EUROPEAN CENTRAL BANK

EUROSYSTEM

WORKING PAPER SERIES

NO 947 / OCTOBER 2008

FOREIGN-CURRENCY BONDS

CURRENCY CHOICE AND THE ROLE OF UNCOVERED AND COVERED INTEREST PARITY

by Maurizio Michael Habib
and Mark Joy

EUROPEAN CENTRAL BANK

EUROSYSTEM

WORKING PAPER SERIES

NO 947 / OCTOBER 2008

FOREIGN-CURRENCY BONDS

CURRENCY CHOICE AND THE ROLE OF UNCOVERED AND COVERED INTEREST PARITY[1]

by Maurizio Michael Habib[2]
and Mark Joy[3]

In 2008 all ECB publications feature a motif taken from the €10 banknote.

This paper can be downloaded without charge from http://www.ecb.europa.eu or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=1275832.

1 The authors would like to thank Christophe Beuve, Carsten Detken, Simone Manganelli, Adalbert Winkler, and an anonymous referee for useful comments on the paper. The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank.

2 European Central Bank, Directorate General International and European Relations, Kaiserstrasse 29, D-60311, Frankfurt am Main, Germany; e-mail: maurizio.habib@ecb.europa.eu

3 University of Glasgow, Department of Economics, Adam Smith Building, Glasgow, United Kingdom; e-mail: m.joy.1@research.gla.ac.uk

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Website
http://www.ecb.europa.eu

Fax
+49 69 1344 6000

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract 4

Non-technical summary 5

1 Introduction 7

2 Review of the literature 10

3 The model 14
- 3.1 Uncovered cost savings 15
- 3.2 Covered cost savings 16
- 3.3 Random utility maximisation 18
  - 3.3.1 A count model of currency choice 19

4 Empirical methodology 22
- 4.1 Count model empirical methodology 22
- 4.2 Currency share empirical methodology 24

5 The data 25

6 Results 27
- 6.1 Count-model results 29
- 6.2 Currency-share-model results 31
  - 6.2.1 Financial versus non-financial issuers 33

7 Conclusions 36

Appendices 39
- A.1 Data sources and definitions 39
- A.2 Multiple-currency model 39

References 42

European Central Bank Working Paper Series 46

Abstract

Using count-data techniques, this paper studies the determinants of currency choice in the issuance of foreign-currency-denominated bonds. In particular, we investigate whether bond issuers choose their issuance currency in order to exploit the borrowing-cost savings associated with deviations from uncovered and covered interest parity. Our sample includes issuers from both the public sector and private sector. Our findings show that the choice of issuance currency is sensitive to deviations from uncovered interest parity but insensitive, in general, to deviations from covered interest parity. Furthermore, the influence of deviations from uncovered interest parity is stronger for financial issuers than for nonfinancial issuers.

Keywords: foreign exchange; currency choice; international debt securities; bonds; interest-rate parity.

JEL Classifications: F31, F36, G14, G15, G32.

Non-technical summary

This paper investigates the aggregate behaviour of issuers of foreign-currency-denominated bonds—that is, bonds issued in a currency other than the currency of the country in which the borrower resides—and addresses the question of why issuers choose to issue bonds denominated in certain currencies and not others. Evidence is offered showing that issuers of foreign-currency-denominated bonds are sensitive to international differences in nominal interest rates and choose their currency of issuance at least partly in response to these differences. Issuers seem to prefer, all else being equal, to borrow in currencies that are associated with low nominal interest rates. Furthermore, financial entities, such as investment banks, are more likely than the average issuer to choose their currency of issuance in response to low nominal interest rates (perhaps because financial issuers are better informed about the market opportunities for lowering borrowing costs and better able to exploit these opportunities). However, while issuers prefer to issue bonds in a currency that is associated with relatively low interest rates, empirical tests show that this aggregate behaviour is not allied with expectations for an appreciation of the issuance currency. Implicit in this finding is the failure of a key pillar of international financial theory: uncovered interest parity. This paper assesses the relevance of deviations from not just uncovered interest parity, but also covered interest parity, for currency choice in the issuance of foreign-currency-denominated bonds.

Issuance of foreign-currency-denominated debt securities has been an important feature in global financial markets for many years, with net issuance more than tripling in value during the past decade (measured at constant exchange rates), reaching USD 1.4 trillion in 2007. The choice of issuance currency is affected by a number of factors. One major factor is the issuer's desire to ensure its financial obligations are in currencies that match the currencies of its cash inflows. By doing so, the issuer creates a "natural hedge" against its currency risk.

Another factor is strategy. The issuer's strategic considerations may include the desire to diversify its investor base and, for large-size bond issues, the opportunity to exploit fewer credit constraints in more liquid, foreign bond markets.

A third factor affecting the choice of issuance currency (and a factor that is not well explored in the academic literature) is the scope for reductions in borrowing costs through issuing bonds in whichever currencies offer the lowest effective cost of capital. Lower effective borrowing costs can mean lower covered costs (incorporating the cost of covering against exchange-rate risk) or lower nominal costs, reflecting, simply, lower nominal interest rates. Anecdotally, both covered and uncovered costs play important roles in the choice of issuance currency.

In this paper we focus on the latter factor, presenting an empirical assessment of the extent to which uncovered borrowing-cost savings (defined as deviations from uncovered interest parity) and covered borrowing-cost savings (defined as deviations from covered interest parity) generate significant responses in the issuance of foreign-currency-denominated bonds.

Empirical testing shows that deviations from uncovered interest parity do matter, while deviations from covered interest parity do not. That is, issuers do not seem to choose their issuance currencies in order to secure covered borrowing-cost savings. Issuers do, however, seem to respond in a statistically significant manner to uncovered borrowing-cost savings, choosing to issue bonds in those currencies that offer the greatest savings. For five-year and ten-year-maturity bonds, a 50-basis-point increase in uncovered borrowing-cost savings is associated with an increase in the currency share of issuance of around one percentage point. For two-year-maturity bonds, currency share increases by around two percentage points. For financial entities issuing bonds, the increase is even greater.

Uncovered borrowing-costs savings are assessed in terms of their two main component parts: nominal interest-rate differentials and expected exchange-rate depreciation of the issuance currency. Interest-rate differentials are shown to have a statistically significant impact on currency choice across different empirical specifications, consistent with the findings of other studies. The implication is that issuers prefer to borrow in currencies that offer low nominal interest rates. Meanwhile, issuance does not respond in a consistent manner to expected depreciation of the issuance currency, suggesting that issuers do not, at the aggregate level, attempt to lower borrowing costs by issuing bonds in currencies that are expected to fall in value.

The implication of these findings is that nominal interest rates and uncovered borrowing-cost savings play an important role in the determination of currency choice in the issuance of foreign-currency-denominated bonds. Other factors matter too, such as the business cycle and the desire to issue bonds in order for these bonds to act as an offsetting liability against foreign cash flows. But deviations from uncovered interest parity explain a significant proportion of the behaviour of issuers in terms of their choice of issuance currency.

1 Introduction

The bulk of outstanding debt securities at the global level is denominated in the issuer's home currency. However, a small but not marginal share of total outstanding debt is denominated in a currency other than the home currency of the issuer. This debt is defined as *foreign-currency debt*.[1] As of 2007, the share of foreign-currency bonds was equal to 12% of the global outstanding amount of debt securities (ECB 2008). Analysis of the currency composition of these foreign currency bonds is particularly interesting since it allows us to gauge the international role of major currencies.

The popularity of the US dollar among non-US residents as a financing currency in bond markets is one of the main indicators of the US dollar's international status. However, since the advent of Economic and Monetary Union (EMU) in Europe, the emergence of the euro in international financial markets has presented a new competitor to the US dollar. In value terms, the share of the US dollar in total foreign-currency debt securities declined from more than 50% at the beginning of the 1990s to 43% in 2007. Over the same period, the share of the Japanese yen also declined whereas the share of the euro—the sum of the shares of the EMU legacy currencies before 1999—increased from less than 20% to more than 30%. Structural factors may explain these long-term trends. Surely, the launch of the euro, with a deep and liquid market for sovereign debt, has been a catalyst for further transformations in the international bond market.

Beyond some tentative explanations, not much is known about the factors that may lead to an increase in the attractiveness of one currency over another one for the denomination of foreign-currency debt. This paper attempts to shed some light on this topic, by looking at the role played by changes in borrowing costs, both covered and uncovered, in affecting the choice of issuance currency. More specifically, this paper uses count-data methods to examine the extent to which deviations from uncovered interest parity and swap-covered interest parity affect currency choice in the issuance of foreign-currency bonds, where bonds are defined as securities with a maturity of more than one year.

This paper makes three main contributions to the existing literature. First, this paper employs a unique dataset that draws on the entire population of international bond issues during the sample period. The second contribution is an analysis of the issuance of foreign-currency bonds by *number* of issues rather than, as is customary in the literature, by *value* of issues (that is, this paper draws on count-data techniques). Third, this paper embeds its model of bond issuance within a framework of random utility maximisation.

The first contribution of this paper is its dataset, which incorporates, as far as the authors are aware, the largest sample of bond issues to ever have been used in a study of this kind, with the value, at issuance, of the final sample having an aggregate US dollar equivalent of $29 trillion. This paper is the first to use this dataset. Perhaps the most important unique feature of the dataset,

[1] Foreign-currency bonds, throughout this paper, are defined as those bonds issued in a currency other than the currency of the country in which the borrower resides.

after its scale, is that it is constructed in a manner that allows for an assessment of bond-issuance behaviour by maturity. Bonds of a given maturity are matched with interest rates and swaps of the same maturity. Therefore this study avoids the inaccurate assumption (implicit in studies that pool all maturities together) that bond issuers make consistent errors of judgement in the term structure of their hedging strategies. The frequency of the data is quarterly and the sample includes foreign-currency-denominated bonds issued by all issuer types (eg, corporate, governmental, agency, financial, supranational) from a total of 116 countries over the period 1999 to 2008.[2] The sample covers bonds issued in the five main international currencies of issuance: the US dollar, the euro, the Japanese yen, the Swiss franc and the UK pound.

The second contribution of this paper is the analysis of bond issuance by number of issues rather than by value of issues.[3] This paper is the first to do so. This approach is taken because we are interested in the time-varying aspects of currency choice in bond issuance and there is reason to believe that the number of issues is more responsive to changes in this paper's key variables: deviations from both uncovered interest parity and covered interest parity. This is because the issuer's decision over the value of any bond offering tends to be determined before the actual date of the offering, sometimes up to a year before, and is affected mostly by issuer-specific factors—such as retained earnings, project finance, target-debt ratios and share-price valuation—and market-specific, time-invariant factors—such as a large investor base and liquid financial markets in a given currency.[4] Irrespective of the value of the bond issue, a broker will advise the issuer of the most advantageous time to execute the bond offering. This advice will be based, for issuers of foreign-currency-denominated bonds, on an evaluation of international financial conditions.[5] At an aggregate level, therefore, the main, detectable response to deviations from covered and uncovered interest parity, in any given period, will not, necessarily, be a change in total *value* of bonds issued in a certain currency, it will be a change in total *number* of bonds issued.

In addition, there are two empirical advantages of conducting an analysis of bond issuance by number of bonds issued. First, it eliminates the problem of valuation-effects—that is, it eliminates the problem, inherent in an analysis of the nominal value of bond issuance, of interpreting a rise in the value of bond issuance in a given currency as a rise in issuance when, in fact, it may represent nothing more than a strengthening of the issuance currency. Second, it permits the application of count-data techniques, which offer a number of advantages over other empirical approaches to choice behaviour, most notably a

[2]Money market instruments and debt securities with a maturity of less than one year, are not included in the sample.

[3]For comparison purposes, an analysis of value of issuance is also undertaken, as described in Section 6.

[4]See, for instance, Myers (2001).

[5]Descriptions, presented in this paper, of the mechanics of standard bond-issuance procedures are informed by the relevant literature and by market participants, including brokers, underwriters and representatives of a number of major bond issuers.

freedom from the assumption of independence of irrelevant alternatives.[6] This, alone, makes count-data techniques a particularly powerful tool for tackling the question of currency choice in the issuance of foreign-currency-denominated bonds.

The third main contribution of this paper is the use of an econometric model of bond issuance that sits within a framework of random utility maximisation, making the model entirely consistent with utility theory. In particular, the analysis is interpretable as describing a population of heterogenous decision-makers (here, issuers of bonds choosing between a set of issuance currencies), each of whom chooses, at each point in time, the best available alternative. More formally, issuance behaviour is compatible with a random utility model of observed choices, where the probability of choosing, in any given period, issuance currency i is equal to the probability that an issuer chosen at random from the population has a utility function that makes i the utility-maximising alternative.

Summarising the main results, this paper finds that while deviations from swap-covered interest parity do exist—implying that issuers of foreign-currency-denominated bonds do have the opportunity, in any given period, to achieve cost savings by issuing bonds in whichever currency offers the lowest covered cost of issuance—issuers are not responsive. That is, the availability of covered borrowing-cost savings does not trigger a statistically significant response in terms of number of bonds issued. A significant response is, however, associated with deviations from uncovered interest parity. If, in any given period, the basis-point measure of uncovered borrowing-cost savings for, say the euro, rises by 20 basis points, then the expected number of foreign-currency-denominated bonds issued in euros increases, on average, by almost 10%. The picture is very similar when issuance is examined in terms of number of bonds issued in each of the five main issuance currencies as a share of total number of bonds issued in all currencies. For two-year-maturity bonds, a 50-basis-point increase in uncovered borrowing-cost savings is associated with a rise in currency share of more than 2 percentage points. Furthermore, in terms of number of bonds issued, financial corporations are even more responsive than the average issuer to uncovered borrowing-cost savings.

The rest of this paper is structured as follows. Section 2 surveys the relevant literature. Section 3 presents a model of the choice of issuance currency and then describes how this model can be embedded within a framework of random utility maximisation. Section 4 describes the empirical treatment of the model while Section 5 provides a description of the data on bond issuance and on this paper's constructed measures of covered and uncovered borrowing costs. Sec-

[6]The assumption of independence of irrelevant alternatives implies that the relative probability of each option is independent and so does not change if other options are added or retracted. More simply, if, given a choice between the US dollar and the euro as a currency of issuance, a bond issuer prefers the US dollar, the assumption of independence of irrelevant alternatives implies that this preference for the US dollar will not change by introducing as an additional option, the yen. But in practice it may well change (see McFadden (1980) and Luce & Suppes (1965)).

tion 6 presents the empirical tests and results, while Section 7 offers concluding remarks.

