Currency composition of international bonds: the EMU effect

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Abstract

We make use of micro–level data on private international bond issues in 1990-2006 to analyze the impact that the launch of the EMU had on their currency denomination. A stylized model predicts that the introduction of the euro would lead to an increase in the share of euro–denominated debt and a decline in the share of dollar–denominated bond issues, especially for non–financial firms. Empirical results are consistent with these predictions: we find a substantial increase in international euro–denominated issuance and a decline in international dollar–denominated issuance by non–financial firms from countries outside the United States or the euro area. We find that among non–financial firms the impact on new issuers is larger than on seasoned issuers. Extending the model to allow for differences in issuance volumes prior to integration, we predict larger increases among firms from smaller future monetary union member countries. We confirm empirically that the share of international bond issues denominated in euro grew more in the small EMU member countries than in the large ones.

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1 Introduction

Firms issuing bonds in international bond markets face a choice concerning the currency denomination of their issues. On the one hand, issuing in domestic currency avoids currency mismatch for firms whose revenues are biased towards their domestic currencies. There may also be increased administrative costs associated with marketing an issue in a foreign currency. On the other hand, international currencies, such as the dollar, euro, pound, or yen, offer substantial cost reductions due to scale economies. Increases in the volume of transactions in a given currency raises analyst coverage, hedging opportunities, and the set of potential creditors. Similarly, borrowers that are deciding in which of the international currencies to denominate their bonds are faced with the tradeoff between differential impacts these currencies may have on their balance sheet structure and different transactions costs that may be associated with these currencies.

The choice of invoice currency in international goods transactions has been studied extensively. Early studies emphasized choosing a currency to reduce transactions costs, e.g. Swoboda (1968), while more recent studies have stressed minimizing exposure to macroeconomic volatility [e.g. Giovannini (1988)] and network effects [e.g. Rey (2001) and Goldberg and Tille (2008)]. Similar concerns should arise in the currency-denomination decision for bond issuance. For example, issuing bonds in U.S. dollar versus the euro has different implications for the dynamics of the liability side of a firm's balance sheet as the dollar-euro exchange rate moves. In this paper, we investigate the determinants of currency denomination in bond issuance by examining the impact of the launch of the euro on world bond markets using theoretical argument and micro–level data analysis.

The introduction of the euro has been shown to lead to a reduction in the cost of bond issuance in euro relative to pre-monetary union national currencies [e.g. Santos and Tsatsaronis (2006)]. Coeurdacier and Martin (2006) find that the advent of the euro has resulted in a 14% to 17% reduction in transactions costs. Kim, Moshirian, and Wu (2006) confirm that the launch of the EMU corresponded to a period of increased financial market integration in European stock

and bond markets. Melnik and Nissim (2006) find that the introduction of the euro reduced the cost of issuing bonds in euro relative to the cost of issuing in national currencies of future EMU member countries. Kalemli-Ozcan, Papioannou, and Peydró (2009) find that elimination of the currency risk and legislative–regulatory convergence played role in financial integration of the eurozone. Drudi (2007) demonstrates that euro area firms moved from bank to bond financing subsequent to the launch of the EMU. Galati and Tsatsaronis (2003) and Pagano and Von Thadden (2004) find large effects of the advent of the euro on volumes and yield spreads in European bond markets. Similarly, Lane (2006a) and (2006b) find evidence of a euro–area bias in international bond portfolio movements. Spiegel (2009) finds evidence of a euro–area bias among Portuguese and Greek commercial bank borrowers subsequent to EMU accession.

To understand the tradeoffs involved in the firms' choice of the currency in which they issue bonds, we construct a stylized model in which firms have heterogeneous capacities to issue debt denominated in foreign currency. The main tension of the model is between the transaction costs associated with issuing in a given currency, which we assume to be decreasing with market size due to increased competition between investors and other external scale economies, and currency risk premia or other costs associated with issuance in foreign currency. We model the advent of the euro as a switch from many individual currency markets to a single euro market. Our model predicts an increase in the share of euro issuance and a decline in the share of dollar issuance for all countries, including those outside the United States or the euro area. Moreover, non–financial firms are likely to be more affected by the advent of the euro, because they are likely to be less adept at hedging currency risks on average and hence more likely to be influenced by the increased scale economies associated with issuing in euro.

We then take these predictions to a large data set of individual bond issues. Because we don't have data on domestic bonds, which are likely to be denominated in home currency, we limit our empirical analysis to international bonds issued by firms from countries that are outside the United

States or the euro area. We do this to make sure that our results are not driven by the omission of domestic bond markets (see Burger and Warnock (2006)). Our data come from Dealogic DCM Analytics data base, a.k.a Bondware, and include all bonds issued in *international* bond markets by private firms with nationality of operations in one of 9 countries active in international bond markets between 1990 and 2006.[1] To our knowledge, our paper is the first to bring a large micro–level data set to bear on this issue.[2] The use of micro–level data allows us to condition on the currency of each bond issue, its size, its maturity, its governing law, and the issuer's nationality of operations. The latter is especially important because it allows us to distinguish between changes attributable to the advent of the monetary union, and those attributable to issuer nationality effects and because, as Warnock and Cleaver (2003) point out, analysis based on aggregate data is subject to a bias due to offshore bond issuance. Finally, aggregate data is reported as either debt outstanding or issuance net of repayments, which are noisy measures of issuer's behavior, unlike the issuance data.

We first examine the impact of the advent of the euro on the currency denomination of international bond issues in a multinomial logit specification, separately for financial and non–financial firms. Firms choose their currency of issue between US dollars, euro, or another currency. Our results are consistent with the predictions of our model in that they confirm an economically and statistically significant impact of the advent of the euro on non–financial firms, but not on financial firms. Our point estimates indicate that, other things being equal, the probability that a non–financial firm's international bond issue was denominated in euro was 17 percentage points higher after the advent of the EMU, while the probability that it was denominated in U.S. dollars was 13 percentage points lower. This indicates that most of the increase in euro–issuance was "at the expense" of U.S. dollar issuance. We find no significant impact of the EMU on the currency

[1] We restricted our sample to bonds issues with market type not explicitly labeled as "Domestic."

[2] Melnik and Nissim (2006) do look at a smaller sample of 316 eurobond issues, but the focus of their study is on changes in the terms of borrowing, rather than volumes. Santos and Tsatsaronis (2006) show that the arrival of the euro led to a reduction in the underwriting fees of corporate bonds issued in the new currency due to increased competition.

denomination of bonds issued by financial firms.

We next split our sample into new and seasoned issuers, to allow for heterogeneity in the EMU effect across these two groups. Unseasoned firms may lack incentives linking them to a specific currency market. These may include fixed costs associated with launching in a currency for the first time, or long–term relationships with firm underwriters or important customers in certain currency bond markets. The literature supports the existence of such fixed costs. Cai, Helwege, and Warga (2007) find that IPO bonds are subject to more underpricing, while Gande, Puri, and Saunders (1999) find that IPO bonds carry higher spreads than bonds of seasoned issuers, and Hale and Santos (2008) find that firms pay higher spreads on their IPO bonds than on subsequent issues. Repeating our analysis for new issuers and for seasoned issuers separately we find that, as we expected, the effects of the EMU are larger for new issuers than for those firms that issued both before and after the introduction of the euro. Financial firms remain largely unaffected.

These results are important because over time the decisions made by unseasoned issuers are likely to drive the global pattern of currency denomination, as some seasoned issuers will eventually exit the market. Moreover, the forces tying issuers to a specific currency, such as informational asymmetries across markets, are also likely to diminish with time. As such, if unseasoned firms are systematically more sensitive to changes in market volumes, such as those associated with the advent of the euro, aggregate studies of the initial response to the launch of the EMU are likely to underestimate the magnitude of the longer run impact of the EMU.

