-1.409)	(3.138)
LN_OFF			1.727***						
			(4.312)						
ISSUE_OFF				0.455***					
				(3.004)					
TNVR					0.381***				
					(2.83)				
OFF_ON_ID						-0.144***			
						(-3.13)			
USD_SWAP							-0.141***		
							(-2.425)		
OFF_USD_ID								-0.09	
								(-1.375)	
MAX_APP									-11.067***
									(-2.43)
No.Obs	35	35	35	35	35	35	35	35	35
Adj Rsq	0.81	0.80	0.87	0.64	0.06	0.20	0.12	0.00	0.71

Note: Diffusion model results are reported. The dependent variable is the market share of RMB bond amount issued. Robust standard errors are presented in parentheses. The standard errors are clustered by firm. * p<0.1, ** p<0.05, *** p<0.01. LN_OFF is the logarithm of the amount of total offshore debt securities outstanding in RMB million. ISSUE_OFF is the quarterly volume of total new issuance in the offshore RMB market in RMB. TNVR denotes the turnover in the secondary market for RMB securities using data from the Hong Kong Monetary Authority monthly statistical bulletin. OFF_ON_ID measures the differences in the yields that issuers must provide to issue in respective markets using the HSBC offshore RMB bond index from Bloomberg versus the CCDC's China Bond New Composite Index reported on the official website. SWP-USD is the cross-currency swap rate for RMB-USD. OFF_USD_ID is calculated by taking the HSBC offshore RMB bond index and subtracting the HSBC Asian USD bond index. MAX_APP is the 3-month expected maximum appreciation as a percentage return.

Table 4: Diffusion Model Using Number of Bonds Issued (RMB)

Equation number	Eq.(1)	Eq.(3)	Eq.(5)						
Model number	M1	M2	M3	M4	M5	M6	M7	M8	M9
Pioneer effect (a)		0.01	0.00	0.01	0.031***	0.05***	0.054***	0.051***	0.008**
		(0.383)	(1.419)	(1.322)	(3.191)	(4.554)	(4.226)	(3.614)	(2.148)
Diffusion speed (b)	0.561***	0.529***	0.009***	0.00	-0.038**	-	-	-	0.00
	(12.178)	(5.471)	(4.199)	(0.355)	(-2.149)	(-3.64)	(-3.584)	(-2.976)	(0.553)
LN_OFF			1.144***						
			(5.826)						
ISSUE_OFF				0.384**					
				(2.148)					
TNVR					0.235***				
					(2.812)				
OFF_ON_ID						0.04			
						(0.618)			
USD_SWAP							0.12		
							(1.103)		
OFF_USD_ID								0.11	
								(1.16)	
MAX_APP									-22.229***
									(-3.236)
No.Obs	35	35	35	35	35	35	35	35	35
Adj Rsq	0.81	0.80	0.87	0.64	0.06	0.20	0.12	0.00	0.71

Note: Diffusion model results are reported. The dependent variable is the market share using RMB bond issuers' number. Robust standard errors are presented in parentheses. The standard errors are clustered by firm. * p<0.1, ** p<0.05, *** p<0.01. LN_OFF is the logarithm of the amount of total offshore debt securities outstanding in RMB million. ISSUE_OFF is the quarterly volume of total new issuance in the offshore RMB market in RMB. TNVR denotes the turnover in the secondary market for RMB securities using data from the Hong Kong Monetary Authority monthly statistical bulletin. OFF_ON_ID measures the differences in the yields that issuers must provide to issue in respective markets using the HSBC offshore RMB bond index from Bloomberg versus the CCDC's China Bond New Composite Index reported on the official website. SWP-USD is the cross-currency swap rate for RMB-USD. OFF_USD_ID is calculated by taking the HSBC offshore RMB bond index and subtracting the HSBC Asian USD bond index. MAX_APP is the 3-month expected maximum appreciation as a percentage return.