2 Review of the literature

Corporate and sovereign borrowers take advantage of global financial markets by issuing bonds denominated in a variety of currencies that do not necessarily coincide with their own domestic currency. Why do they issue foreign-currency bonds instead of borrowing in their domestic currency? In general, there are three possible answers to this question. First, issuers have revenues in foreign currency and want to match these revenues with foreign-currency cash outflows in order to balance the foreign-exchange exposure. Second, they may be rationed in the domestic currency market and wish to tap broader and more liquid markets in the major international currencies. Third, they may have some opportunistic reasons and attempt to lower the cost of servicing their debt by exploiting tax differences across countries, arbitrage opportunities or, simply, lower interest rates in a foreign currency. Let us review in this section the main findings of the literature with respect to these three potential answers.

The first explanation for the decision to issue foreign currency bonds, the "natural hedge" motive, is the most popular one. A growing number of studies focussing on selected samples of listed non-financial firms confirms that the exposure to foreign-exchange risk is an important determinant of foreign-currency debt. In particular, the probability of issuing foreign-currency debt is positively correlated with proxies of foreign-exchange exposures such as foreign sales as a share of total sales for US firms (Allayanis & Ofek 2001) or worldwide (Elliot et al. 2003); earnings or cash in foreign currency as a percentage of firm value in a set of East Asian companies (Allayannis et al. 2003); exports as a fraction of net sales for Finnish companies (Keloharju & Niskanen 2001); the number of foreign subsidiaries of large Danish firms (Aabo 2006); the fraction of foreign subsidiaries to total subsidiaries among US companies (Kedia & Mozumdar 2003) or for firms in the US, the UK, Japan and the euro area (Siegfried et al. 2007).[7]

Overall, it is uncontested that the presence of foreign operations and foreign-currency earnings leads to higher levels of debt denominated in foreign currency. Nevertheless, it is much less clear how hedging through foreign-currency debt interacts with other hedging instruments, such as currency derivatives. Over short horizons up to one-year, firms may sell foreign currency forward in liquid foreign exchange markets and lock in the current exchange rate. In this case, forward and foreign-currency debt hedge over different time horizons—short and long respectively—and may be regarded as complementary. Beyond one year, forward markets become less liquid, but firms may still issue domestic currency debt and use currency swaps to create synthetic *foreign* currency debt, transforming a stream of cash payments in domestic currency into one in

[7]See also Elliot et al. (2003) or Clark & Judge (2007) for comprehensive reviews of this literature.

foreign currency. In this case, swaps and foreign currency debt are substitutes. Similarly, currency swaps may be used to create synthetic *domestic* currency debt, transforming foreign-currency issuance into a domestic-currency liability. In this case, a higher level of foreign-currency debt is positively associated with the use of currency swaps and the former is not used as a natural hedge.[8]

The empirical evidence suggests that large firms with long-term exposure to foreign markets will be more likely to issue foreign currency debt. However, it remains unclear to what extent long-term currency swaps are used together with domestic currency issuance to create synthetic *foreign* currency debt competing with actual foreign currency debt or, instead, used together with foreign currency debt to create synthetic *domestic* currency debt competing with actual domestic currency debt. Gczy et al. (1997) find that the likelihood of using currency derivatives is positively related with exposure to foreign exchange risk, but also the use of foreign-currency debt. In particular, firms using currency swaps have higher levels of foreign-currency debt.

Allayanis & Ofek (2001) find that large multinationals are indifferent between hedging through foreign debt or currency derivatives, but exporters prefer tailor-made foreign-currency derivatives. Similarly, Elliot et al. (2003) note that US multinationals use both hedging strategies, which may considered as substitutes and not complements. Aabo (2006) also supports the notion that foreign-currency debt and derivatives are alternative hedging strategies. Finally, Clark & Judge (2008) provide evidence suggesting that foreign currency debt (hedging long-term cash-flows) complements foreign currency forwards and options (short-term hedging), but swaps used to create *synthetic* foreign currency debt are used as substitutes for issuing *actual* foreign currency debt.

The second reason why borrowers may decide to target international investors issuing in a foreign currency is due to the fact that domestic currency markets are too thin and shallow, or virtually absent, in particular for long-term maturities. The high liquidity and large investor base associated with debt markets in major international currencies may reduce the transaction costs of issuing securities in those currencies. Here, it is useful to distinguish between corporate borrowers in developed economies and borrowers, often sovereign, in emerging markets. The former may still face a trade-off between domestic and foreign currency issuance, whereas the latter—the emerging markets' borrowers—may have no other choice than issuing bonds denominated in a major international currency.

As regards firms in developed economies, Kedia & Mozumdar (2003) find that the liquidity of the underlying debt markets, proxied by the size of the relative markets as a share of GDP, does not influence the decision of US firms to issue foreign-currency debt.[9] The empirical evidence suggests that large firms, which may be more likely to meet credit constraints in the domestic market and have a greater incentive to broaden the investor base, tend to issue more foreign currency debt (Allayanis & Ofek 2001, Siegfried et al. 2007, Kedia & Mozumdar

[8]See Hull (2006) for a discussion of currency swaps.

[9]Rather surprisingly, to our knowledge, this is the only study explicitly taking into account the issue of liquidity of the underlying debt markets.

2003). Large firms, however, may be more likely to issue foreign-currency debt for other reasons such as lower transaction costs and lower information asymmetry compared with small firms. Indeed, an issuance in international markets may imply higher transactions costs for the issuer due to the need to comply with different legal regimes and complex tax treatments of gains and losses, plus greater costs for the foreign investors in gathering information. In both cases, larger firms may benefit from scale economies.

The inability of borrowers in emerging economies to tap international markets using their domestic currency is known in the literature as "original sin", following the seminal work by Eichengreen & Hausmann (1999). The size of the economy seems to be an important determinant of original sin, but other likely candidates such as institutional quality, fiscal solvency and monetary policy credibility fail to show a robust statistical relationship with this phenomenon (Hausmann & Panizza 2003).[10]

There is also a domestic dimension of original sin, since emerging economies may be forced to issue foreign-currency debt because they are rationed in their domestic market, in particular for the issuance of local-currency bonds with long maturity and fixed coupons. Mehl & Reynaud (2005) study this phenomenon and find that domestic-oriented original sin is severe in countries with high inflation, a high ratio of the debt service to GDP, an inverted yield curve and a narrow investor base.[11]

Finally, borrowers may decide to issue foreign currency debt for opportunistic reasons, in order to exploit savings in the cost of servicing their debt that may arise from time to time. Tax advantages could occasionally prompt the issuance in foreign currency;[12] however, Kedia & Mozumdar (2003) do not find that they are important in the case of US firms. Borrowers may be also attracted by relatively low interest rates abroad. From a theoretical point of view, this aspect should not matter and risk-averse agents should be indifferent among various currencies. If the uncovered interest parity holds, any gain resulting from issuing in the low yielding currency would be wiped out by a future appreciation of the latter. A large body of literature rejects the hypothesis that interest differentials are an unbiased predictor of future exchange rate movements,[13] even though Chinn & Meredith (2005) maintain that the bias disappears over

[10]For instance, Hausmann & Panizza (2003) note that all countries with high inflation are affected by "the original sin", but this problem is also present in many countries with low inflation and low public debt.

[11]It should be noted that the market for foreign-currency bonds is dominated by issuers residing in developed economies and off-shore financial centres, whereas emerging-market issuers account for a small fraction of this market (see ECB (2008)). Therefore, the "original sin" argument is extremely important from the point of view of emerging economies, but less relevant for the purpose of this paper which attempts to explain the currency choice in the foreign currency bond market at a global level.

[12]Usually, the tax advantages are linked to the "location" of debt issuance and not necessarily to the currency in which bonds are issued. For instance, Kim & Stulz (1988) note that US dollar-denominated bonds issued off-shore by US corporations were usually bearer bonds and not subject to withholding taxes. This made them more attractive to foreign investors compared with domestic US dollar bonds.

[13]See Sarno & Taylor (2002), Chaper 2, for a survey.

longer horizons.

On empirical grounds, therefore, the relative level of interest rates, at least as perceived by borrowers, might play a role in the currency choice of debt. Indeed, a survey by Graham & Harvey (2001) confirms that the low level of foreign interest rates is an important factor in the decision to issue foreign debt for 44% of firms in their sample.[14] Johnson (1988) finds that Canadian financial corporations alter the currency patterns of their outstanding debt in response to a perceived differential in borrowing costs. Similarly, Keloharju & Niskanen (2001) show that Finnish firms tend to borrow in foreign currency when the domestic interest rates are higher relative to other currencies, in spite of tax incentives to do the opposite. Asian firms also seem to tap foreign currency markets in order to obtain a cheaper source of funding, measured by a positive interest rate differential between local and foreign interest rates (Allayannis et al. 2003, Esho et al. 2007). On the other hand, Henderson et al. (2006) obtain only weak empirical support for the hypothesis that firms issue debt abroad to profit from lower foreign interest rates—without controlling for the currency denomination of debt.

A different strand of literature, still in its infancy, investigates the opportunistic determinants of currency choice in foreign currency bond issuance from a macroeconomic perspective. Differently from the literature based on panels of individual firms, these studies focus on the time variation of currency shares in aggregate bond issuance, testing the role of interest rate differentials together with some assumptions on the role of exchange rate changes. Correctly, these studies assume that the possible decisive variable prompting an opportunistic issuance is not the interest rate differential, but possible deviations from uncovered or covered interest parity.

Cohen (2005) finds that, for major currencies excluding the British pound, the share in "international" bond issuance tends to increase with relatively higher interest rates, implying higher costs of servicing the debt for the borrowers.[15] However, Cohen (2005) notes that when currencies are strong—as measured by the level of their exchange rate—their currency share in international bond issuance tends to rise. To the extent that exchange rates are mean-reverting, borrowers may take advantage of expected depreciation of the issuance currency. McBrady & Schill (2007) instead, maintain that deviations from the uncovered or the covered interest parity present opportunities to lower borrowing costs by issuing in foreign currency, which are taken up by borrowers.[16] They find that borrowers are able to time their issuance in order to

[14]In the survey, this is the fourth factor in order of importance after the "natural hedge" motive (85% of firms), keeping the "source of funds" close to the "use of funds" (63%) and favourable tax treatment relative to the US (52%).

[15]It is important to remark that, according to the definition used by Cohen (2005), "international" debt securities include not only foreign-currency debt securities, but also home-currency debt securities issued outside the borrower's market or issued in the domestic market but targeted at foreign investors.

[16]In particular, McBrady & Schill (2007) limit their sample to issuances by sovereign government and agency borrowers which have no foreign currency cash flows and no "natural hedge" reason to issue foreign currency bonds.

borrow in low-interest-rate currencies that subsequently depreciate. In addition, using currency swap yields, they measure deviations from covered interest parity over the long-run and conclude that these deviations are large enough to trigger one-way arbitrage opportunities, which are exploited by bond issuers.[17]

In this paper, in particular, we focus on this latter fertile field of research, investigating whether bond issuers, at an aggregate level, choose their issuance currencies in an attempt to exploit arbitrage opportunities in the currency swap markets or on the basis of interest-rate differentials and exchange-rate expectations.

3 The Model

This paper models currency choice in the issuance of foreign-currency bonds within a framework of random utility maximisation. In the model issuers of foreign-currency bonds choose, all else remaining equal, to issue bonds in currencies that offer the lowest cost of borrowing either including, or excluding, the cost of hedging against exchange-rate risk.

Furthermore, it is the central tenet of this paper that when borrowing costs in a given currency are low, the main detectable response, in terms of issuance, is an increase in the *number* of bonds issued in that currency and not necessarily an increase in the *value* of bonds issued in that currency. This draws on the notion that any window of opportunity offering lower borrowing costs in a given currency will result in a greater number of entities issuing bonds in the low-cost currency irrespective of the total value of issuance.[18]

This section offers an outline of the model of currency choice focusing on a description of the main explanatory variables, "uncovered cost savings" and "covered cost savings", in Section 3.1 and Section 3.2. Thereafter follows a brief discussion of how this model of currency choice fits into a framework of utility maximisation when issuance is measured in terms of number of bonds issued rather than value of bonds issued (Section 3.3).

Consider first an issuer that chooses to issue bonds denominated in foreign currency for one reason only: to act as a natural hedge (an offsetting liability) against its foreign-currency cash inflows (inflows generated perhaps by foreign assets such as overseas subsidiaries). If such an issuer has h per cent of its cash-inflow-generating stock of assets denominated in foreign currency and, in each period t, the issuer is faced with the question of what proportion, b, of its

[17] There is large empirical support for covered interest parity over short horizon, but less evidence over longer horizons. The available evidence, however, does not seem to support the claim by McBrady & Schill (2007) that there are outstanding profitable arbitrage opportunities using currency swaps over longer horizons. Popper (1993) notes that deviations from long-term covered interest parity are somewhat larger than those from short-term parity, but differences are small. Similarly, Fletcher & Taylor (1996) remark that deviations from swap covered interest parity diminish over time and disappear over the long-run. In support of McBrady & Schill (2007), they note that "unexploited profit opportunities do exist", since there are "neither rare nor short lived" deviations from parity, net of transaction costs. However, measurement errors could, for instance, account for these outliers.

[18] See, for instance, Fisher et al. (1989) and Graham & Harvey (2001).

borrowing to denominate in foreign currency, then in order to create a suitable natural hedge against its foreign-currency cash inflows, the issuer will choose to issue foreign-currency bonds such that $b_t = h_t + e_t$, where the random error $e_t \sim N(0, \sigma^2)$.[19] The main concern of this paper is to test whether an issuer might choose to alter the currency composition of its foreign borrowing, and deviate from h, in order to reduce its borrowing costs.

By altering the currency composition of its foreign debt an issuer can bring about a reduction in its overall borrowing costs through two main channels. First, an issuer may decide leave its foreign-exchange risk unhedged in an attempt to gain from favourable deviations from uncovered interest parity. In other words, an issuer can reduce its borrowing costs by issuing bonds in foreign currencies that *ex post* do not appreciate enough to offset the savings accrued through borrowing at lower interest rates.[20] This approach offers "uncovered cost savings". Second, an issuer can hedge its foreign-currency risk and look for arbitrage, risk-free, opportunities to lower borrowing costs when deciding the currency choice of issuance. In this case, the issuer can reduce its costs by issuing bonds in low-interest-rate currencies even after accounting for the additional cost of covering for (hedging against) exchange-rate risk. The next two sections discuss and explain these strategies.