To isolate the components of the overall increase in euro–denominated issues, we compare the changes in volumes of debt issued in euro and other currencies by new and seasoned firms. We find a positive, but insignificant, impact of the launch of the euro on the volume of euro–denominated issues by firms that issued both in future euro–area national currencies prior to the launch of the EMU and in euro afterwards. In contrast, we find a positive statistically and economically significant impact among all seasoned firms. This provides weak evidence that the euro effect

among seasoned firms was stronger among those that had previously not issued in euro. We also find that the impact of the EMU launch on unseasoned issuers was higher than for the full sample. This would be expected, as both unseasoned issuers and those that had not previously issued in euro would be more likely to respond to the enhanced scale opportunities presented by the launch of the euro if there are fixed costs of issuing in a currency for the first time, as in Hale and Santos (2008).

To focus on the impact the advent of the euro may have had on euro area issuers, we extend the model to allow future monetary union members to differ by size. The volume of issuance continues to rise among all of the future monetary union members, with the impact of the union largest for smaller monetary union countries. To test this prediction, we repeat our empirical analysis for international bond issues by the euro area firms only, restricting our sample in the same way as before, and include among our control variables a measure of each county's currency share in the overall pre-EMU issuance in currencies of future EMU countries. We also interact this measure for the EMU indicator, allowing the effect of the euro to vary with the importance of the country's currency in the euro area, and then estimate the model for the sample of bonds issued by euro area firms only. We find, consistent with the model's prediction, that the effect of EMU is larger for smaller countries. In fact, we find no statistically significant effect of the euro on currency denomination of bonds issued by all firms from Germany and seasoned firms from France. Firms from smaller countries, in contrast, show a statistically and economically significant increase in the probability of denominating their issues in euro after its adoption.

The remainder of this paper is divided five sections. Section 2 presents the model and its testable implications. Section 3 lays out in detail our empirical approach. Section 4 describes our data sources and characterizes the sample. Section 5 presents our empirical results. Section 6 presents the extension of our model and our empirical analysis to the euro area firms. Section 7 concludes with final remarks.

2 Model

We begin by presenting a simple model which illustrates the mechanism we have in mind that would lead to the changes in the currency composition of the bond issuance as a result of the introduction of the euro.

2.1 Setup

There are two types of countries in the model: a single country, which is assumed to be a large world financial center, called country u, and m identical countries that choose to enter into the European monetary union. For simplicity we model these m countries in terms of a single representative prospective EMU member, henceforth referred to as country e.

There is a continuum of types of atomistic firms i in each country. Each firm issues debt, which is taken as exogenous and normalized to 1 for simplicity. Each firm is also associated with a firm "type," indexed by i, which reflects its relative costs of issuance in the home and foreign markets. Within a firm type, issuance costs are assumed to be homogeneous. For simplicity, the distribution of firm types i is assumed to be constant across countries, with the density of each firm type i equal to $f(i)$. However, countries differ in size, such that firms in countries u and e issue a total volume of debt equal to U and E, respectively, where $K = \int jf(i)di; k = e, u$.

There are economies of scale associated with the volume of issues in each individual market, which we define as debt denominated in a given currency. Let V_j represent the volume of issues in the currency of country j, $j = u, e$.

We specify $c(V_j)$ as the transactions cost of issuing in the currency of country j, which is dependent on the volume of transactions in that currency. In particular, we specify that $c(\cdot) \geq 0$, $c'(\cdot) \leq 0$, and $c"(\cdot) \geq 0$. We think of this transactions cost as a combination of underwriters' fees, costs of hedging, and liquidity premia. As the size of the market and therefore the number of

potential investors increases, we expect these costs to decline due to scale economies and increased competition. The cost to an individual firm in country u of issuing in its domestic currency, $r_{u,u}$ then satisfies

$$r_{u,u} = r^* + c(V_u), \tag{1}$$

where r^* represents the world risk-free rate of interest. Let η represent an indicator variable equal to 1 after the the launch of the monetary union, and 0 before. The cost to an individual firm in country e of issuing in its domestic currency satisfies

$$r_{e,e} = r^* + c\{[(1 + \eta(m-1)]V_e\}. \tag{2}$$

Firms also differ in their propensity to issue in a foreign currency: First, we assume that there are country-specific administrative costs associated with foreign firms issuing in their currency, equal to $\phi_j;\ j = u, e$. Second, firms differ idiosyncratically in their propensity to issue abroad. We model this by assuming that each firm from country j receives an idiosyncratic shock, $\xi_{j,i}$, which measures its idiosyncratic disadvantage in issuing in foreign currency, where $\xi_{j,i} \sim N(0, \sigma^2)$.

If the firm from country u issues in currency e, the interest rate that it pays satisfies

$$r_{u,e,i} = r^* + c\{[(1 + \eta(m-1)]V_e\} + \phi_e + \xi_{u,i}, \tag{3}$$

and if the firm from country e issues in currency u, the interest rate that it pays satisfies

$$r_{e,u,i} = r^* + c(V_u) + \phi_u + \xi_{e,i}. \tag{4}$$

2.2 Equilibrium

Equilibrium is defined as a set of firm currency of issuance decisions in each country that maximize expected profits. For simplicity, we rule out the possibility that a firm issuing from one of the future monetary union countries e would choose to issue in the currency of another e country.[3] By equations (1) and (3), a firm in country u will prefer to issue in its home currency if

$$\xi_{u,i} \geq [c(V_u) - c\{[(1 + \eta(m-1)]V_e\}] - \phi_e, \tag{5}$$

while by equations (2) and (4) a firm in country e will prefer to issue in its home currency if

$$\xi_{e,i} \geq [c\{[(1 + \eta(m-1)]V_e\} - c(V_u)] - \phi_u. \tag{6}$$

Define $\xi^*_{u,i}$ as the realization of $\xi_{u,i}$ for which (5) is just binding, and define $\xi^*_{e,i}$ as the realization of $\xi_{e,i}$ for which (6) is just binding. Let θ_u represent the share of firms from country u that issue in domestic currency. θ_u satisfies $\theta_u = 1 - F(\xi^*_{u,i})$, where $F(\xi^*_{u,i})$ is the density of realizations of $\xi_{u,i}$ that lie below $\xi^*_{u,i}$. Similarly, let θ_e represent the share of firms from country e that issue in domestic currency. θ_e satisfies $\theta_e = 1 - F(\xi^*_{e,i})$.

We assume that issues from firms from country u choosing to issue in currency e are divided equally among the m future union countries. Issues in country e currency prior to the formation of the union from firms headquartered in country u are equal to $(1 - \theta_u)U/m$. Issues from all m future union countries in currency u total $(1 - \theta_e)mE$.

Substituting for θ_u and θ_e, prior to the formation of the monetary union, the total volume of

[3] In principle, one could create a "European world financial center" in one of the e countries. This would be possible if the administrative costs to a European firm of issuing in another European country were sufficiently lower than those that would be encountered in issuing in the United States, or if scale economies were larger in the European financial center. We extend the model to consider a larger European country in Section 2.4.

issues in the currency of country u satisfies

$$V_u - [1 - F(\xi^*_{u,i})]U - F(\xi^*_{e,i})mE = 0, \tag{7}$$

while the total volume of issues in the currency of a representative future monetary union country satisfies

$$mV_e - F(\xi^*_{u,i})U - [1 - F(\xi^*_{e,i})]mE = 0. \tag{8}$$

Equations (7) and (8) then comprise a system of two equations in two unknowns, V_u and V_e.

2.3 Comparative statics

We derive the comparative statics of the model in the Appendix. In particular, we examine the impact of an increase in η, our monetary union indicator variable which goes from 0 to 1 after the advent of the union. By (7) and (8), the impact of an increase in η satisfies

$$\frac{\partial V_u}{\partial \eta} = m\{f(\xi^*_{u,i})U + f(\xi^*_{e,i})mE\}c'([1 + \eta(m-1)]V_e)(m-1)V_e/D \leq 0, \tag{9}$$

and

$$\frac{\partial V_e}{\partial \eta} = -\{f(\xi^*_{u,i})U + f(\xi^*_{e,i})mE\}c'([1 + \eta(m-1)]V_e)(m-1)V_e/D \geq 0, \tag{10}$$

given that D, the determinant of the system, is non-negative, which is required for stability. We derive D in the Appendix and demonstrate that satisfaction of the restriction $D \geq 0$ requires that the economies of scale are not "too large."

Recalling that η increases as a result of the EMU, this leads to our first proposition

Proposition 1 *Formation of the monetary union leads to an increase in the volume of issues denominated in the currency of the union and a decrease in the volume of issues denominated in the currency of the non–member country.*

2.4 Effect on outsider countries

These results have implications for bond issuance by firms from countries outside of the world financial center and the currency union members. Because the introduction of the monetary union changes the relative volume of these markets, it will affect the transaction costs faced by all firms that consider issuing in these currencies. We therefore move next to consider the decision of whether to issue in dollars or euro (or the national currencies of future EMU countries prior to monetary union) among firms from countries outside either the US or the euro area.

We limit our analysis to the currency of issuance decision conditional on having already decided to issue abroad.[4] To obtain an interior solution for the shares of issuance by firms from the outside country, we require firms to be heterogeneous in their capacity to issue in dollars or euro. In the absence of such heterogeneity, firms would choose a corner solution based on comparison of volumes and transactions costs.

To allow for this heterogeneity, we change the idiosyncratic shock faced by foreign-issuing outside country firms to single shock ξ_i that measures the idiosyncratic portion of the costs of issuing in euro – or pre-EMU monetary union currencies – relative to the cost of issuing in dollars, where $\xi_i \sim N(0, \sigma^2)$. Besides this change, we retain the above model framework. We specify the cost of issuing in euro for a firm i from outsider country o as satisfying

[4]We would require data on domestic issuance to test the generalized model that would incorporate secondary impacts of the advent of the EMU on domestic volumes and hence domestic issuance, which are unavailable for a large cross-section.

$$r_{o,e,i} = r^* + c\{[(1 + \eta(m-1)]V_e\} + \phi_e + \xi_i, \tag{11}$$

and the cost of issuing in dollars for a firm i from outsider country o as satisfying

$$r_{o,u,i} = r^* + c(V_u) + \phi_e - \xi_i. \tag{12}$$

Define ξ_i^* as the realization of ξ_i that leaves a firm issuing in foreign currency indifferent between issuing in country u or e currencies. By equations (11) and (13), ξ_i^* satisfies

$$\xi_i^* = \frac{1}{2}[c(V_u) - c\{[(1 + \eta(m-1)]V_e\}]. \tag{13}$$

Given Proposition 1, one can see by inspection that ξ_i^* decreases with the formation of the monetary union. This leads to our second proposition

Proposition 2 *Other things being equal, formation of the monetary union will shift the composition of foreign currency bond issues by firms from outsider countries towards the currency of the union and away from the currency of the non–member country.*

For the purposes of our empirical analysis, it is also useful to think about the difference between financial and non–financial firms. In particular, one may think that the transaction costs of issuing bonds are lower and, more importantly, less sensitive to the market size for financial firms, compared to non–financial firms. In terms of our model this means that $c'(\cdot)$ is lower in absolute value for financial firms. Two main reasons this might be true are (a) the fact that market for financial issues is larger, so $|c'(\cdot)|$ is likely to be lower as $c''(\cdot) \geq 0$, and (b) the fact that there is more information about financial institutions that is available to underwriters. From equations (9) and (10), this implies that the effect of EMU on financial firms will be lower. More formally, we have

Proposition 3 *If for non-financial firms transaction costs are more sensitive to the market size than for financial firms (i.e. $|c'(\cdot)|$ is higher for non-financial firms), the effect of EMU on issuance by non-financial firms from an outsider country will be larger than for financial firms from an outsider country.*

We take these last two predictions to the data.

3 Empirical approach

Not all countries have firms that borrow internationally. Therefore, we only observe foreign (and foreign currency) bond issues for a relatively small subset of countries, which raises the possibility of selection bias. To address this issue, we estimate a selection equation concerning the determinants of issuing internationally. Our selection equation is a probit regression with the dependent variable being an indicator of whether private firms operating in a particular country issued an international bond in a given year. We use as explanatory variables the variables that are found to affect international capital flows, including GDP in U.S. dollars, the current account scaled by GDP, capital account openness, country credit ratings, an annual coefficient of variation of exports, the nominal interest rate, the 1-year US treasury rate, and the exchange rate regime.[5] From this regression we construct an inverse Mills ratio, which we include as a regressor, denoted *Selection* among other country–specific time–varying control variables, in our currency denomination regressions.[6]

Our goal is both to measure the size of the effect of EMU on currency denomination of international bonds and to estimate the relative importance of the three margins along which this effect could potentially work: firms entering the international bond market for the first time choosing to issue in euro, firms already in the international bond market changing their issue currency in

[5] We estimate the selection equation over all countries with available data. The results of this regression are reported in the Appendix Table A.1.

[6] Alternatively, we included the propensity score from a probit, logit, or a linear probability model, instead of the inverse Mills ratio, among control variables. Our results were essentially unaffected.

favor of euro, and firms issuing in multiple currencies altering their currency shares in their overall portfolio in favor of the euro. We begin by analyzing the currency composition of bond issues in the full sample of bonds by estimating a multinomial logit system of equations as follows

$$\mathrm{I}(CUR_{ifjt} = k) = \alpha_j^k + \beta^k \mathrm{I}\,(t > 1999) + \mathbf{X}_i'\gamma_1^k + \mathbf{Y}_t'\gamma_2^k + \mathbf{Z}_{jt}'\gamma_3^k + \varepsilon_i^k, \tag{14}$$

where k is one of the currencies: U.S. Dollar, a euro area currency (which we refer to as euro even in the period before the EMU), or "other currency," which represents the base category. CUR_{ifjt} is a currency in which bond i issued by a firm f from country j in year t is denominated. α_j are country fixed effects, $\mathbf{X}_i$ is a set of bond–specific control variables, $\mathbf{Y}_t$ is a set of global variables that only vary over time, and $\mathbf{Z}_{jt}$ is a set of country–specific time–varying control variables.

Our coefficients of interest are the β^k's, which measure how the probability of issuing a bond in each of the four currencies k versus any other currency has changed after the EMU took effect. Thus, the multinomial logit approach will allow us not only to see whether the probability of issuing in euro increased after the launch of the EMU, but also whether this increase was due to decline in U.S. dollar issuance or not.

We next identify three margins along which the EMU effect could take place: (a) firms entering the international bond market for the first time might be more likely to choose to issue in euro; (b) seasoned firms that issued in other currencies might be more likely to switch to euro in subsequent issues; and (c) firms that issued in currencies of future EMU members may increase their share of issuance in euro.

We first estimate the model in equation (14), but limit our sample to the first international bond issued by a given borrower. As we described above, this isolates the effects of the EMU on new entrants to the international bond market. We then estimate the same model again, but only for borrowers that issued both before and after the introduction of the euro.

As a final test, we aggregate our data by country–year. This allows us to consider borrowing volumes in addition to the frequency of issues in any given currency. To continue focusing on the three possible margins along which the euro effect could have taken place, we construct four sets of aggregates: (a) total borrowing in euro and in all currencies combined by firms in each country–year, (b) the amount borrowed through first international bond issues (first for each firm) in each country–year in euro and in all currencies combined, (c) the amount borrowed in euro and in all currencies combined by firms that issued in international bond market both before and after the EMU took effect, and (d) the amount borrowed in euro and in all currencies combined by firms that issued *in euro* in the international bond market both before and after the EMU took effect. Using these aggregates, we calculate the share of euro–denominated bonds in the total amount borrowed in each country–year for each of the four sets of firms. With these shares (SH) as our dependent variables we estimate four linear regressions with country fixed effects.

$$SH_{jt} = \alpha_j + \beta \, \mathrm{I}\left(t > 1999\right) + \mathbf{Y}_t' \gamma_2 + \mathbf{Z}_{jt}' \gamma_3 + \varepsilon_{jt}. \tag{15}$$

As discussed below, comparisons of these four linear regressions allows us to estimate the relative importance of each of these three channels in terms of volumes, as well as the number of issues for the three euro effect channels we consider.