3.1 Uncovered cost savings

In the absence of exchange-rate hedging, an issuer of foreign-currency bonds can realise savings on its borrowing costs if (i) it issues in a low-interest-rate currency that does not appreciate enough to offset the savings accrued from the favourable interest-rate differential, or (ii), it issues in a high-interest-rate currency that depreciates so much as to offset the extra cost incurred from the unfavourable interest-rate differential. Such savings are possible only if uncovered interest parity does not hold and, as has been discussed in Section 2, empirical evidence suggests that it does not. That is, most evidence suggests a failure of the standard expression of uncovered interest parity,

$$r_{t,t+k} = r^{\star}_{t,t+k} + (s^{e}_{t,t+k} - s_t) \tag{1}$$

where $r_{t,t+k}$ is the time t home interest rate (compounded continuously) that pertains over time interval $t + k$, where $r^{\star}_{t,t+k}$ is the time t foreign interest rate (again, compounded continuously) defined over the same interval, where s_t is the log of the spot exchange rate (defined in terms of home currency per foreign currency), and where $(s^{e}_{t,t+k} - s_t)$ is the expected rate of foreign-currency appreciation (compounded continuously) during the time interval $t + k$.

In Eqn.(1), the implication is that the domestic interest rate should, in frictionless markets with perfect foresight, equal the foreign interest rate plus

[19] See also McBrady & Schill (2007) and Allayanis & Weston (2001).

[20] Alternatively, it is possible to reduce borrowing costs by issuing in foreign currencies for which interest rates are relatively higher, but that *ex post* depreciate so much as to offset the extra cost associated with higher interest rates.

the expected rate of foreign-currency appreciation. But if the empirical evidence is right and the foreign currency tends, in practice, to depreciate rather than appreciate when foreign interest rates are lower than domestic interest rates, then an issuer, by issuing in a low-interest currency while leaving its currency risk uncovered, can realise expected borrowing-cost savings equal to

$$\varepsilon_t^u \equiv (r_{t,t+k} - r^\star_{t,t+k}) - (s^e_{t,t+k} - s_t) \tag{2}$$

Of course, in Eqn.(2), ε^u is an "expected" cost saving and, as a result, risk aversion will reduce the sensitivity of an issuer to ε^u.

As McBrady & Schill (2007) suggest, the proportion, b, of debt that the issuer may decide to denominate in a foreign currency will be a positive function of ε^u. Combining this with the fraction of borrowing set aside as a natural hedge, h, against the issuer's foreign-currency cash inflows, gives

$$b_t = h_t + \beta^u \varepsilon_t^u + e_t \tag{3}$$

where any expected uncovered savings in borrowing costs will cause the issuer to increase b by an amount equal to $\beta^u \varepsilon^u$. Likewise, b will decrease by this amount when ε^u is negative.

So far, the discussion above assumes that currency choice is a binary variable in a two-country setting: a choice between home and foreign currency. However, for the purposes of this study, it is necessary to develop a multi-country model, accommodating a choice among a number of alternative issuance currencies. Appendix A.2 outlines the multiple-currency extension to Eqn.(2), describing how the foreign interest rate is replaced by the issuance-currency interest rate, and the domestic interest rate replaced by a contemporaneous average of interest rates for all currencies other than the currency of issuance.

3.2 Covered cost savings

In perfectly integrated and liquid financial markets, where it is possible to hedge foreign-exchange risk at a low cost, there is no opportunity for cost savings to be made by borrowing in one currency rather than another. In this case, the cost of borrowing is identical irrespective of the borrower's choice of currency (or equivalently, the issuer's choice of issuance currency). More explicitly, arbitrage will ensure the maintenance of covered interest parity, implying that interest rates across countries will be the same once the cost of hedging foreign-currency exposure is taken into account. Covered interest parity can, in the absence of a risk premium, be expressed as

$$r_{t,t+k} = r^\star_{t,t+k} + (f_{t,t+k} - s_t) \tag{4}$$

where $r_{t,t+k}$ and $r^\star_{t,t+k}$ are defined as before, where $f_{t,t+k}$ is the log of the forward exchange rate for k periods into the future and where s_t is the log of the spot exchange rate (defined in terms of home currency per foreign currency). The quantity $(f_{t+k} - s_t)$ is the forward premium, and represents the price paid in the forward market, over and above the spot exchange rate, to cover the foreign-currency exposure that is incurred by borrowing at foreign interest rate $r^{\star}_{t,t+k}$. If covered interest parity holds, the implication is that covered foreign borrowing is no cheaper, or more expensive, than uncovered home borrowing.

Theory suggests that Eqn.(4) will hold true in frictionless markets and empirical evidence suggests that covered interest parity is indeed the rule rather than the exception. However, most empirical studies of covered interest parity deal with time horizons of less than one year. These horizons are too short to be relevant for the vast majority of international bond issuance, where bond maturities can range from one year to twenty years and beyond. The forward market becomes illiquid for time horizons much greater than a year.

For issuers of foreign-currency bonds, forward cover is provided not by the forward market, but instead by the swaps market. Popper (1993) and Fletcher & Taylor (1996) explain how issuers of foreign-currency bonds cover exchange-rate risk using currency swaps.[21]

Looking again at Eqn.(4), what matters for issuers seeking to cover the exchange-rate risk associated with foreign-currency bond issuance, is not the forward premium, but instead the difference in continuously-compounded currency swap yields, such that

$$r_{t,t+k} = r^{\star}_{t,t+k} + (c^{sw}_{t,t+k} - c^{sw^{\star}}_{t,t+k}) \tag{5}$$

where $c^{sw}_{t,t+k}$ is the domestic currency swap yield of the relevant maturity k, and $c^{sw^{\star}}_{t,t+k}$ is the foreign currency swap yield also of maturity k (with both yields compounded continuously).

A standard currency swap (known also as a cross-currency, interest-rate swap) transforms fixed-rate cash flows in one currency into floating-rate cash flows in US dollars. One important point to note is that a currency swap, unlike a forward contract, is not an agreement to exchange a *fixed* payment in two currencies. It is an agreement to exchange a *stream* of payments in two currencies.

An issuer of a foreign-currency bond pays the rate $r^{\star}_{t,t+k}$ to borrow in the debt securities market and then enters a swap transaction to transform its foreign-currency payment stream into a payment stream denominated in domestic currency. In the swap transaction, the issuer receives the foreign-currency swap rate, $c^{sw^{\star}}_{t,t+k}$, and pays the domestic-currency swap rate, $c^{sw}_{t,t+k}$. In this way, the issuer of the foreign-currency bond creates a "synthetic" domestic-currency bond, incurring a cost equal to $r^{\star}_{t,t+k} + (c^{sw}_{t,t+k} - c^{sw^{\star}}_{t,t+k})$.

Eqn.(5) indicates that the cost of this "synthetic" domestic-currency bond must be equal to the cost, $r_{t,t+k}$, of issuing directly in domestic currency. Covered borrowing-cost savings will exist if the spread between bond yields and

[21] Since these descriptions were first presented, in the 1990s, the swaps market has, to some extent, moved on, and covering for exchange-rate risk is no longer undertaken in precisely the same manner. Cover for an individual issue can now be acquired via a single, bespoke swap rather than a combination of standardised swaps in the manner suggested by Popper (1993). However, present-day methods of covering exchange-rate risk in the swaps market, and the pricing of this cover, are derived precisely from the underlying logic outlined by Popper (1993), and this logic is employed in this paper with no known loss of accuracy.

currency-swap rates is not equal across currencies and is not arbitraged away. The magnitude of any covered borrowing-cost savings, ε^c, will equal

$$\varepsilon_t^c \equiv (r_{t,t+k} - c_{t,t+k}^{sw}) - (r_{t,t+k}^\star - c_{t,t+k}^{sw^\star}) \tag{6}$$

where the implication is that an issuer of bonds can achieve savings on its covered foreign-currency borrowing whenever the spread between foreign-currency bond yields and swap rates, $(r_{t,t+k}^\star - c_{t,t+k}^{sw^\star})$, is less than the spread between domestic bond yields and swaps rates, $(r_{t,t+k} - c_{t,t+k}^{sw})$. Put simply, an issuer can lower its borrowing costs by an amount ε^c if, rather than issue bonds in domestic currency, the issuer chooses instead to issue in foreign currency and swap its foreign-currency bond payments back into domestic currency. Since the complete currency-swap arrangement allows the domestic-currency principal and foreign-currency principal to be exchanged at maturity at the original exchange rate, the issuer accrues its cost saving, ε^c, with no exposure to exchange-rate risk.

Following McBrady & Schill (2007), incorporating ε^c into the issuance decision, it is now possible to hypothesize that an issuer chooses the foreign-currency share, b, of its total borrowing according to

$$b_t = h_t + \beta^c \varepsilon_t^c + e_t \tag{7}$$

whereby, in response to positive ε_t^c, the issuer is expected to increase b_t by an amount equal to $\beta^c \varepsilon_t^c$. The coefficient β^c measures the unit response of foreign-currency borrowing share to the percentage change in covered cost savings. Should, in any period t, ε_t^c take a negative value, b_t will decrease rather than increase.

Appendix A.2 outlines the extension of Eqn.(6) to a multiple-currency specification. It is this multiple-currency format that is used for estimation purposes.

3.3 Random utility maximisation

This section describes how the model, outlined above, can be set in a framework of utility maximisation when the dependent variable, issuance of foreign-currency bonds, is measured in terms of number of bonds issued rather than value of bonds issued—that is, when the model is a count-data model, with the dependent variable having no upper bound but having a lower bound of zero.[22] As discussed in Section 1, there is an *a priori* basis for thinking that a count dependent variable should be more responsive to changes in covered and uncovered borrowing-cost savings and, indeed, estimation results presented later, in Section 6.2, confirm that this is the case.

The question of currency choice in the issuance of foreign-currency bonds, when issuance is measured in terms of number of issues, has yet, in the limited literature that addresses this question, to be phrased within a framework

[22]See Cameron & Trivedi (1998) for a full discussion of count-data models.

of random utility maximisation.[23] The econometric approach that lends itself most readily to a utility-consistent treatment of choice is the polychotomous-dependent-variable approach, where estimation of a multiple-choice discrete variable is undertaken by a generalisation of the logit and probit models. McFadden (1974) provides one of the first lasting contributions to utility-consistent, econometric modelling of choice with polychotomous dependent variables by presenting a conditional logit model based on random utility maximisation. Carlton (1979, 1983), among others, employs the techniques of McFadden (1974) to address the question of industrial location within a utility-consistent framework.

The conditional logit model does, however, have its limitations, the most notable of which is its assumption of independence of irrelevant alternatives, which, in the present context of currency choice among issuance currencies, states that issuers look at all currencies as similar after controlling for the observable characteristics tested in the model. If the assumption of independent errors is violated, it can lead to coefficient estimates that are biased.

Within the conditional logit model, no study has been able to fully accommodate the independence-of-irrelevant-alternatives problem. One solution, however, is to eschew the conditional logit model and employ, instead, a Poisson model—that is, a count-data model. Unlike a conditional logit model, which deals with choice among a number of alternatives, a count-data model allows the data to be treated in terms of number of non-negative integer events per period, per choice category (where choice category, in the present context, is issuance currency).

Only recently have attempts been made to set Poisson models within frameworks of random utility maximisation. Guimaraes et al. (2003) derive a Poisson model directly from random utility maximisation by finding an equivalence relation between the likelihood function of the conditional logit and the Poisson regression. This paper exploits the same equivalence relation in order to cast its count-model-based analysis in a framework of random utility maximisation.

3.3.1 A count model of currency choice

This section gives an explicit description of how a count model of currency choice can be set in a framework of random utility maximisation. The starting point for this description is a statement of the equivalence relation derived by Guimaraes et al. (2003).

First, assume that issuers of bonds maximise profits by minimising their costs of issuance. Consider (without, for the moment, incorporating a time dimension) J issuers of bonds ($j = 1, \ldots, J$), each of which select independently an issuance currency i from a set of N potential currencies ($i = 1, \ldots, N$), then the profit the issuer will accrue, if it selects currency i, will be,

$$\pi_{ij} = \beta' \boldsymbol{x}_i + e_{ij} \tag{8}$$

[23] Claessens (1992) studies the optimal currency composition of external debt using a utility-maximising approach where optimal means risk-minimising, and composition refers to currency composition by value.

where β is a vector of unknown parameters, $\boldsymbol{x}_i$ is a vector of currency-specific variables (including covered and uncovered borrowing-cost savings) and e_{ij} is an identically and independently distributed random term assumed to have an Extreme Value Type I distribution.[24]

Using the approach employed by McFadden (1974), it is possible to show that issuer j's probability of choosing issuance currency i, is equal to,

$$p_i = \frac{\exp(\beta'\boldsymbol{x}_i)}{\sum_{i=1}^{N}\exp(\beta'\boldsymbol{x}_i)} \tag{9}$$

which is the common representation of the conditional logit model. If, now, the number of bonds issued in currency i is denoted by n_i, it is possible to estimate the parameters in Eqn.(9) by maximising the log-likelihood function,

$$\log L_{cl} = \sum_{i=1}^{N} n_i \log p_i \tag{10}$$

Guimaraes et al. (2003) show that this log-likelihood function is equivalent to a Poisson model with n_i as its dependent variable and $\boldsymbol{x}_i$ as its vector of explanatory variables. In other words, a Poisson model will yield the same results if n_i conforms to a Poisson distribution such that,

$$E(n_i) = \lambda_i = \exp(\beta'\boldsymbol{x}_i) \tag{11}$$

where λ_i is the Poisson mean parameter (in this case, the expected number of bond issues).

The count model as outlined thus far still fails to account adequately for the possibility of a violation of the assumption of independence of irrelevant alternatives. The most straightforward answer is to add to the profit function an additional effect, γ_i, specific to each alternative, which captures all the factors that may affect the choice of issuance currency but are unaccounted for by the explanatory variables, such that,

$$\pi_{ij} = \beta'\boldsymbol{x}_i + \gamma_i + e_{ij} \tag{12}$$

and further, if γ_i is a random variable, then the probability of an issuer choosing currency i is,

$$p_{i/\gamma} = \frac{\exp(\beta'\boldsymbol{x}_i + \gamma_i)}{\sum_{i=1}^{N}\exp(\beta'\boldsymbol{x}_i + \gamma_i)} \tag{13}$$

where choice of issuance currency is conditional on γ.

One option for estimation of Eqn.(13) is to exploit the relation between the conditional logit model and the Poisson model and estimate by means of

[24]The Extreme Value Type I distribution, also known as the Weibull distribution, has the property that the cumulative density of the difference between any two random variables with this distribution is given by the logistic function. This property makes it possible to link the random utility function with the logistic function. See Maddala (1983).

a Poisson regression with random effects. More appropriate, however, for the purposes of modelling choice among issuance currencies (where there is no guarantee that the alternative specific effects are uncorrelated with the explanatory variables), is to assume that γ_i is a fixed effect, including a dummy variable for each currency of issuance, i, so that,

$$p_i = \frac{\exp(\beta' \boldsymbol{x}_i + \gamma_i)}{\sum_{i=1}^{N} \exp(\beta' \boldsymbol{x}_i + \gamma_i)} \tag{14}$$

Introducing, now, a longitudinal time dimension to Eqn.(14), sufficient time-series variation allows estimation of all parameters of interest. As such,

$$p_{it} = \frac{\exp(\beta' \boldsymbol{x}_{it} + \gamma_i)}{\sum_{i=1}^{N} \exp(\beta' \boldsymbol{x}_{it} + \gamma_i)} \tag{15}$$

where p_{it} is the probability of an issuer choosing, in time t, to issue debt denominated in currency i.

The formulation in Eqn.(15) is, as it stands, based on the Poisson regression model, which assumes that the mean number of events per period, $\lambda_i = \exp(\beta' \boldsymbol{x}_i)$, is equal to the variance λ_i. However, for most count data and for the sample employed in this study, the mean does not equal the variance. An alternative model that relaxes this assumption of equidispersion and allows instead for overdispersion (variance greater than the mean) is the negative binomial model, which represents a generalisation of the Poisson model. The Poisson model is generalised by introducing an individual, unobserved effect into the conditional mean (Greene 2008). It is then assumed, as per Hall et al. (1984), that the conditional mean λ_{it} follows a gamma distribution with shape parameter ϕ and scale parameter δ, specified such that $\phi = e^{X_{it}\beta}$ with δ common both across issuance currencies and across time. Taking the gamma distribution for λ_{it} and integrating by parts gives,

$$\begin{aligned} p(n_{it}) &= \int_0^{\infty} \frac{1}{n_{it}} e^{-\lambda_{it}} \lambda_{it}^{n_{it}} f(\lambda_{it}) \, \mathrm{d}\lambda_{it} & (16) \\ &= \frac{\Gamma(\phi_{it} + n_{it})}{\Gamma(\phi_{it})\Gamma(n_{it}+1)} \left(\frac{\delta}{(1+\delta)} \right)^{\phi_{it}} (1+\delta)^{-n_{it}} & (17) \end{aligned}$$

which is the negative binomial distribution with parameters (ϕ_{it}, δ), where $\Gamma(.)$ is the gamma function. In order to add issuance-currency-specific effects (that is, fixed effects) to the negative binomial model, the approach of Hall et al. (1984) is adopted, allowing for the construction of the joint probability of bond issuance in a given currency conditional on the full-period total of bond issues, such that,

$$p(n_{i1}, \ldots, n_{iT}) = \frac{\Gamma\left(1 + \sum_{t=1}^{T_i} n_{it}\right) \Gamma\left(\sum_{t=1}^{T_i} \lambda_{it}\right)}{\Gamma\left(\sum_{t=1}^{T_i} n_{it} + \sum_{t=1}^{T_i} \lambda_{it}\right)} \prod_{t=1}^{T_i} \frac{\Gamma(n_{it} + \lambda_{it})}{\Gamma(1 + n_{it})\Gamma(\lambda_{it})} \tag{18}$$

which is the specification used for the empirical analysis presented in the next section.

4 Empirical Methodology

This section presents an overview of the empirical techniques used to estimate the model introduced above. The thesis that currency choice in bond issuance is affected by covered and uncovered cost savings is tested, first, in a model where the dependent variable is a count variable, defined as number of bonds issued in a given currency at time t (Section 4.1). In an extension of this approach, and as a robustness check, estimation is also undertaken with the dependent variable expressed as number of bonds issued in a given currency *as a share* of all bonds issued (Section 4.2).

4.1 Count model empirical methodology

This section presents the empirical counterpart to the discussion in Section 3.3.1 of a count-model approach to choice among issuance currencies. Allowing for unobserved heterogeneity across issuance currencies, fixed-effects panel regressions are estimated in a manner suitable for a dependent variable that behaves as a count variable, in this case the number of bonds issued in currency i. Recall that a count variable is bounded from below by zero and has no effective upper limit. Estimation is by means of a negative binomial model, which accounts for overdispersion in the data (that is, accounts for the fact that the variance of the dependent variable can, and often does, exceed its mean).[25]

Within this fixed-effects framework, the number of bonds issued in currency i is assumed to depend on a vector of explanatory variables such that,

$$B_{it}^{c} = \alpha_i + \beta K_{it} + \gamma R_{it} + e_{it} \tag{19}$$

where B_{it}^{c} is the dependent variable defined as number of bonds issued in currency i in period t, where α_i is a currency-specific fixed effect, where K_{it} is a vector of variables representing the incentive to issue bonds denominated in currency i in order for these bonds to act as a natural hedge (as outlined in Section 3), and where R_{it} is a vector of variables representing both covered and uncovered cost savings.

In accounting for an empirical representation of aggregate tendency to issue bonds in currency i as a natural hedge, the vector K contains variables that reflect issuance-currency-country fundamentals plus variables that capture the scale of foreign-owned, cash-flow-generating assets in the issuance-currency region.[26] Specifically,

$$K_{it} = \beta_1 rgdp_{it} + \beta_2 ma_{it} + \beta_3 dinv_{it} + \beta_4 liq_{it} \tag{20}$$

[25]See Hall et al. (1986) for a discussion of the fixed effects model in a negative binomial setting.

[26]Choice of these variables draws on the findings of other studies that account for the natural hedge, such as Cohen (2005) and Siegfried et al. (2007). Other variables, such as imports and investment in the issuance-currency region, were discarded when found to be statistically insignificant in all cases.

where the frequency of all data is quarterly and where $rgdp$ is real GDP (in constant US dollar millions) in the issuance-currency country (or region) as a share of total GDP across all issuance-currency countries; where ma is the number of cross-border mergers and acquisitions into the issuance-currency country (or region), by acquirers that match, in nationality, the set of issuers in the given currency (again this is measured as a share of total mergers and acquisitions in all issuance-currency countries); where $dinv$ is direct investment in the issuance-currency country (or region) in US dollar millions as a share of total direct investment into all issuance-currency countries; and where liq is a proxy for financial depth, represented by total issuance of bonds and notes in the issuance currency (both domestic and foreign issues), divided by GDP (and, again, measured as a share of total liquidity in all issuance currencies). For further details see Appendix A.1.

The vector of variables, R, in Eqn.(19), contains the two main variables of interest, namely, covered cost savings, ε^c_{it}, and uncovered cost savings, ε^u_{it}. These two variables are measured at the beginning of each quarter and expressed in terms of basis points. If issuers respond, as expected, to covered cost savings in currency i by issuing, in aggregate, more bonds denominated in currency i, then the parameter estimate for ε^c_{it} should be positive. Equally, if issuers respond, as expected, to uncovered cost savings in currency i, then the parameter estimate for ε^u_{it} should be positive also.

Note that a full re-expression of uncovered cost savings, ε^u_{it}, as a multiple-currency variable requires that $(s^e_{t,t+k} - s_t)$, the expected appreciation of the foreign currency, be set in a new framework that gauges this appreciation (where the foreign currency is now redefined as the issuance currency i), not as a bilateral concept, but as a multilateral concept, with appreciation measured against all other currencies. In addition, a choice must be made regarding just how, empirically, to measure exchange-rate expectations.[27]

This paper uses survey data to construct its measure of exchange-rate expectations. Surveyed exchange-rate expectations are obtained from Consensus Forecasts, a British-based surveyor of financial forecasters (including banks, economic consultancies and central banks). Bilateral forecasts for 14 major

[27]Typically, in empirical work, there are four different approaches available for modelling expected changes in the exchange rate. One approach is to assume perfect foresight and measure expected changes in the exchange rate by observing *ex post* changes. That is, assume $(s^e_{t,t+k} - s_t) = s_{t,t+k} - s_t$. The drawback with this approach is that when expectation horizons are lengthy, as is the case in this study, with horizons of up to ten years, then putting aside observations to be used as *ex post* measures of expected changes in the exchange rate causes the sample size to become prohibitively small. Two alternative approaches are to assume static expectations, letting $(s^e_{t,t+k} - s_t) = 0$, and extrapolative expectations, where $(s^e_{t,t+k} - s_t) = s_t - s_{t,t-k}$. The static-expectations approach is based on the idea that exchange rates follow a random walk, while extrapolative expectations assume a backward-looking behaviour. Although the theoretical basis for this seems unsound, in practice the difference in results between from an extrapolative-expectations model and a perfect-foresight model can be quite small (see, for instance, Cavaglia et al. (12) and MacDonald & Torrance (1990)). A fourth approach is to use surveys of exchange-rate expectations, letting $(s^e_{t,t+k} - s_t) = s^{survey}_{t,t+k} - s_t$, in an attempt to take a direct, as much as is possible, measurement of expectations.

currencies, with two-year forecast horizons (the longest available horizons), are used to calculate implicit forecasts of the nominal effective exchange rates for each of the five currencies of issuance in the sample. This multiple-currency formulation of exchange-rate expectations permits a complete, re-expression of uncovered cost savings, ε_t^u, where,

$$\varepsilon_{it}^u \equiv (\bar{r}_{t,t+k} - r_{i(t,t+k)}) - (sn_{i(t,t+8)}^e - sn_{it}) \tag{21}$$

with $(sn_{i(t,t+2)}^e - sn_{it})$ representing the expected appreciation, over $t+8$ quarters, of the nominal effective exchange rate for currency i.

One criticism of Eqn.(21) is that a forecast horizon of eight quarters matches only one of the three maturity brackets (where the brackets are two year, five year and ten year) that define the sample. However, the vast majority of financial forecasters do not calculate forecasts for time horizons greater than eight quarters, suggesting these two-year-ahead forecasts do, in fact, represent long-term forecasts suitable for both a five-year horizon and ten-year horizon. In addition, of those forecasters that do provide forecasts with horizons greater than two years, these forecasts deviate only marginally from two-year-ahead forecasts when compared with the extent of the deviations between two-year-ahead forecasts and forecasts of less than a year.

4.2 Currency share empirical methodology

An alternative to addressing the question of currency choice through a count-data approach is to adopt an approach wherein the dependent variable is transformed so as to represent the number of bonds issued in currency i as a *share* of total number of bonds issued in all currencies. Currency share is an alternative gauge of currency choice and, as such, an empirical analysis of currency share acts as a robustness check on the results from the model presented in Section 4.1.

Building on the count-model approach discussed above, a similar model can be constructed whereby the dependent variable is the number of foreign-currency bonds issued in currency i during period t as a share of the total number of foreign-currency-bonds issued in the same period in all currencies. This is a simple transformation of the count variable employed in Section 4.1. The count variable, B_{it}^c is replaced with a share variable, B_{it}^s, such that,

$$B_{it}^s = \alpha_i + \beta K_{it} + \gamma R_{it} + e_{it} \tag{22}$$

Transforming the dependent variable into a share variable is not without consequence. The dependent variable is, now, bounded between zero and one, and can, in theory, include both zero and one. The most appropriate estimator for an endogenous variable with such characteristics comes from the fractional logit approach developed by Papke & Wooldridge (1996). Proper application of this estimator in a panel requires, however, that the cross-sectional dimension of the panel is large (N greater than 100), but here, this is not the case ($N = 5$). For this reason, an alternative approach is adopted that assumes, as a starting point, that a standard Gaussian model is appropriate, and deals with departures from the Gauss-Markov conditions on an *ad hoc* basis.[28]

As a share variable, however, bond issuance exhibits a number of non-standard characteristics. One of these characteristics is contemporaneous correlation across error terms because, in any given period, currency shares sum almost to one. In addition, disturbances are likely to be heteroscedastic across issuance currencies. Furthermore, it is possible that currency-specific residuals are autocorrelated, with the autocorrelation parameter either constant for all issuance currencies or, perhaps, different for each currency.

More formally, if the disturbances in Eqn.(22) exhibit both heteroscedasticity and contemporaneous correlation, the disturbance covariance matrix will be represented by,

$$E[ee'] = \mathbf{\Omega} = \begin{pmatrix} \sigma_{11}\mathbf{I}_{11} & \sigma_{12}\mathbf{I}_{12} & \cdots & \sigma_{1n}\mathbf{I}_{1n} \\ \sigma_{21}\mathbf{I}_{21} & \sigma_{22}\mathbf{I}_{22} & \cdots & \sigma_{2n}\mathbf{I}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{n1}\mathbf{I}_{n1} & \sigma_{n2}\mathbf{I}_{n2} & \cdots & \sigma_{nn}\mathbf{I}_{nn} \end{pmatrix}$$

where σ_{ii} is the variance of the disturbances for issuance currency i, where σ_{ij} is the covariance of the disturbances between currency i and currency j when the periods are matched, where $i = 1, \ldots, n$, and where $\mathbf{I}$ is a T_i by T_i identity matrix, with T_i the number of periods.

Since our sample contains a limited number of heterogeneous units, the best approach is to use ordinary least squares to calculate unbiased parameter estimates in the absence of autocorrelation, and calculate Prais-Winsten estimates when autocorrelation is present.[29] For all regression specifications examined, Breusch-Pagan tests reject separate null hypotheses of cross-sectional independence of the residuals.

5 The Data

Data on international bond offerings are obtained from the Bondware database maintained by Dealogic, a financial-information provider. This database provides coverage of the world's debt markets with information, along numerous dimensions, on the entire population of bond offerings. The sample period

[28] As an empirical starting point, the Gaussian model does, in fact, seem valid for the dependent variable expressed as a share variable, since there are no zero observations in the two-year-maturity sample bracket, and just 3% of observations take the value zero in the five-year-maturity bracket and the ten-year-maturity bracket. The standard linear Gaussian model requires that the mean of the dependent variable is high enough so as not to be characterised by a preponderance of zero observations.

[29] See Prais & Winsten (1954). An alternative estimation technique would be the application of feasible generalised least squares (FGLS). However, Beck & Katz (1995) have shown that FGLS variance-covariance estimates are unacceptably optimistic when dealing with panels where the number of heterogenous units is less than 20 and where there are 40 time periods per unit or less. The implication is that FGLS is inappropriate for the purposes of the present study.