4 Data and Sample Description

An important advantage of our analysis is the use of micro–level data. Our bond data provides ample information on bond issue characteristics and some information on the issuer. The information on the issuer allows us to identify the true nationality of the issuer and whether the issuer's main operation is in the financial industry. It also allows us to keep track of bonds issued by the same firm. However, as we do not have firm balance sheet information, our ability to condition on

firm characteristics is limited to these indicators, and our primary conditioning is on the characteristics of the issue. We supplement our bond data with country–level macroeconomic data and with LIBOR interest rates for main currencies.

We use all bonds issued in international bond markets by private firms. This information comes from DCM Analytics, a.k.a. Bondware, which is available from Dealogic. The data span 1980 through February 2007. However, because there are only a few international bonds issued during the 1980-1985 period, and because we want to balance the number of years before and after the EMU, we limit the sample period in our analysis to 1990-2006. Thus, we have 9 years of data before the EMU took effect and 8 years of data afterwards.[7] We identify the nationality of the issuer by its nationality of operations. The nationality of operations is likely to best match the currency in which the bond issuer's expenses are invoiced.

Unfortunately the coverage of domestic bond issuance is incomplete in the Bondware, which is why we limit our analysis to international bond issues, information on which appears to at least be consistent across countries. To do so, we exclude from our sample bond issues for which market type is labeled as "Domestic" by Dealogic. This, however, creates a problem in analyzing the share of dollar and euro issuance of firms from the United States and the euro area, as domestic issuance from both regions tends to be almost universally in home currencies. For this reason, we limit our analysis to bond issues by firms from the "outsider" countries, which leaves us with a sample of 9 countries that are outside the U.S. or the euro area and are active in international bond markets: Australia, Canada, Denmark, Japan, New Zealand, Norway, Sweden, Switzerland, and the U.K.

Table A.2 shows the comparison between total amounts of new issues in our data and the amounts outstanding, both domestic and international, for the non-financial firms from the 9 countries we consider, as reported by BIS. The amounts cannot be compared directly because our data add up to gross issuance, but we can see that Bondware is likely to cover the bulk of the new

[7] We keep 1990 in the sample because in some regressions we use lagged variables.

issues. We can also see that for the set of countries we consider, international bond issuance is an important share of total, in terms of amounts outstanding reported by the BIS. We also note a secular increase in international bond issuance. The top panel of Table A.3 presents the count and the volume (in US dollars) of international bonds issued during our sample period by firms in countries outside the US and the EMU. We find that both the number and the U.S. dollar volume of bond issues increased dramatically from the period before EMU to the period after. Looking deeper into the data, we find that the sample of outsider countries' issues is dominated by issuers from U.K. We verify that our empirical results that follow are not driven by U.K. issuers and hold if U.K. issuers are excluded from the sample.

Our sample includes both financial and non–financial firms. By Proposition 2 above, these groups should react differently to the introduction of the euro. We therefore conduct all our analysis for these groups separately. Figure 1 shows the shares of the volume of bond issues in each market before and after EMU by borrowers from the 9 outsider countries in our sample. The share of bonds issued by non-financial firms denominated in euro area currencies increased dramatically from the period before EMU to the period after. This observation is consistent with findings of previous studies (e.g. Lane (2006a,b)).[8] We see a much smaller increase in the share of issues denominated in euro area currencies by financial firms.

Figure 2 shows the shares of the volume of bond issues in each market before and after the launch of the EMU by the borrowers from outsider countries. We can see that for both nonfinancial and financial borrowers from outsider countries the share of bond issues denominated in euro area currencies increased after the launch of the EMU, dramatically in case of nonfinancial firms.

Other data sources are conventional. National accounts data come from the IMF's World Economic Outlook Online Database, April 2008 edition. The capital controls variable, an index in which a higher value indicates a country is more open to cross–border capital transactions,

[8]Given the overall increase in bond issuance discussed above, it is important to keep in mind that while the share of U.S. dollar denominated issues declined, the total amount issued in U.S. dollars has still increased substantially.

comes from Chinn and Ito (2006). Country credit ratings are compiled from the Institutional Investor magazine's annual September ratings. Data for nominal interest rates come from the IMF's International Financial Statistics, with lending rates replaced with deposit rates for countries for which deposit rates are missing. The 1-year US treasury rate data was obtained from FAME, a Federal Reserve Board database, LIBOR rates are from Bloomberg. Finally, exchange rate regime data come from Ilzetzki, Reinhart, and Rogoff (2008); we use their "coarse" classification codes. We use some of these variables as controls in our second stage regressions as well.

5 Empirical results

We first confirm our finding of an overall increase in euro–denominated bond issuance after the EMU, predicted by the model and discussed above. The top panel of Table 1 presents the marginal effects of the "After EMU" indicator from our multinomial logit regression for the full sample of bond issues from outsider countries, separately for financial and non–financial issuers.[9] In this specification each firm chooses one of the three currencies for each of its bond issues: dollar, euro, or any other currency. We choose "other currency" as our base category. We find that, for the sample of non–financial firms, there is a strongly significant 17.3 percentage point increase in the probability of denominating in euro after the EMU launch, and a similar decrease (13.1 percentage points) in the probability of denominating in dollars. However, for financial firms we do not find a statistically significant euro effects. This is consistent with our conjecture that financial firms' transaction costs are less sensitive to the size of the market.

We next turn to the three channels of response to the launch of the euro discussed before. These include a potential increase in the choice of the euro for international bond issues by firms that are issuing in these markets for the first time, changes in international bond issue currency denomination in favor of the euro by seasoned issuers, and an increase in the share of euro area

[9] All multinomial regressions are fully reported in the Appendix.

currency issues in total international bond issuance by borrowers that issue in multiple currencies.

5.1 New issuers

We expect new issuers to be more sensitive to the savings that the emergence of a new deep market potentially presents, because, unlike seasoned borrowers, they are not tied to any specific currency of bond denomination through rollover needs or underwriter relationships.

The middle panel of Table 1 presents the marginal effects of the same multinomial logit regressions as before, except this time we limit our sample to the first international bond issue for each firm. We can see that for nonfinancial firms the the effect of EMU is even larger than for the full sample, confirming our intuition — after the launch of the EMU the probability of issuing in euro area currencies increased by 31.3 percentage points while the probability of denominating bonds in U.S. dollar fell by 22.1 percentage points, although the latter coefficient is not statistically significant. We repeat our analysis for financial firms and find, once again, no effect.

5.2 Seasoned issuers

We next consider the currency choice of seasoned firms that issued international bonds both before and after the launch of the EMU (Firms BA). We limit our sample to this set of firms and repeat the analysis. We expect these firms to be less affected by the introduction of the euro than firms that issue in the international bond market for the first time because they have already paid a cost of entering a given market. The bottom panel of Table 1 presents the marginal effects of the multinomial logit regressions using the same format as before. As we expected, the currency denomination of bonds issued by seasoned nonfinancial firms is less affected by the introduction of the euro than that of new issuers. We continue to find no effect for financial firms.

5.3 Aggregate analysis

We now turn to a third possible channel for change in the share of euro-denominated debt, namely the change in the share of funds raised on the euro–denominated bond market in total bond issuance by firms that issued in currencies of the EMU member countries both before and after the launch of the union (Firms EuroBA).