Table 1: Aggregate Issuance By Currency, 1999-2008*

	Principal Amount, US$bn	(%)	Number of offerings	(%)
US dollar	13,755	47.1	96,533	56.9
Euro	8,646	29.6	36,852	21.7
Yen	3,810	13.0	9,979	5.9
Pound sterling	700	2.4	2,075	1.2
Swiss franc	350	1.2	2,449	1.4
Australian dollar	211	0.7	1,800	1.1
Other	1,759	6.0	19,969	11.8
Total	29,231	100	169,657	100

Notes: Principal amount (value in US$bn equivalent) and number of foreign-currency bonds issued during 1999-2008 ranked according to principal amount. Percentages refer to issuance (by principal amount and by number of bonds issued) in given currency as a per cent of all foreign-currency-denominated bonds issued. Foreign-currency-denominated bonds are defined as those bonds issued in a currency other than the currency of the country in which the borrower resides. Includes only fixed-interest-rate debt securities (ie, straight bonds). Excludes debt securities with maturities of less than one year and more than 15 years. (*) Data for 2008 is for the first half of 2008. Source is Bondware.

extends from 1999 to the second quarter of 2008, with earlier data discarded in order, primarily, to permit an examination of the role of the euro as an issuance currency. Foreign-currency bonds are defined as all non-convertible, fixed-coupon, investment-grade bonds denominated in a currency other than the currency of the nationality of the issuer.[30][31]

The sample is restricted to fixed-coupon bonds, which account for 70% of the total population of issues of foreign-currency bonds within the sample period. The final data-set includes 172,352 bond offerings with an aggregate US-dollar-equivalent principal value of $29 trillion (gross issuance).

Table 1 displays aggregate statistics for the world's major issuance currencies ranked by outstanding amount of foreign-currency bonds issued in each currency throughout the sample period. It can be seen that a small number of issuance currencies, namely the US dollar, the euro, the yen, the UK pound and the Swiss franc, dominate aggregate offerings, with the top five accounting for 93% of total value of announced bond issuances and 87% of the total number of issuances. In the empirical work that follows, the sample is restricted to these five top issuance currencies.

Table 2 shows how the distribution of bond maturities, which range from 1 year to 100 years, is not uniform across the different currencies. For this

[30] Issuer nationality is defined, in a manner consistent with the Bank for International Settlements, as the nationality of the upper-most level of corporate responsibility, which, as a definition, accommodates the possibility that the issuer may be part of a multinational company, eg, a subsidiary, or a branch plant.

[31] In order to ensure that the issuers in the sample are, in fact, able to exercise a reasonable choice among the five currencies in the sample, included are only those issuers that are observed to issue bonds in at least three of the five issuance currencies during the sample period. This sorting procedure is conducted by nationality rather than by individual issuer, so that if one issuer of a given nationality is observed to issue in three or more different currencies, then all issuers of the same nationality are included in the sample.

Table 2: Aggregate Issuance By Maturity, 1999-2008*

	Number of offerings (per cent) in issuance currency		
	2yr maturity	5yr maturity	10yr maturity
US dollar	22.6	40.8	36.6
Euro	55.1	24.6	20.3
Yen	10.8	40.7	48.5
Pound sterling	21.9	43.3	34.8
Swiss franc	12.6	42.4	45.0

Notes: Foreign-currency-denominated bonds of specified maturity issued during 1999-2008 as a share of total foreign-currency-denominated bonds issued in selected currencies. Maturity here refers to maturity "brackets", as described in the text. Foreign-currency-denominated bonds are defined as those bonds issued in a currency other than the currency of the country in which the borrower resides. Sample includes only fixed-interest-rate securities. (*) Data for 2008 is for the first half of 2008. Source is Bondware.

reason, the sample of bonds is partitioned into three maturity brackets (two year, five year and ten year) in order to match bonds with interest rates and swap rates of corresponding maturity along the yield curve. All bonds in the sample are allocated to one of these three maturity brackets.[32] Table 3 presents a comparison of aggregate annual offerings of foreign-currency bonds both by value and by number. One interesting observation is that during 2007 and 2008 the share of foreign-currency-denominated bonds issued in euros dropped sharply in terms of number of bonds issued, but not in terms of value. Over the same period, interest rates were falling elsewhere in the world (most notably in the US) but not in the euro area.

6 Results

This section presents results from empirical tests of the hypothesis that issuers of foreign-currency-denominated bonds choose, all else being equal, to issue in currencies that offer the lowest available uncovered and covered borrowing costs. Results from count-model panel regressions are presented first, followed by results from an empirical model of currency share.

[32]Securities with maturities of one year or less are excluded because for securities with such short maturities the forward market can provide cover for exchange-rate risk. Bonds with maturities greater than 15 years are omitted in order to reduce the scope for matching errors generated by inexact matching of maturities between bonds, swap yields and interest rates. The two-year-maturity bracket includes all bonds with maturities greater than one year but less than or equal to three years. The five-year-maturity bracket includes all bonds with maturities greater than three years but less than or equal to seven years. The ten-year-maturity bracket includes all bonds with maturities greater than seven years but less than or equal to 15 years.

Table 3: Aggregate Issuance By Year Of Offering, 1999-2008*

Panel A. Total number of foreign-currency-denominated bonds offered										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
US dollar	9,046	7,428	14,479	12,985	15,589	14,299	9,710	7,709	4,502	786
Euro	2,828	2,370	2,113	2,153	3,751	6,405	7,937	6,765	2,258	272
Yen	1,027	1,252	1,287	1,201	1,077	948	1,178	1,069	791	149
Pound sterling	160	201	136	139	171	282	263	305	239	179
Swiss franc	257	303	214	255	228	208	312	251	277	144
Other	673	1,485	2,330	2,883	3,174	3,348	3,637	3,794	2,452	688
Total	13,991	13,039	20,559	19,616	23,990	25,490	23,037	19,893	10,519	2,218
Panel B. Currency share (per cent) of total number of foreign-currency-denominated bonds offered										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
US dollar	64.7	57.0	70.4	66.2	65.0	56.1	42.1	38.8	42.8	35.4
Euro	20.2	18.2	10.3	11.0	15.6	25.1	34.5	34.0	21.5	12.3
Yen	7.3	9.6	6.3	6.1	4.5	3.7	5.1	5.4	7.5	6.7
Pound sterling	1.1	1.5	0.7	0.7	0.7	1.1	1.1	1.5	2.3	8.1
Swiss franc	1.8	2.3	1.0	1.3	1.0	0.8	1.4	1.3	2.6	6.5
Other	4.8	11.4	11.3	14.7	13.2	13.1	15.8	19.1	23.3	31.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Panel C. Total principal amount, gross issuance (US$bn)										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
US dollar	1,056.7	919.7	1,842.8	1,794.5	2,060.4	1,955.6	1,601.5	1,738.3	574.6	210.8
Euro	756.2	557.2	662.7	587.3	781.7	909.1	1,956.5	1,778.5	461.8	195.0
Yen	77.4	128.8	433.3	457.7	473.8	632.5	752.0	735.8	102.4	16.7
Pound sterling	38.0	34.3	31.2	39.1	79.2	94.3	113.0	135.6	82.3	52.9
Swiss franc	34.0	34.8	26.7	34.0	34.0	32.6	49.0	41.6	39.5	23.4
Other	87.0	92.7	125.9	164.8	197.4	321.9	392.9	433.7	176.3	52.3
Total	2,049.4	1,767.5	3,122.6	3,077.4	3,626.5	3,946.0	4,864.9	4,863.5	1,436.8	551.0
Panel D. Currency share (per cent) of total principal amount, gross issuance										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
US dollar	51.6	52.0	59.0	58.3	56.8	49.6	32.9	35.7	40.0	38.3
Euro	36.9	31.5	21.2	19.1	21.6	23.0	40.2	36.6	32.1	35.4
Yen	3.8	7.3	13.9	14.9	13.1	16.0	15.5	15.1	7.1	3.0
Pound sterling	1.9	1.9	1.0	1.3	2.2	2.4	2.3	2.8	5.7	9.6
Swiss franc	1.7	2.0	0.9	1.1	0.9	0.8	1.0	0.9	2.7	4.2
Other	4.2	5.2	4.0	5.4	5.4	8.2	8.1	8.9	12.3	9.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: Foreign-currency-denominated bonds issued in selected issuance currencies during 1999-2008. Number of foreign-currency-denominated bonds issued (Panel A) in selected currencies and number issued as a share (in per cent) of all foreign-currency-denominated bonds issued (Panel B). Gross issuance total principal amount (Panel C) in US-dollar equivalents at current exchange rates. Foreign-currency-denominated bonds are defined as those bonds issued in a currency other than the currency of the country in which the borrower resides. Includes only fixed-interest-rate debt securities. Excludes debt securities with maturities of one year or less, and with maturities greater than 15 years. (*) Data for 2008 is for the first half of 2008. Source is Bondware.

6.1 Count-model results

Results from empirical testing of the count model of currency choice among the five currencies of issuance (the US dollar, the euro, the yen, the UK pound and the Swiss franc) are presented in Table 4. Coefficient estimates and standard errors (corrected for the overdispersion in the data) are displayed for the three separate maturity brackets under analysis—two years, five years and ten years. Table 4 reports a number of different specifications of the basic model, in particular testing the impact of covered and uncovered borrowing costs separately (columns 1 and 2) and jointly (column 3). In addition, columns 4 and 5 isolate the separate contributions to uncovered borrowing costs of interest-rate differentials and expected exchange-rate appreciation.

Likelihood-ratio tests indicate that all specifications outperform a pooled estimator (where the negative binomial estimator takes a constant dispersion). Parameter estimates suggest issuers of foreign-currency bonds do not respond to covered cost savings, with ε_{it}^{c} proving to be statistically insignificant across all three maturity brackets. While the availability of covered cost savings appears to play a negligible role in the issuance decision, this is not the case with uncovered cost savings. Issuers appear to be responsive to uncovered cost savings when issuing bonds of all maturities. In all three maturity brackets the estimated coefficient on ε_{it}^{u} carries the expected sign, namely positive, and its magnitude is similar (around 0.3), implying that a 20 basis-point increase in uncovered borrowing-cost savings (the average absolute change in ε_{it}^{u} for bonds of all maturities during the sample period is 25 basis points) is associated with a 7% increase in the expected number of bonds issued in the issuance currency.[33]

Table 4 also presents a decomposition of ε_{it}^{u} into its two component parts, the interest-rate differential $(\overline{r}_{t,t+k} - r_{i(t,t+k)})$ and the expected appreciation of the issuance currency $(sn_{i(t,t+8)}^{e} - sn_{it})$.[34] Examining these two component variables, it becomes clear that what drives the overall significance of ε_{it}^{u} is not the expected appreciation, or depreciation, of the issuance currency, but the nominal interest-rate differential.[35] The interest-rate-differential parameter is significant for bonds of all maturities and is similar, in magnitude, to parameter estimates for ε_{it}^{u}. The implication is, according to these results, that nominal interest rates do matter, whereas exchange-rate expectations are not generally relevant for the choice of currency in international bond issuance. Figure 6.1

[33]Note that percentage change in the expected number of bonds issued for a unit change in each explanatory variable, holding other variables constant, is calculated as 100*[exp(*estimated coefficient*)-1].

[34]Regressions were also estimated with alternative approximations of "expected appreciation" (based, for example, on backward-looking extrapolative expectations), but the results were not materially different.

[35]Expected appreciation is significant as an explanatory variable for only short-maturity bonds (Panel A), where the estimated coefficient is of the expected sign, namely negative (suggesting that issuers prefer to issue bonds in currencies that they expect, broadly, to depreciate over time), and where the magnitude of the estimated coefficient implies that a one-basis-point increase in expected appreciation (the average absolute change in $(sn_{i(t,t+8)}^{e} - sn_{it})$ during the sample period is 1.5 basis points) is associated with a 9% drop in the expected number of bonds issued in the issuance currency.

Table 4: Fixed effects negative binomial estimation

Panel A. Issuance of foreign-currency bonds, two-year maturity					
	(1)	(2)	(3)	(4)	(5)
ε^c	0.063		0.042		
	(0.12)		(0.12)		
ε^u		0.332**	0.404**		
		(0.11)	(0.11)		
$(\overline{r} - r_i)$				0.301**	0.335**
				(0.11)	(0.11)
$(sn_i^e - sn_i)$					-3.036**
					(1.07)
$rgdp$	0.024	0.032**	0.039**	0.031**	0.032**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$liq(t-1)$	0.008	0.006	0.005	0.006	0.004
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$dinv$	-0.001	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ma	0.008	0.013	0.015*	0.013	0.009
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log likelihood	-978.703	-974.267	-972.424	-975.059	-971.041
Likelihood ratio	152.795	159.068	160.095	157.859	164.849
Panel B. Issuance of foreign-currency bonds, five-year maturity					
ε^c	-0.073		0.022		
	(0.01)		(0.11)		
ε^u		0.212**	0.219**		
		(0.08)	(0.08)		
$(\overline{r} - r_i)$				0.219**	0.218**
				(0.08)	(0.08)
$(sn_i^e - sn_i)$					0.519
					(0.75)
$rgdp$	0.030**	0.020*	0.019	0.020*	0.021*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$liq(t-1)$	0.003	0.001	0.001	0.001	0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$dinv$	0.000	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ma	0.018**	0.013**	0.013**	0.013**	0.013**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log likelihood	-1005.457	-1002.062	-1002.041	-1001.823	-1001.585
Likelihood ratio	146.374	146.281	125.814	148.517	141.225
Panel C. Issuance of foreign-currency bonds, ten-year maturity					
ε^c	-0.129		-0.012		
	(0.09)		(0.09)		
ε^u		0.299**	0.296**		
		(0.08)	(0.08)		
$(\overline{r} - r_i)$				0.311**	0.308**
				(0.08)	(0.08)
$(sn_i^e - sn_i)$					1.054
					(0.75)
$rgdp$	0.014	0.004	0.004	0.003	0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$liq(t-1)$	0.004	0.001	0.001	0.001	0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$dinv$	0.000	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ma	0.009*	0.005	0.005	0.004	0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log likelihood	-1001.585	-995.025	-995.017	-994.387	-993.413
Likelihood ratio	129.332	122.63	119.45	124.336	125.762

Notes: Fixed effects, negative binomial, count-data model accommodating overdispersion. Dependent variable is number of foreign-currency bonds issued in currency i at time t. Regressions include fixed effects and year dummies. All explanatory variables are measured at the beginning of the quarter and are expressed as proportions (as explained in the text), measured in percentage points. The sample period is from 1999 to the second quarter of 2008. Standard errors are in parenthases. (**) and (*) denote significance at the 1% and 5% levels respectively. All p-values for the likelihood ratio tests are smaller than 0.001.

illustrates these findings graphically for euro-denominated bonds carrying a five-year maturity: issuance can be seen to correlate strongly with interest-rate differentials, less strongly with uncovered cost savings, and correlate hardly at all with covered cost savings.

Table 4 shows that relative financial depth of the bond market associated with each issuance currency (*liq*), relative share of direct investment into each issuance-currency region (*dinv*) and relative share of cross-border mergers and acquisitions into each issuance-currency region (*ma*) are found in general, for bonds of all maturities, to be statistically insignificant as drivers of currency choice among issuance currencies.[36] According to our evidence, these variables fail to capture the potential incentive among issuers to issue foreign-currency-denominated bonds in order for these bonds to act as a natural hedge against foreign cash inflows. The role of the natural hedge, if present, is captured by fixed effects or, potentially, *rgdp*.

Indeed, Table 4 shows that economic activity within the issuance-currency region (*rgdp*) acts as a significant driver of issuance for all bonds in the sample except for those with the longest maturities. For all bonds other than those that fall into the ten-year-maturity bracket, the estimated coefficients imply that a one percentage point increase in the share of economic activity in the issuance-currency region (the average absolute change in share throughout the sample period is indeed one percentage point) is associated with an increase of roughly 4% in the number of bonds offered in the issuance currency.[37]

6.2 Currency-share-model results

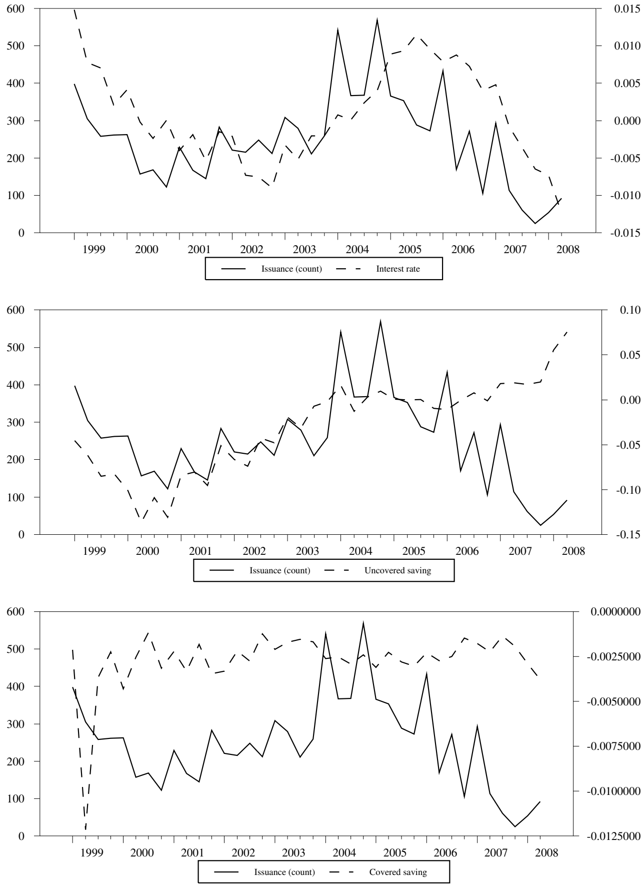
Table 5 reports coefficient estimates, standard errors (in brackets) and goodness-of-fit measures for panel estimation of the currency share of issuance of foreign-currency bonds for the five sample currencies. More precisely, the dependent variable is number of bonds issued in currency i as a *share* of number of bonds issued in all issuance currencies. The results are broadly consistent with those presented in Section 6.1. Uncovered cost savings, ε^u, play an important role in the choice of issuance currency for bonds of all maturities: the total share of the number of bonds issued in currency i tends to increase in tandem with an increase in the magnitude of uncovered borrowing-cost savings associated with currency i. For two-year-maturity bonds, a 50-basis-point increase in uncovered borrowing-cost savings is associated with in an increase in currency share of issuance of more than 2 percentage points.[38] For five-year and ten-year-maturity bonds, a 50-basis-point increase in uncovered borrowing-cost savings

[36]Recall that variables *liq*, *dinv*, *ma* and *rgdp* are expressed as shares relative to total amounts in all issuance-currency regions. These variables are expressed as relative shares in order to facilitate comparability with results presented in subsequent sections, Section 6.1 and Section 6.2.1 Other formulations of these variables (for instance, relative rates of change), yield similar results.

[37]Note that the variables *rgdp*, *liq*, *dinv* and *ma* are expressed in terms of percentage points.

[38]The average absolute quarterly change in currency share of issuance during the sample period (for bonds that fall into the two-year-maturity bracket) is 3 percentage points. Recall also that the average absolute change in ε^u_{it} during the sample period is 25 basis points.

Figure 1: Issuance, interest-rate differentials, uncovered cost savings and covered cost savings for five-year-maturity, euro-denominated issuance



Notes: Top chart shows the number of foreign-currency bonds carrying a maturity of five years (for maturity details see text) issued in euros versus the interest-rate differential (weighted average of other interest rates minus euro interest rates) for the euro, where all interest rates are of a five-year maturity. Centre chart shows the number of foreign-currency bonds carrying a maturity of five years issued in euros versus uncovered borrowing-cost savings, as defined in the text. Bottom chart shows the number of foreign-currency bonds carrying a maturity of five years issued in euros versus covered borrowing-cost savings, as defined in the text. Left scale corresponds to number of bonds issued. Right scale is decimal scale for interest-rate differential, uncovered cost savings and covered cost savings.

is associated with an increase in currency share of around 0.8 percentage points.

Estimates of the two component parts of ε^u, namely the interest-rate differential, $(\overline{r} - r_i)$, and the expected appreciation of the issuance currency, $(sn_i^e - sn_i)$, again, indicate that the nominal interest-rate differential is the biggest factor influencing the statistical significance of uncovered borrowing-cost savings.[39] The expected change in the value of the issuance currency appears to play no role in the choice of issuance currency for bonds across all maturities. Similarly, covered borrowing-cost savings do not appear to exert an economically important influence on currency choice during the sample period.

Relative economic activity, as in the count model, is found to be a significant driver of currency choice for issuance of bonds of all maturities. For bonds with a maturity of roughly two years, a one percentage point rise in real output in the issuance-currency region relative to all other issuance-currency countries is associated with a rise in currency share of issuance of around three percentage points. For bonds with longer maturities, the influence of relative economic activity is less strong, but still significant. The main difference with results from the count model in Section 6.1 is the statistical significance of the coefficient associated with relative financial depth, *liq*. Financial depth exerts a small but significant influence on currency choice among issuance currencies. A one percentage point increase in relative financial depth (total capitalisation of both domestic plus foreign announced issues denominated in issuance currency i) corresponds to a rise in currency share of issuance of around 0.3 percentage points. Neither relative direct investment nor relative share of cross border mergers and acquisitions influence the choice of issuance currency for bonds of all maturities.

Finally, it is important to note that all of these findings are consistent with this study's underlying assumption, outlined in Section 1, that it is more appropriate to measure the *number* of bonds issued rather than the *value* of bonds issued when assessing the responsiveness of issuance to changes in covered and uncovered borrowing-cost savings. When Prais-Winsten panel regressions are estimated with the dependent variable (in Eqn.(22)) defined in terms of currency share of issuance *value*, the explanatory power of the key variables in this study drops significantly. Adjusted R-square statistics for each regression are, on average, 20 percentage points lower than those reported in Panels A, B and C in Table 5. In addition, both ε^u and ε^c are found to be insignificant in general as determinants of choice among issuance currencies. Relative economic activity is the only variable found to be consistently significant across all specifications. Results are not reported here due to the limitations of space but are available from the authors upon request.

6.2.1 Financial versus non-financial issuers

One common message from the count-model estimates in Section 6.1 and the currency-share estimates, in Section 6.2, is that uncovered borrowing costs do

[39] In tests of parameter equality, unreported, we are unable to reject the null hypothesis of equality of coefficients for ε^u and $(\overline{r} - r_i)$.

Table 5: Fixed effects Prais-Winsten estimation

	(1)	(2)	(3)	(4)	(5)
Panel A. Currency share of foreign-currency bonds, two-year maturity					
ε^c	-0.316		3.903		
	(2.19)		(2.53)		
ε^u		4.370**	5.094**		
		(0.6)	(0.75)		
$(\overline{r} - r_i)$				4.354**	4.266**
				(0.61)	(0.58)
$(sn_i^e - sn_i)$					9.375
					(27.93)
$rgdp$	3.204**	3.438**	3.294**	3.448**	3.466**
	(0.33)	(0.30)	(0.32)	(0.3)	(0.31)
$liq(t-1)$	0.428**	0.412**	0.387**	0.416**	0.424**
	(0.11)	(0.11)	(0.10)	(0.11)	(0.11)
$dinv$	0.001	-0.009	-0.011	-0.008	-0.008
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ma	0.654**	0.618**	0.568**	0.620**	0.625**
	(0.19)	(0.18)	(0.17)	(0.18)	(0.18)
Adj. R^2	0.872	0.892	0.894	0.892	0.892
RMSE	9.611	9.157	9.112	9.153	9.175
Panel B. Currency share of foreign-currency bonds, five-year maturity					
ε^c	-1.201		-0.044		
	(1.98)		(2.30)		
ε^u		1.405**	1.397*		
		(0.43)	(0.59)		
$(\overline{r} - r_i)$				1.331**	1.652**
				(0.44)	(0.41)
$(sn_i^e - sn_i)$					-34.068
					(22.08)
$rgdp$	2.216**	2.239**	2.240**	2.238**	2.172**
	(0.26)	(0.24)	(0.25)	(0.24)	(0.24)
$liq(t-1)$	0.257**	0.246**	0.246**	0.247**	0.217**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
$dinv$	0.005	0.001	0.001	0.001	0.000
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ma	0.097	0.072	0.073	0.074	0.055
	(0.11)	(0.11)	(0.10)	(0.11)	(0.11)
Adj. R^2	0.925	0.942	0.943	0.942	0.944
RMSE	6.530	6.473	6.491	6.479	6.421
Panel C. Currency share of foreign-currency bonds, ten-year maturity					
ε^c	0.523		2.082		
	(1.69)		(1.88)		
ε^u		1.496**	1.882**		
		(0.37)	(0.44)		
$(\overline{r} - r_i)$				1.508**	1.391**
				(0.37)	(0.36)
$(sn_i^e - sn_i)$					12.425
					(17.78)
$rgdp$	1.788**	1.899**	1.822**	1.903**	1.927**
	(0.21)	(0.19)	(0.2)	(0.19)	(0.2)
$liq(t-1)$	0.236**	0.234**	0.221**	0.235**	0.246**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
$dinv$	0.012	0.009	0.008	0.009	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ma	0.049	0.044	0.017	0.045	0.051
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Adj. R^2	0.955	0.968	0.968	0.968	0.968
RMSE	5.378	5.287	5.267	5.284	5.287

Notes: Fixed-effects panel estimation with panel-corrected standard errors, corrected for heteroscedasticity and contemporaneous correlation across panels (ie, across issuance currencies). Accommodation for first-order autocorrelation (common to all panels) where present. Dependent variable is number of foreign-currency bonds issued in currency i at time t as a share of all foreign-currency bonds issued (expressed in percentage points). Regressions include fixed effects and panel-specific time trends. All explanatory variables are measured at the beginning of the quarter. The sample period is from 1999 to the second quarter of 2008. Standard errors are in parenthases. (**) and (*) denote significance at the 1% and 5% levels respectively.

Table 6: Financial issuers of international bonds and notes, 1999-2008*

	Number of offerings by financial entities as share (per cent) of all offerings		
	2yr maturity	5yr maturity	10yr maturity
US Dollar	85.2	73.7	72.3
Euro	97.1	71.0	53.6
Yen	60.3	51.3	85.7
UK Pound	81.5	79.8	64.0
Swiss Francs	88.2	70.8	76.6

Notes: Foreign-currency-denominated bonds of specified maturity issued by financial entities during 1999-2008 as a share of total foreign-currency-denominated bonds issued in selected currencies. Maturity here refers to maturity "brackets", as described in the text. Securities with maturities of less than one year are excluded. Foreign-currency-denominated bonds are defined as those bonds issued in a currency other than the currency of the country in which the borrower resides. Sample includes only fixed-interest-rate securities. (*) Data for 2008 is for the first half of 2008. Source is Bondware.

play an important role in currency choice for bond issuance. If there is no omitted-variable bias then a significant number of issuers must be responding positively to signals indicating cheaper uncovered borrowing costs in given issuance currencies. The purpose of this section is to examine whether this result is sensitive to the distinction between the type of issuer, in particular differentiating between financial and non-financial issuers.

In terms of number of bonds issued, financial corporations (ie, investment banks, commercial banks, credit institutions and international banks) dominate global issuance of foreign-currency bonds. Table 6 shows the extent to which financial issuers dominate issuance in all major currencies, in particular, in the issuance of shorter-maturity bonds. For instance, financial issuers account for 97% of all bonds issued in euros with an average maturity of two years.

If uncovered cost savings are an important influence on the issuance decision, then it is conceivable that, of all potential issuers, financial corporations will be most responsive to these cost savings because, firstly, they have a greater speculative motive, and secondly, they have the market knowledge necessary to exploit such savings. Meanwhile, the empirical literature shows that non-financial issuers are concerned mainly with the need to find a natural hedge when issuing foreign-currency bonds (see Section 2).

In order to assess the difference in issuance behaviour, if any, between financial issuers and non-financial issuers, the full sample is split according to Standard Industrial Classification codes (SIC codes) so as to separate all those issuers operating in the financial sector (coinciding, mostly, with the 6000-7000 SIC classification codes) from the rest. The same Prais-Winsten regressions, as above, are run on the two sample subgroups for each of the three maturity brackets. Table 7 reports the results for financial issuers, and Table 8 for non-financial issuers.

The results suggest that financial issuers do, indeed, respond more strongly than non-financial issuers to uncovered borrowing-cost savings. For longer maturities (beyond two years), coefficient estimates for ε^u are larger and more significant for financial issuers. Coefficient estimates suggest that financial issuers are most responsive when the bonds they are issuing carry maturities of roughly five years in length. For five-year-maturity bonds, a 50-basis-point increase in uncovered borrowing-cost savings is associated with an increase in currency share of around 1.8 percentage points. For short-maturity bonds, uncovered borrowing-cost savings are a statistically significant driver of issuance for financial issuers but not for nonfinancial issuers.

Coefficients associated with control variables accounting for the natural hedge (*rgdp*, *liq*, *dinv* and *ma*) are in general consistent with estimates returned for the full sample in Section 6.2. Relative share of economic activity is in general important for both financial and nonfinancial issuers. However, relative share of direct investment and relative share of mergers and acquisitions exert an unexpected influence on issuance (ie, negative rather than positive) in a few specifications. Overall, the role of uncovered cost savings remains a consistent feature in the issuance of foreign-currency bonds of all maturities.