To investigate this channel, we aggregate the total amount borrowed by each specific group of firms in euro and other currencies for each country–year and compute the share of euro–denominated issuance in each country in each year for each group of firms. In addition to the full sample of bonds issued by non–financial firms, we consider initial bond issues, bond issues by firms that borrowed both before and after the EMU, and bond issues by firms that borrowed in euro area currencies both before and after the EMU. Clearly the fourth group is a subset of the third.

Table 2 presents the results of linear regression with country fixed effects for the country–year panel, where the dependent variable is the share of issuance in euro by all non-financial firms from outsider countries, as well as specified sub-samples. Once again, we confirm that there is an increase in the share of euro–denominated bonds (first column) after the launch of the EMU in the full sample of non–financial firms from outsider countries. This share increased by 25.9 percentage points after the launch of the EMU. We also see a slightly smaller impact, 18.9 percentage points, of the launch of EMU for the sub–sample of first issues (second column). We do not, however, find any evidence for our third channel — the coefficient on the "After EMU" indicator is basically zero in the sub–sample of firms that were active on the euro–denominated bond market both before and after the launch of the EMU (Firms EuroBA, last column). Keeping in mind that these firms also enter in the subset of firms that were active on overall international bond market both before and after the EMU launch (Firms BA, third column), we can see that the second channel discussed above, namely the switching of the firms from other currencies into euro, is what is driving the significant and positive coefficient in the third column. As before we find no effect of the EMU on

financial firms.[10]

We conclude from this analysis that the introduction of the euro affected the currency denomination of international bond issues primarily for nonfinancial firms. The most important channel for the euro effect was that on the currency denomination of the new international bond issues by unseasoned issuers. There is some evidence of switching from dollars to euro by seasoned borrowers, but it is not very strong. We find no evidence of an increase in the share of euro issuance by firms that were already active on European currencies' markets prior to the EMU.

6 Effects on the EMU-member countries

One particular question of interest is how the introduction of the euro affected the behavior of the firms from the EMU-member countries. In order to make the model more realistic, we move away from the assumption that all pre-EMU countries are identical and provide an extension of the model that considers the case where the euro area had a "financial center" prior to the unification. The model predicts that the size of the euro effect would be smaller for firms in the European financial center compared to firms from other EMU-member countries. Even though are ability to test the prediction of this specific extension is limited by the lack of data on domestic bond issuance, we are still able to detect differential effects the introduction of the euro may have on bond issuance by firms from larger and smaller EMU-member countries. Because we still find no effects on financial firms, we only report our findings for non-financial firms.

6.1 Extension with pre-EMU financial center

Extending the model to allow for heterogeneity in pre-union country size complicates the analysis, as we now need to keep track of three different-sized countries. We therefore add two minor

[10] In the interest of space we do not report these results.

simplifying assumptions: First, we model the union as integration between a European financial center, which we refer to as g, and one smaller country e (rather than the m identical countries as in the benchmark model above). We assume that the volume of domestic bonds issued by country g firms is higher than the volume of country e, but lower than that of country u, so that $U \geq G \geq E$. Second, we assume that the economies of scale are strictly linear, so that $c''(\cdot) = 0$.[11] We retain all of the other above assumptions and designate total issuance in country g as equal to G, where $G = \int g f(j) dj$.

As above, firms differ idiosyncratically in their propensity to issue abroad. Each firm from country j ($j = u, e, g$) receives an idiosyncratic shock, $\xi_{j,i}$, which measures its disadvantage in issuing in foreign currency, $\xi_{j,i} \sim N(0, \sigma^2)$. For simplicity, we set the administrative costs of issuing in the future monetary union currencies to be the same and equal to ϕ_e.[12]. Given the above assumptions, prior to the formation of the union all firms in country u that issue in foreign currency issue in currency g. The cost to a firm in country g of issuing in its domestic currency then follows

$$r_{g,g} = r^* + c(V_g). \tag{16}$$

The cost to a firm from country u of issuing in foreign currencies e or g satisfies

$$r_{u,e,i} = r^* + c(V_e + \eta V_g) + \phi_e + \xi_{u,i}, \tag{17}$$

and

[11] This assumption is also made only for simplicity, and drives none of our results. Indeed, it works against the result that the impact of the formation of the union is greater for the smaller monetary union members than for the pre-union financial center. With decreasing economies of scale, the pre-union financial center would experience a smaller reduction in transactions costs for any given increase in issuance volume relative to its smaller union partners, as it enters into the union with the higher issuance volume.

[12] This assumption drives none of our results. If country g had different administrative costs than its monetary union partner, the cost of issuing in the monetary union currency subsequent to the formation of the union would be equal to the lowest administrative cost prevailing in the union.

$$r_{u,g,i} = r^* + c(V_g + \eta V_e) + \phi_e + \xi_{u,i}. \tag{18}$$

while the cost to firms from countries e and g of issuing in country u currency is

$$r_{e,u,i} = r^* + c(V_u) + \phi_u + \xi_{e,i}, \tag{19}$$

and

$$r_{g,u,i} = r^* + c(V_u) + \phi_u + \xi_{g,i}. \tag{20}$$

We again define $\xi^*_{j,i}$ $(j = u, g, e)$ as the realization of $\xi_{j,i}$ that leaves a firm from country j indifferent between issuing in domestic and foreign currencies. From the above,

$$\xi^*_{u,i} = c(V_u) - c(V_g + \eta V_e) - \phi_e. \tag{21}$$

Finally, we assume that firms from country g or country e issuing in foreign currency prefer to issue in currency u prior to the formation of the union. This requires that country u administrative costs are not prohibitively expensive relative to those of country e, so that $c(V_u) + \phi_u \leq c(V_e) + \phi_e$. Given this restriction, $\xi^*_{e,i}$ satisfies

$$\xi^*_{e,i} = c(V_e + \eta V_g) - c(V_u) - \phi_u, \tag{22}$$

while $\xi^*_{g,i}$ satisfies

$$\xi^*_{g,i} = c(V_g + \eta V_e) - c(V_u) - \phi_u. \tag{23}$$

The aggregate volumes of debt issues in each currency satisfy

$$V_u - [1 - F(\xi^*_{u,i})]U - F(\xi^*_{e,i})E - F(\xi^*_{g,i})G = 0, \tag{24}$$

$$V_g - [1 - F(\xi^*_{g,i})]G - \eta[1 - F(\xi^*_{e,i})]E - F(\xi^*_{u,i})U = 0, \tag{25}$$

and

$$V_e - [1 - F(\xi^*_{e,i})][1 + \eta(m-1)]E - \eta[[1 - F(\xi^*_{g,i})]G - F(\xi^*_{u,i})U] = 0. \tag{26}$$

Equations (24), (25), and (26) then comprise a system of three equations in three unknowns, V_u, V_g and V_e, that give the equilibrium volume of issuance in each market. In Appendix 2 we solve for the determinant of the system and derive the comparative statics of the model, leading to the following Proposition

Proposition 4 *Formation of the monetary union leads to an increase in the volume of issues denominated in the currency of the union member countries, g and e, and a decrease in the volume of issues denominated in currency u. Moreover, the increase in issuance in country e currency exceeds that of country g.*

6.2 Effect of the pre-EMU market size

We next test the theoretical prediction presented above that domestic currency issuance levels in future EMU countries with larger pre-union bond markets are likely to be less affected by the launch of the union than countries that had smaller bond markets. We use data from the same source and again exclude from our sample bond issues that have market type labeled as "Domestic," so we are

studying the effect of the size of the international bond market in a given currency.[13] We measure the market size relative to that of the future euro area as the share of the amount of bonds issued in that currency in 1991-98 (all in dollars and deflated by US CPI) in the total amount of bonds issued in currencies that comprised the euro in 1999.[14]

Figure 2 shows the total amounts of debt securities outstanding issued by non-financial firms in the EMU-member countries in international and domestic bond markets based on BIS data. Both markets were of roughly equal size throughout our sample period, with the relative importance of international issuance gradually increasing in the first half, reflecting globalization. What matters for our analysis is that the relative importance of international and domestic bond issuance by firms from the euro area did not experience a structural change at the time the euro was introduced.