7 Conclusions

This paper examines the determinants of currency choice in the issuance of foreign-currency-denominated bonds, focussing on the presence of opportunistic behaviour by bond issuers in response to deviations from covered and uncovered interest parity. Count-data techniques are used to study the number of bonds issued across five major currencies during the period 1999 to 2008. In a robustness check, this paper also examines the number of bonds issued in each issuance currency as a share of total number of bonds issued in all currencies. Results are robust across all specifications.

The main finding is that scope for uncovered borrowing-cost savings, defined as deviations from uncovered interest parity, exert a significant influence on choice of issuance currency. These uncovered borrowing-costs savings are assessed in terms of their two main component parts: nominal interest-rate differentials and expected exchange-rate depreciation of the issuance currency. Interest-rate differentials are shown to have a statistically significant impact on currency choice across different empirical specifications, consistent with the findings of other studies. The implication is that issuers prefer to borrow in currencies that offer low nominal interest rates. Meanwhile, issuance does not respond in a consistent manner to expected depreciation of the issuance currency, suggesting that issuers do not, at the aggregate level, attempt to lower borrowing costs by issuing bonds in currencies that are expected to fall in value.

Assessing issuance behaviour by maturity of the bonds being issued reveals that the influence of nominal interest-rate differentials is similar for bonds of all maturities—that is, the influence is no stronger for long-maturity bonds than it is for short-maturity bonds, or vice versa. However, the influence is stronger

Table 7: Fixed effects Prais-Winsten estimation: Financial issuers

Panel A. Currency share of foreign-currency bonds, two-year maturity					
	(1)	(2)	(3)	(4)	(5)
ε^c	0.403		1.934		
	(3.16)		(3.89)		
ε^u		1.489*	1.848		
		(0.68)	(1.27)		
$(\overline{r} - r_i)$				1.345*	2.013*
				(0.61)	(0.82)
$(sn_i^e - sn_i)$					-70.949
					(46.25)
$rgdp$	1.819**	1.923**	1.852**	1.919**	1.782**
	(0.50)	(0.46)	(0.49)	(0.46)	(0.48)
$liq(t-1)$	0.176	0.173	0.161	0.175	0.112
	(0.17)	(0.17)	(0.16)	(0.17)	(0.17)
$dinv$	-0.051	-0.054	-0.056	-0.054	-0.058
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
ma	0.872**	0.866**	0.841**	0.867**	0.829**
	(0.27)	(0.28)	(0.27)	(0.28)	(0.28)
Adj. R^2	0.776	0.782	0.781	0.782	0.785
RMSE	13.964	13.919	13.947	13.925	13.811
Panel B. Currency share of foreign-currency bonds, five-year maturity					
ε^c	-0.302		3.104		
	(2.67)		(3.13)		
ε^u		3.536**	4.112**		
		(0.72)	(0.92)		
$(\overline{r} - r_i)$				3.522**	3.457**
				(0.73)	(0.70)
$(sn_i^e - sn_i)$					6.822
					(34.56)
$rgdp$	1.213**	1.401**	1.286**	1.409**	1.422**
	(0.38)	(0.35)	(0.37)	(0.35)	(0.36)
$liq(t-1)$	0.268*	0.255*	0.235	0.258*	0.264*
	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)
$dinv$	-0.040	-0.048*	-0.050**	-0.048*	-0.047*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ma	0.353	0.323	0.284	0.325	0.329
	(0.19)	(0.19)	(0.18)	(0.19)	(0.19)
Adj. R^2	0.827	0.837	0.837	0.837	0.836
RMSE	10.871	10.612	10.603	10.609	10.638
Panel C. Currency share of foreign-currency bonds, ten-year maturity					
ε^c	-2.617		-2.601		
	(1.39)		(1.40)		
ε^u		1.940*	1.957*		
		(0.94)	(0.89)		
$(\overline{r} - r_i)$				1.868*	2.145*
				(0.94)	(0.95)
$(sn_i^e - sn_i)$					20.035
					(20.33)
$rgdp$	-0.158	-0.254	-0.158	-0.251	-0.212
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
$liq(t-1)$	0.086	0.069	0.085	0.069	0.087
	(0.10)	(0.10)	(0.10)	(0.09)	(0.10)
$dinv$	0.003	0.001	0.003	0.001	0.002
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ma	0.085*	0.052	0.085*	0.052	0.063*
	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)
Adj. R^2	0.856	0.861	0.861	0.861	0.860
RMSE	7.697	7.685	7.669	7.684	7.683

Notes: Fixed-effects panel estimation with panel-corrected standard errors, corrected for heteroscedasticity and contemporaneous correlation across panels (ie, across issuance currencies). Accommodation for first-order autocorrelation (common to all panels) where present. Dependent variable is number of foreign-currency bonds issued in currency i at time t as a share of all foreign-currency bonds issued. Regressions include fixed effects and panel-specific time trends. All explanatory variables are measured at the beginning of the quarter. The sample period is from 1999 to the second quarter of 2008. Standard errors are in parenthases. (**) and (*) denote significance at the 1% and 5% levels respectively.

Table 8: Fixed effects Prais-Winsten estimation: Nonfinancial issuers

Panel A. Currency share of foreign-currency bonds, two-year maturity					
	(1)	(2)	(3)	(4)	(5)
ε^c	-2.272		-3.076		
	(2.92)		(3.36)		
ε^u		1.456	-0.971		
		(0.80)	(0.96)		
$(\overline{r} - r_i)$				1.432	1.495*
				(0.81)	(0.80)
$(sn_i^e - sn_i)$					-6.654
					(38.31)
$rgdp$	1.663**	1.162**	1.646**	1.164**	1.151**
	(0.36)	(0.36)	(0.36)	(0.36)	(0.37)
$liq(t-1)$	-0.13	-0.206	-0.122	-0.204	-0.21
	(0.12)	(0.13)	(0.12)	(0.13)	(0.13)
$dinv$	-0.067***	-0.072***	-0.064***	-0.072***	-0.072***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ma	-0.214	-0.365**	-0.198	-0.364**	-0.367**
	(0.14)	(0.15)	(0.14)	(0.15)	(0.15)
Adj. R^2	0.843	0.823	0.842	0.823	0.823
RMSE	10.738	11.377	10.752	11.378	11.409
Panel B. Currency share of foreign-currency bonds, five-year maturity					
ε^c	-3.704		-3.284		
	(1.97)		(2.29)		
ε^u		1.116*	0.507		
		(0.47)	(0.64)		
$(\overline{r} - r_i)$				1.173*	0.847
				(0.48)	(0.44)
$(sn_i^e - sn_i)$					34.519
					(21.83)
$rgdp$	0.565*	0.453*	0.574*	0.459*	0.525*
	(0.24)	(0.22)	(0.24)	(0.22)	(0.23)
$liq(t-1)$	0.212**	0.187*	0.208**	0.188*	0.218**
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
$dinv$	-0.004	-0.007	-0.005	-0.007	-0.005
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ma	-0.091	-0.142	-0.1	-0.141	-0.123
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Adj. R^2	0.923	0.931	0.931	0.931	0.932
RMSE	6.979	6.975	6.929	6.971	6.918
Panel C. Currency share of foreign-currency bonds, ten-year maturity					
ε^c	-3.557		-3.029		
	(2.16)		(2.49)		
ε^u		1.200*	0.638		
		(0.51)	(0.70)		
$(\overline{r} - r_i)$				1.243*	0.986*
				(0.52)	(0.49)
$(sn_i^e - sn_i)$					27.242
					(22.65)
$rgdp$	1.425**	1.325**	1.437**	1.330**	1.383**
	(0.26)	(0.24)	(0.26)	(0.24)	(0.24)
$liq(t-1)$	0.054	0.03	0.049	0.031	0.055
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
$dinv$	0.026	0.022	0.024	0.022	0.024
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ma	-0.231*	-0.28*	-0.241*	-0.280**	-0.265*
	(0.11)	(0.10)	(0.11)	(0.10)	(0.10)
Adj. R^2	0.931	0.936	0.937	0.936	0.937
RMSE	7.386	7.378	7.346	7.374	7.352

Notes: Fixed-effects panel estimation with panel-corrected standard errors, corrected for heteroscedasticity and contemporaneous correlation across panels (ie, across issuance currencies). Accommodation for first-order autocorrelation (common to all panels) where present. Dependent variable is number of foreign-currency bonds issued in currency i at time t as a share of all foreign-currency bonds issued. Regressions include fixed effects and panel-specific time trends. All explanatory variables are measured at the beginning of the quarter. The sample period is from 1999 to the second quarter of 2008. Standard errors are in parenthases. (**) and (*) denote significance at the 1% and 5% levels respectively.

for financial issuers (eg, investment banks, commercial banks and credit institutions), suggesting that, perhaps, financial issuers are driven by a stronger speculative motive than non-financial issuers when choosing their currency of issuance and have greater access to the type of market information that is necessary to exploit such cost-saving opportunities.

This paper finds no robust evidence that covered cost savings systematically affect the number of bonds issued in a given issuance currency. Arbitrage opportunities do seem to be present in the swaps markets, but are not taken up by bond issuers. It is possible that the frequency of our dataset—quarterly data—may introduce a measurement error that impairs a proper assessment of the impact of this variable. Overall, our findings offer a useful contribution to the understanding of currency choice in the issuance of foreign-currency-denominated bonds and offer support to the notion that bond issuers attempt to lower borrowing costs by "hunting" for lower-yield currencies.

A Appendix

A.1 Data sources and definitions

For data sources and definitions refer to Table 9.

A.2 Multiple-currency model

Empirically, the challenge is to construct measures of both covered cost savings and uncovered cost savings that accommodate a choice among multiple currencies (five in our sample). In Section 3.1 and Section 3.2, the two measures of borrowing-cost savings, ε^c and ε^u, allow for just two currencies.

To accommodate a multiple-currency framework in the calculation of covered cost savings, the foreign interest rate, $r^{\star}_{t,t+k}$, in Eqn.(6), is replaced by $r_{i(t,t+k)}$, representing the continuously compounded yield on the k-year-maturity benchmark government bond associated with issuance currency i (where $i =$ euro, US dollar, yen, UK pound or Swiss franc), and where yields are calculated at the start of quarter t.[40] Meanwhile, the domestic interest rate, $r_{t,t+k}$, in Eqn.(6), is redefined as $\overline{r}_{i(t,t+k)}$, the contemporaneous average of all benchmark government bond yields for currencies L ($l = 1, \ldots, L$), where L includes all currencies in the sample other than the currency of issuance, i (that is, L includes all currencies associated with the nationalities of the issuers, plus the issuance currencies other than the issuance currency selected, i).

[40] Government bond yields are used to proxy borrowing costs for a number of reasons. First, as highlighted by McBrady & Schill (2007), government bond yields, unlike corporate bond yields, are free of contamination from default-risk pricing, which may otherwise affect an issuer's choice of issuance currency. Second, yields on investment-grade corporate bonds (which may could be a better proxy for the borrowing costs faced by issuers of foreign-currency bonds) are unavailable for all currencies. Government bond yields are obtained from Bloomberg.

Table 9: Data Sources And Definitions

Variable	Definition	Source
B_i^c	Number of issues of foreign-currency bonds denominated in currency i, where foreign-currency bonds are defined as all bonds issued in a currency other than the currency of the country in which the borrower resides	Dealogic (Bondware)
B_i^s	Number of issues of foreign-currency bonds denominated in currency i as a share of all issues of foreign-currency bonds (share expressed as fraction of one)	Constructed variable
ε^u	Uncovered borrowing-cost savings, defined as deviations from uncovered interest parity, where $\varepsilon_{it}^u \equiv (\overline{r}_{t,t+k} - r_{i(t,t+k)}) - (sn_{i(t,t+8)}^e - sn_{it})$	Constructed variable
ε^c	Covered borrowing-cost savings, defined as deviations from swap-covered interest parity, where $\varepsilon_i^c t \equiv (\overline{r}_{t,t+k} - \overline{c}_{t,t+k}^{sw}) - (r_{i(t,t+k)} - c_{i(t,t+k)}^{sw})$	Constructed variable
$(\overline{r} - r_i)$	Interest rate differential, defined as home interest rate minus issuance-currency interest rate, where home interest rate $\overline{r}$ is expressed as a multiple-currency average	Constructed variable
$\overline{r}$	Contemporaneous average of all interest rates for currencies L $(l = 1, \ldots, L)$, where L includes all currencies in the sample other than the currency of issuance, i (that is, L includes all currencies associated with the nationalities of the issuers, plus the issuance currencies other than the issuance currency selected, i). The average is a weighted average, where weights reflect the value (US-dollar equivalent) of bonds issued in each currency l at the end of the previous quarter, $t-1$	Constructed variable
r	Yield on benchmark government bond, compounded continuously	Bloomberg
$(sn_i^e - sn_i)$	Expected appreciation of the nominal effective exchange rate for issuance currency i (index)	Constructed variable
sn_i^e	Expected value of the nominal effective exchange rate for issuance currency i, with weights calculated to match trade weights for sn (index)	Constructed variable
sn_i	Nominal effective exchange rate for issuance currency i	International Financial Statistics, IMF
s^e	Exchange-rate expectations, natural logarithm of, where expectations are proxied by two-year ahead consensus forecasts	Consensus Forecasts
s	Exchange rate, natural logarithm of, expressed in terms of home currency per foreign currency	Bloomberg
c	Benchmark currency-swap yield (proxied by interest-rate-swap yield)	Bloomberg
ma	Number of cross-border mergers and acquisitions into the issuance-currency region (by acquirers that match, in nationality, the set of issuers in the issuance currency) as a proportion of cross-border mergers and acquisitions into all issuance-currency countries (in percentage points)	Zephyr, Bureau Van Dijk
$rgdp$	Constant GDP in the issuance-currency region as a share of total constant GDP in all other issuance-currency countries (in percentage points)	International Financial Statistics, IMF
$dinv$	Direct investment into the issuance-currency region as a share of total direct investment into all sample issuance-currency regions (in percentage points)	International Financial Statistics, IMF
liq	Capitalisation of market for issuance-currency debt securities (both domestic bonds and foreign bonds) divided by issuance-currency GDP, as a share of total capitalisation of market for all debt securities in all issuance currencies divided by total GDP (in percentage points)	Dealogic (Bondware)

The contemporaneous average yield is, in fact, a weighted average, where weights reflect the value (US-dollar equivalent) of bonds issued in each currency l at the end of the previous quarter, $t-1$. The logic behind weighting yields by value is straightforward. Value, in this case, is used as a proxy for liquidity. All else being equal, an issuer, in making a comparison between borrowing costs available in the issuance currency $(r_{i(t,t+k)})$ and in rival currencies $(\overline{r}_{i(t,t+k)})$, will, among the rival currencies, be more concerned about borrowing costs available in currencies associated with liquid markets for debt. The more liquid the market, the more attractive it will be as an alternative to the issuance-currency market. Weighting yields by value does, therefore, allow liquidity to be incorporated directly into the issuer's decision over currency choice.