The bottom panel of Table A.3 presents the number and the volume of international issuance by each of the euro area countries before and after EMU as reported in Bondware. We can see that in both periods the total *amount* borrowed by euro area issuers is roughly comparable to that issued by firms in outsider countries, while the *number* of bonds issued by euro area firms is more than double that of the outsider firms. This implies that an average issue by a euro area firm is smaller than that of firms in the outsider countries. Figure 3 shows that for both financial and non-financial euro area issuers the share of international bond issues in euro was already greater than 50 percent before the EMU. However, issuance in euro increased substantially after unification, with the nonfinancial firm increase being larger.

We repeat our previous multinomial logit analysis for the EMU insiders, allowing the EMU effect to vary with the size of the pre-EMU market. The results for non-financial firms are reported in Table 3 — we report the coefficients on the indicator that the bond is issued after the introduction

[13] We do this because domestic issuance is incomplete in Bondware.

[14] Specifically, the shares are as follows: Germany 32.3%, France 23.2%, Netherlands 12.8%, Italy 12.5%, Luxembourg 9.0%, Ireland 4.2%, Finland 3.9%, Spain 1.2%, Portugal 0.7%, Belgium 0.2%, and Austria 0.1%. As a robustness test, we estimated the same model with the size measured as the average share of a country's GDP in total euro area GDP from 1991 to 1998. We found that the results remained the same qualitatively.

of the euro and on the interaction of this coefficient with the size variable. We confirm that the effect of the EMU was smaller for larger countries, as indicated by the negative estimated coefficient on the interaction term. The main effect should not be interpreted in isolation, as it corresponds to the EMU effect for a country of size zero. Therefore, we report the cut-off size, as a percentage of total size of the euro area market, below which our F-tests indicate that the effect of the EMU was statistically significant. A missing value indicates that the total effect is never significant for the range of the country size between 0 and 1.

We find that the effect of the EMU on the full sample of non-financial firms from the euro area was statistically significant for firms from all countries except Germany and France, since these two countries' currencies each comprised more than cut-off value, 23 percent, of the euro area bond market. When we limit the sample to only first international bond issues we estimate that the effect of the EMU on the probability of denominating bonds in dollars was significant for new nonfinancial issuers from countries other than Germany, France, Netherlands, and Italy. However, the probability of issuing in euro increased significantly for firms from all countries, except Germany.

We do not report similar analysis for financial firms, because neither the main effect nor its interaction with country size have statistically significant coefficients.[15]

7 Conclusion

In this paper we use micro–level data to analyze the impact that the launch of the EMU had on the currency denomination of international bond issues. While the increase in bond issuance in the currencies of the euro area after the launch of the EMU has been documented at the aggregate level, to our knowledge ours is the first systematic analysis of this issue at the micro level.

[15]Moreover, their sums are not statistically significant for any level of country size. These results are available upon request.

Micro–level analysis allowed us to study separately financial and non–financial firms and to determine the relative importance of the channels through which this increase took place. We find that the bulk of the increase occurred among non–financial firms, and do not even find a significant "euro effect" among financial firms. This suggests that financial firms, which are quite adept at hedging currency risk and conducting international transactions, were closer to their optimal exposure to euro area currencies prior to the launch of the EMU, and did not increase that exposure markedly afterwards. In contrast, we find a substantial statistically significant euro effect for our sample of non–financial firms.

We then examine the channels through which this increase in euro denomination by non–financial firms took place. We find that the increase in the issuance of euro–denominated bonds by non–financial firms was mainly driven by a large increase in the propensity of new entrants to the international bond market to denominate their first bond issues in euro, and by the increase in the number of firms that continued issuing in euro once they entered that market. We do not find significant evidence of an increase in share of euro issuance by firms that were already active issuers in the currencies of future EMU members before the launch of the EMU.

Using a multinomial logit specification, we also find that most of the increase in euro issuance was at the expense of dollar issuance. Taken together, these findings suggest that we might expect the launch of the euro to accelerate the decline in the share of dollar–denominated issues in international bond markets: First, the bulk of the increase in euro–denominated bond issues occurred through an increase in euro-denominated issuance by new issuers, and we would expect the decisions made by these new issuers to become more representative going forward, as characteristics tying firms to individual currencies are likely to weaken over time. Second, the increase in euro–denominated issues came largely at the expense of the dollar.

It therefore appears that on average firms that are issuing in dollars are less tied to that currency than are firms issuing in other currencies, such as yen or pounds. This would be intuitive,

since the dominant position of the dollar would likely leave it the currency denomination of choice for firms that had little preference over currency denominations. However, as the market for bonds denominated in euro continues to grow, these more footloose firms will be the most likely to respond to the increased liquidity in euro–denominated bond markets by switching to issuing in that currency. Since these firms are most likely to be initially issuing in dollars, these increases are likely to come at the expense of the share of dollar–denominated issues, and may portend further declines in the share of dollar-denominated issues in this market.

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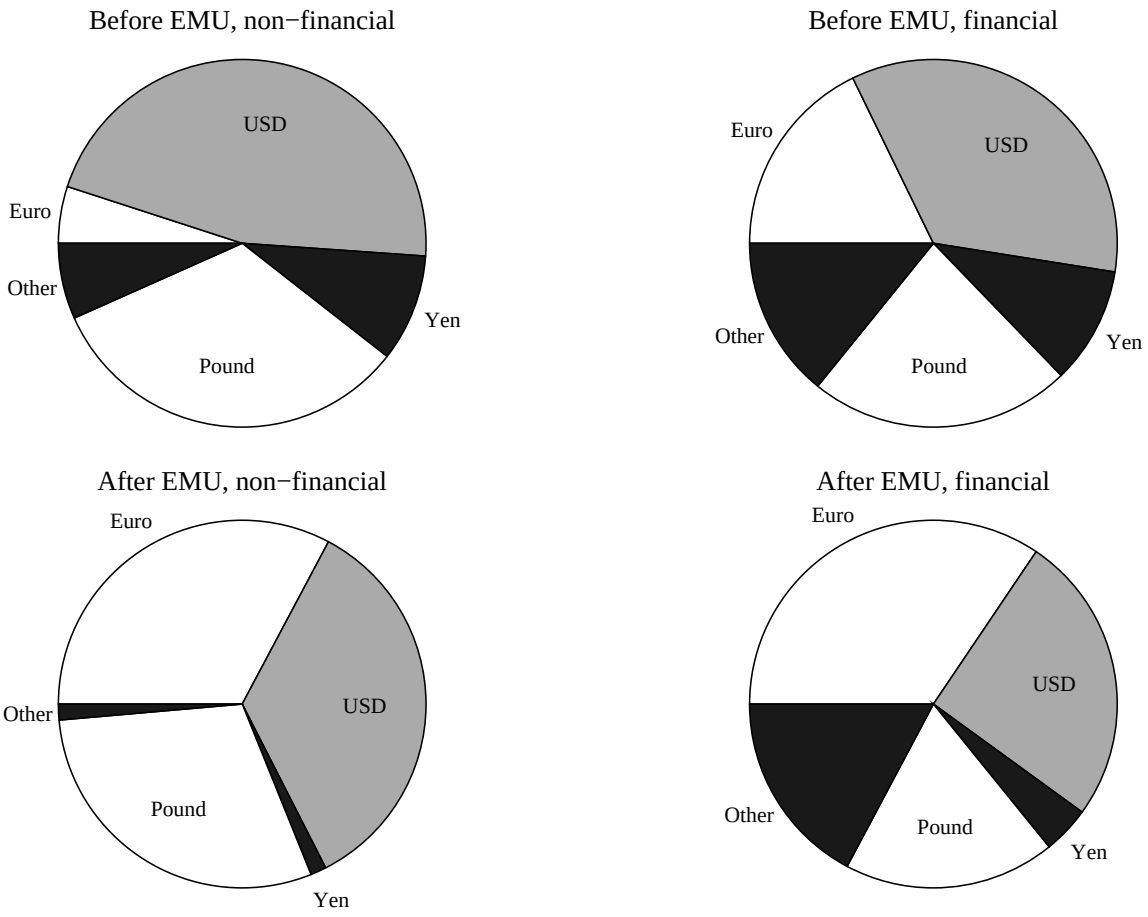
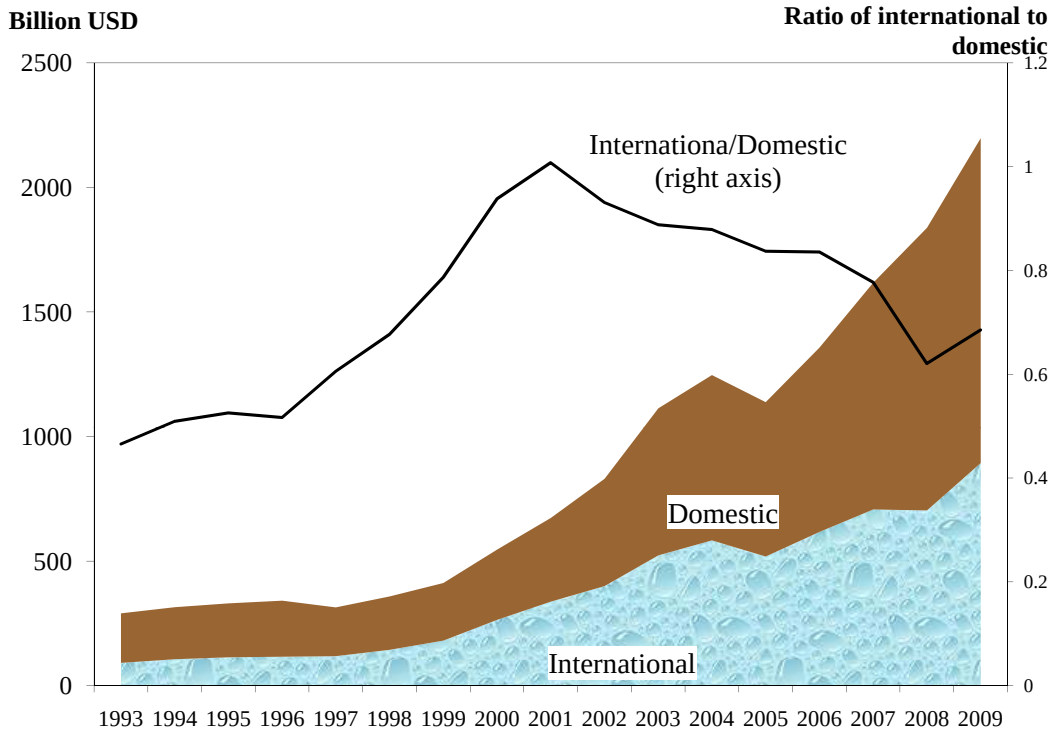
Figure 1: Currency denomination of international bond issues. Outsider issuers.



Note: pie charts constructed by amount issued. Outsider countries include Australia, Canada, Denmark, Japan, New Zealand, Norway, Sweden, Switzerland, UK.

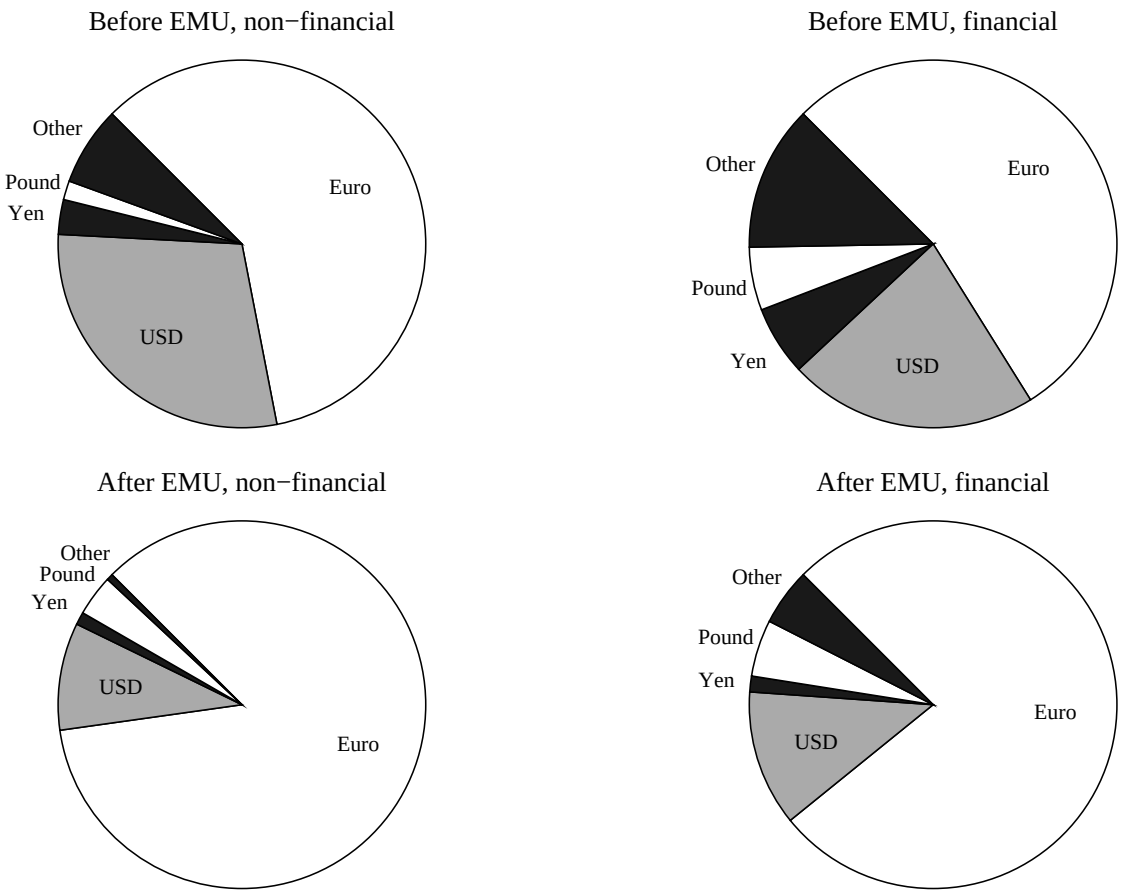
Figure 2: Domestic and foreign debt securities of corporates outstanding in the Euro area.



Source: BIS, Quarterly Review, series 12C - amounts outstanding, 16B - corporate amounts outstanding.

Note: Amounts outstanding. Corporate issuers. Nominal USD. BIS quarterly report series 12C and 16B.

Figure 3: Currency denomination of international bond issues. Euro area issuers.



Note: pie charts constructed by amount issued. Excluding Greece.