In order to complete the adjustments necessary to reset Eqn.(6) into a multiple-currency framework, adjustments are made to the empirical treatment of fixed-for-floating currency swaps. The treatment adopted is identical to that outlined for interest rates, above. That is, $c^{sw^\star}_{t,t+k}$ is replaced with $c^{sw}_{i(t,t+k)}$, representing the currency-swap rate, continuously compounded, for currency i and maturity k, while $c^{sw}_{t,t+k}$ is replaced with $\overline{c}^{sw}_{t,t+k}$, the contemporaneous weighted average of all currency-swap rates for currencies L $(l = 1, \ldots, L)$, where L includes all currencies in the sample other than the currency of issuance, i. The new, multiple-currency formulation, is,

$$\varepsilon^c_i t \equiv (\overline{r}_{t,t+k} - \overline{c}^{sw}_{t,t+k}) - (r_{i(t,t+k)} - c^{sw}_{i(t,t+k)}) \tag{23}$$

where, in a similar fashion to Eqn.(6), $(\overline{r}_{t,t+k} - \overline{c}^{sw}_{t,t+k})$ is the average weighted spread between bond yields and currency-swap rates for all currencies L and, likewise, $(r_{i(t,t+k)} - c^{sw}_{i(t,t+k)})$ is the spread for issuance currency i.

Unfortunately, while fixed-for-floating currency swaps are the appropriate measure of the cost of covering exchange-rate risk for issuance of foreign-currency bonds, consistent time-series data on currency swaps are unavailable. A proxy is required. One amenable proxy, for which data are available, is the interest-rate swap. An interest-rate swap is a mechanism that allows fixed-rate payments in one currency to be swapped into floating-rate payments in the same currency. It differs, in magnitude, from a fixed-for-floating currency swap by an amount equal, in basis points, to a currency basis swap, which, itself, represents a swap of floating-rate payments in one currency into floating-rate payments in US dollars. This relationship between the three swap transactions (currency swap, interest-rate swap and currency-basis swap) can be expressed as,

$$c^{sw}_{t,t+k} = c^{bsw}_{t,t+k} + i^{sw}_{t,t+k} \tag{24}$$

where $c^{sw}_{t,t+k}$, as before, is the domestic fixed-for-floating currency swap, where $c^{bsw}_{t,t+k}$ is the domestic currency basis swap and where $i^{sw}_{t,t+k}$ is the domestic interest-rate swap.

An interest-rate swap is a good proxy for a currency swap only if it can be established that currency basis swaps are small, in magnitude, compared with both $c^{sw}_{t,t+k}$ and $i^{sw}_{t,t+k}$. This is, in fact, the case. Although there is insufficient data upon which to conduct tests of measurement error, the data that are available for $c^{bsw}_{t,t+k}$, for the five main currencies of issuance in the sample, show that currency basis swaps vary by no more than 20 basis points throughout the sample period (that is, they are bounded above by positive 10 basis points, and below by negative 10 basis points).

Uncovered cost savings, ε^u_t), can also, like the concept of covered cost savings, be translated into a multiple-currency framework. Interest rates are dealt with as before. That is, the foreign interest rate, $r^\star_{t,t+k}$, in Eqn.(2), is replaced with $r_{i(t,t+k)}$, the continuously compounded yield on the k-year-maturity benchmark government bond associated with issuance currency i. The domestic interest rate, $r_{t,t+k}$, is redefined as $\overline{r}_{i(t,t+k)}$ the contemporaneous average of all benchmark government bond yields for all currencies other than the currency of issuance, i. Exchange-rate expectations are treated as per Section 4.1.

References

Aabo, T. (2006), 'The importance of corporate foreign debt in managing exchange rate exposures in non-financial companies', *European Financial Management* **12**(4), 633–649.

Allayanis, G. & Ofek, E. (2001), 'Exchange rate exposure, hedging and the use of foreign currency derivatives', *Journal of International Money and Finance* **20**, 273–296.

Allayanis, G. & Weston, J. (2001), 'The use of foreign-currency derivatives and firm market value', *Review of Financial Studies* **14**, 243–276.

Allayannis, G., Brown, G. & Klapper, L. (2003), 'Capital structure and financial risk: evidence from foreign debt use in east asia', *Journal of Finance* **58**, 2667–2709.

Beck, N. & Katz, J. (1995), 'What to do (and not to do) with time-series cross-section data', *American Political Science Review* **89**, 634–647.

Cameron, C. & Trivedi, P. (1998), *Regression Analysis of Count Data*, number 30 *in* 'Econometric Society Monograph', Cambridge University Press.

Carlton, D. (1979), *Why New Firms Locate Where They Do: An Econometric Model*, The Urban Institute.

Carlton, D. (1983), 'The location and employment choices of new firms: an econometric model with discrete and continuous endogenous variables', *Review Of Economics And Statistics* **65**(3), 440–449.

Cavaglia, S., Verschoor, W. & Wolff, C. (12), 'Further evidence on exchange rate expectations', *Journal of International Money and Finance* pp. 78–98.

Chinn, M. D. & Meredith, G. (2005), 'Testing uncovered interest parity at short and long horizons during the post-bretton woods era', *National Bureau of Economic Research Working Paper Series* (11077).

Claessens, S. (1992), 'The optimal currency composition of external debt: theory and applications to mexico and brazil', *The World Bank Economic Review* **6**, 503–528.

Clark, E. & Judge, A. (2007), 'The determination of foreign currency hedging: Does foreign currency debt induce a bias?', *European Financial Management* **14**(3), 445–469.

Clark, E. & Judge, A. (2008), 'Foreign currency derivatives versus foreign currency debt and the hedging premium', *European Financial Management* .

Cohen, B. (2005), 'Currency choice in international bond issuance', *Bank For International Settlements Quarterly Review* .

ECB (2008), 'Review of the international role of the euro', *European Central Bank* .

Eichengreen, B. & Hausmann, R. (1999), *Exchange rates and financial fragility*, Federal Reserve Bank of Kansas City, Kansas City.

Elliot, W., Huffman, S. & Makar, S. (2003), 'Foreign-denominated debt and foreign currency derivatives: Complements or substitutes in hedging foreign currency risk?', *Journal of Multinational Financial Management* **13**, 123–139.

Esho, N., Sharpe, I. & Webster, K. (2007), 'Hedging and choice of currency denomination in international syndicated loan markets', *Pacific-Basin Finance Journal* **15**, 195–212.

Fisher, E., Heinkel, R. & Zechner, J. (1989), 'Dynamic capital structure choice: theory and tests', *Journal of Finance* **44**, 19–40.

Fletcher, D. & Taylor, L. (1996), 'Swap covered interest parity in long-date capital markets', *Review of Economics and Statistics* **78**, 530–538.

Gczy, C., Minton, B. & Schrand, C. (1997), 'Why firms use currency derivatives', *Journal of Finance* **52**(4), 1323–1354.

Graham, J. & Harvey, C. (2001), 'The theory and practice of corporate finance: Evidence from the field', *Journal of Financial Economics* **61**, 187–243.

Greene, W. (2008), *Econometric Analysis*, 6 edn, Prentice Hall, Englewood Cliffs.

Guimaraes, P., Figueiredo, O. & Woodward, D. (2003), 'A tractable approach to the firm location decision problem', *Review of Economics and Statistics* **85**(1), 201–204.

Hall, B., Griliches, Z. & Hausman, J. (1984), 'Econometric models for count data with an application to the patents-research-and-development relationship', *Econometrica* **52**(4), 909–983.

Hall, B., Griliches, Z. & Hausman, J. (1986), 'Patents and r and d: Is there a lag?', *International Economic Review* **27**(2), 265–283.

Hausmann, R. & Panizza, U. (2003), 'On the determinants of original sin: an empirical investigation', *Journal of International Money and Finance* **22**, 957–990.

Henderson, B., Jegadeesh, N. & Weisbach, M. (2006), 'World markets for raising new capital', *Journal of Financial Economics* **82**, 63–102.

Hull, J. (2006), *Options, futures, and other derivatives, 6th edition*, Pearson Prentice Hall.

Johnson, D. (1988), 'The currency denomination of long-term debt in the canadian corporate sector: an empirical analysis', *Journal of International Money and Finance* **7**, 77–90.

Kedia, S. & Mozumdar, A. (2003), 'Foreign currency-denominated debt: An empirical examination', *Journal of Business* **76**(4), 521–546.

Keloharju, M. & Niskanen, M. (2001), 'Why do firms raise foreign currency denominated debt? evidence from finland', *European Financial Management* **7**(4), 481–496.

Kim, Y. & Stulz, R. (1988), 'The eurobond market and corporate financial policy: A test of the clientele hypothesis', *Journal of Financial Economics* **22**, 189–205.

Luce, R. & Suppes, P. (1965), *Handbook of Mathematical Psychology*, Vol. 3, John Wiley and Sons, New York, chapter Preference, utility and subjective probability, pp. 249–410.

MacDonald, R. & Torrance, T. (1990), 'Expectations formation and risk in four foreign exchange markets', *Oxford Economic Papers* **42**, 544–561.

Maddala, G. (1983), *Limited-Dependent and Qualitative Variables In Econometrics*, Cambridge University Press, Cambridge.

McBrady, M. & Schill, M. (2007), 'Foreign currency-denominated borrowing in the absence of operating incentives', *Journal of Financial Economics* **86**, 145–177.

McFadden, D. (1974), *Conditional logit analysis of qualitative choice behaviour*, Vol. 4, Academic Press, New York.

McFadden, D. (1980), 'Econometric models for probabilistic choice among products', *Journal of Business* **53**(3), 13–29.

Mehl, A. & Reynaud, J. (2005), 'The determinants of "domestic" original sin in emerging market economies', *European Central Bank Working Paper Series* (560).

Myers, S. (2001), 'Capital structure', *Journal of Economic Perspectives* **15**(2), 81–102.

Papke, L. & Wooldridge, J. (1996), 'Econometric methods for fractional response variables with an application to 401(k) plan participation rates', *Journal of Applied Econometrics* **11**(4), 619–632.

Popper, H. (1993), 'Long-term covered interest parity: evidence from currency swaps', *Journal of International Money And Finance* **12**, 439–438.

Prais, S. & Winsten, C. (1954), 'Trend estimators and serial correlation', *Cowles Commission Discussion Papers* (383).

Sarno, L. & Taylor, M. (2002), *The economics of exchange rates*, Cambridge University Press.

Siegfried, N., Simeonova, E. & Vespro, C. (2007), 'Choice of currency in bond issuance and the international role of currencies', *European Central Bank Working Paper Series* (814).

European Central Bank Working Paper Series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.europa.eu).

916 "Optimal reserve composition in the presence of sudden stops: the euro and the dollar as safe haven currencies" by R. Beck and E. Rahbari, July 2008.

917 "Modelling and forecasting the yield curve under model uncertainty" by P. Donati and F. Donati, July 2008.

918 "Imports and profitability in the euro area manufacturing sector: the role of emerging market economies" by T. A. Peltonen, M. Skala, A. Santos Rivera and G. Pula, July 2008.

919 "Fiscal policy in real time" by J. Cimadomo, July 2008.

920 "An investigation on the effect of real exchange rate movements on OECD bilateral exports" by A. Berthou, July 2008.

921 "Foreign direct investment and environmental taxes" by R. A. De Santis and F. Stähler, July 2008.

922 "A review of nonfundamentalness and identification in structural VAR models" by L. Alessi, M. Barigozzi and M. Capasso, July 2008.

923 "Resuscitating the wage channel in models with unemployment fluctuations" by K. Christoffel and K. Kuester, August 2008.

924 "Government spending volatility and the size of nations" by D. Furceri and M. Poplawski Ribeiro, August 2008.

925 "Flow on conjunctural information and forecast of euro area economic activity" by K Drechsel and L. Maurin, August 2008.

926 "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability" by R. A. De Santis, C. A. Favero and B. Roffia, August 2008.

927 "Monetary stabilisation in a currency union of small open economies" by M. Sánchez, August 2008.

928 "Corporate tax competition and the decline of public investment" by P. Gomes and F. Pouget, August 2008.

929 "Real convergence in Central and Eastern European EU Member States: which role for exchange rate volatility?" by O. Arratibel, D. Furceri and R. Martin, September 2008.

930 "Sticky information Phillips curves: European evidence" by J. Döpke, J. Dovern, U. Fritsche and J. Slacalek, September 2008.

931 "International stock return comovements" by G. Bekaert, R. J. Hodrick and X. Zhang, September 2008.

932 "How does competition affect efficiency and soundness in banking? New empirical evidence" by K. Schaeck and M. Čihák, September 2008.

933 "Import price dynamics in major advanced economies and heterogeneity in exchange rate pass-through" by S. Dées. M. Burgert and N. Parent, September 2008.

934 "Bank mergers and lending relationships" by J. Montoriol-Garriga, September 2008.

935 "Fiscal policies, the current account and Ricardian equivalence" by C. Nickel and I. Vansteenkiste, September 2008.

936 "Sparse and stable Markowitz portfolios" by J. Brodie, I. Daubechies, C. De Mol, D. Giannone and I. Loris, September 2008.

937 "Should quarterly government finance statistics be used for fiscal surveillance in Europe?" by D. J. Pedregal and J. J. Pérez, September 2008.

938 "Channels of international risk-sharing: capital gains versus income flows" by T. Bracke and M. Schmitz, September 2008.

939 "An application of index numbers theory to interest rates" by J. Huerga and L. Steklacova, September 2008.

940 "The effect of durable goods and ICT on euro area productivity growth?" by J. Jalava and I. K. Kavonius, September 2008.

941 "The euro's influence upon trade: Rose effect versus border effect" by G. Cafiso, September 2008.

942 "Towards a monetary policy evaluation framework" by S. Adjemian, M. Darracq Pariès and S. Moyen, September 2008.

943 "The impact of financial position on investment: an analysis for non-financial corporations in the euro area" by C. Martinez-Carrascal and A. Ferrando, September 2008.

944 "The New Area-Wide Model of the euro area: a micro-founded open-economy model for forecasting and policy analysis" by K. Christoffel, G. Coenen and A. Warne, October 2008.

945 "Wage and price dynamics in Portugal" by C. Robalo Marques, October 2008.

946 "Macroeconomic adjustment to monetary union" by G. Fagan and V. Gaspar, October 2008.

947 "Foreign-currency bonds: currency choice and the role of uncovered and covered interest parity" by M. M. Habib and M. Joy, October 2008.

ISSN 1561-0810