Table 1: The effect of the EMU on international bond issuance by firms from outsider countries

Currency:	USD	Euro	Other cur.	N.obs.
All firms				
Non-financial	-13.1***	17.3***	-4.14	4810
	(4.37)	(1.95)	(3.74)	
Financial	-3.13	-1.70	4.82	9682
	(4.25)	(1.59)	(4.74)	
First-time issuers				
Non-financial	-22.1	31.3***	-9.18	2715
	(14.2)	(5.93)	(8.77)	
Financial	2.17	-1.89	-0.28	326
	(3.42)	(5.51)	(7.03)	
Firms that issued before and after EMU				
Non-financial	-10.2***	-1.12	11.3**	1217
	(3.63)	(1.80)	(5.04)	
Financial	-1.20	-0.80	2.00	6825
	(4.56)	(2.79)	(6.71)	

Note: Reported are marginal effects of "After EMU" indicator in multinomial logit regressions (percentage points). Dependent variable is currency of bond issue, base category is "other currency." Full regressions are reported in Appendix Tables A.3 through A.8. Standard errors of marginal effects are in parenthesis. Marginal effects might not add up to 0 across outcomes due to rounding. Significance levels are based on z-statistic's P-value: * is significant at 10%, ** — at 5%, *** — at 1%.

Table 2: The effect of the EMU on the share of euro–denominated international bond issues (by real amount) by nonfinancial firms from outsider countries

	All firms	First issues	Firms BA[a]	Firms EuroBA[b]
I(After EMU)	0.259***	0.189*	0.137*	-0.002
	(0.069)	(0.097)	(0.076)	(0.159)
USD int. rate	0.014	-0.020	0.041	-0.054
	(0.025)	(0.036)	(0.029)	(0.059)
DM-USD int. rate	0.006	-0.015	-0.018	-0.054
	(0.033)	(0.044)	(0.037)	(0.072)
JY-USD int. rate	0.008	-0.008	0.051	-0.017
	(0.040)	(0.057)	(0.046)	(0.087)
BP-USD int. rate	0.025	0.022	-0.031	-0.035
	(0.031)	(0.047)	(0.035)	(0.065)
Inflation	-0.033	0.006	-0.001	0.031
	(0.020)	(0.027)	(0.023)	(0.051)
II rating	1.542**	1.279	2.097***	1.399
	(0.590)	(0.825)	(0.688)	(1.599)
ER volatility	-0.014	-0.007	-0.002	0.122
	(0.038)	(0.047)	(0.039)	(0.085)
Selection	-1.004	1.261	-6.842**	-2.966
	(1.031)	(1.552)	(2.957)	(4.882)
Observations	125	98	104	70
Countries	9	9	8	7
R^2	0.426	0.254	0.388	0.294

[a] Firms BA: firms that issued bonds both before and after EMU.

[b] Firms EuroBA: firms that issued bonds in a currency of the euro area both before and after EMU.

Note: Dependant variable is the share of issues (by amount) denominated in a currency of the euro area, aggregated across a sample of firms, as indicated, at country-year level.

Fixed effects regression. Non-financial firms only. Standard errors are in parenthesis.

Table 3: The effect of the EMU on international bond issuance by firms from the Euro area depending on their currency market size before EMU

Currency:	USD	Euro	Other cur.	N.obs
Non–financial firms				
All issues				
I(After EMU)	-22.3**	34.6***	-12.3	3765
	(10.5)	(10.1)	(8.19)	
Size*I(After EMU)	15.1*	-33.6	18.5	
	(7.94)	(22.2)	(18.9)	
Max. size	0.23	0.23	·	
First issues only				
I(After EMU)	-55.9***	55.5***	0.39	2179
	(21.3)	(21.0)	(1.08)	
Size*I(After EMU)	26.7***	-17.6*	-9.04	
	(7.34)	(10.5)	(9.35)	
Max. size	0.11	0.27	·	
Only firms that issued before and after EMU				
I(After EMU)	-3.18	12.6	-9.39	951
	(6.21)	(16.8)	(14.8)	
Size*I(After EMU)	-22.3	-26.2	48.5	
	(15.2)	(60.4)	(59.7)	
Max. size	·	·	·	

Note: Reported are marginal effects of "After EMU" indicator and its interaction with Size in multinomial logit regressions (percentage points), β_1 and β_2, respectively. Size is the share of country's currency issues between 1991 and 1998 in the total issuance in euro area currencies. Dependent variable is currency of bond issue, base category is "other currency." Full regressions are reported in Appendix Tables A.3, A.5, and A.7 (last columns). Regressions are also reported for financial firms in Appendix Tables A.4, A.6, and A.8. Standard errors of marginal effects are in parenthesis. Max. size indicates the maximum value of Size for which the probability that $\beta_1 + \text{Size} * \beta_2 = 0$ is less than 10%. · indicates that such value does not exist. Marginal effects might not add up to 0 across outcomes due to rounding. Significance levels are based on z-statistic's P-value: * is significant at 10%, ** — at 5%, *** — at 1%.

A Appendix

A.1 Additional Tables

Table A.1: 1st stage results

	Coefficient	Std. error
GDP (in U.S. dollars)	0.006***	0.001
CA/GDP	-0.009**	0.004
Financial account openness	0.075***	0.028
II credit rating	0.043***	0.003
Coef. of variation of exports	-14.877***	5.539
Interest rate	-0.0003**	0.0001
1-year U.S. Treasure rate	-0.028	0.034
ER regime: hard or crawling peg	0.109	0.471
ER regime: crawling peg	-0.204**	0.092
ER regime: crawling peg or band	-0.345	0.480
ER regime: crawling band	-0.004	0.110
ER regime: free float	0.169	0.197
ER regime: free fall	-0.061	0.162
ER regime: dual market	0.052	0.340
Pseudo-R^2: 0.57; Num. obs.: 2361; Num. countries: 139; Log Likelihood: -695.6		

Probit regression. Panel of country–year observations.
Dependent variable: I(Number of foreign bond issues > 0.
Exchange rate regime: hard peg is an omitted category.
Year fixed effects for 1981-2006 omitted.

Table A.2: Bondware data coverage for corporate issuers

Year	Bondware International New Issues	BIS international Outstanding 12C	BIS domestic Outstanding 16B - corporate
non-financial firms			
1990	16		415
1991	27		447
1992	25		455
1993	29	337	526
1994	17	338	608
1995	17	323	656
1996	36	295	650
1997	53	266	618
1998	124	288	769
1999	100	318	892
2000	136	330	838
2001	187	330	797
2002	254	365	881
2003	374	411	999
2004	588	449	1039
2005	795	431	936
2006	2426	492	923
financial firms			
1990	16	309	1636
1991	14	330	1786
1992	18	313	1814
1993	27	348	2018
1994	31	396	2291
1995	25	434	2377
1996	41	515	2340
1997	44	593	2172
1998	49	679	2275
1999	67	841	2546
2000	78	923	2273
2001	67	997	2046
2002	79	1215	2144
2003	134	1651	2464
2004	168	2170	2709
2005	181	2415	2546
2006	227	3196	2792

Sum over countries listed as "Outsiders" in Table A.3. In billion nominal U.S. dollars. Source: Bondware, BIS Quarterly Report, author's calculations.

Table A.3: International bond issues by country of issuer

	Number of issues			Volume of issues (bil. USD)		
	Before EMU	After EMU	Total	Before EMU	After EMU	Total
Outsiders	3841	11358	15199	617.9	5868.9	6486.8
Australia	331	1920	2251	36.9	262.8	299.8
Canada	359	753	1112	67.2	207.9	275.1
Denmark	197	397	594	13.5	75.7	89.2
Japan	1068	676	1744	93.9	121.1	214.9
New Zealand	22	92	114	2.0	18.5	20.5
Norway	149	1726	1875	17.9	77.7	95.6
Sweden	106	337	443	7.2	19.7	26.9
Switzerland	216	294	510	63.0	96.5	159.4
UK	1393	5163	6556	316.3	4989.0	5305.4
EMU	5655	16339	21994	837.6	5557.0	6394.5
Austria	139	653	792	14.8	89.7	104.6
Belgium	380	684	1064	21.9	150.1	172.1
Finland	157	34	191	17.8	10.0	27.8
France	1282	3952	5234	200.2	1089.0	1289.2
Germany	1770	4860	6630	337.7	1764.8	2102.4
Greece	12	221	233	1.3	74.3	75.6
Ireland	112	1259	1371	16.8	283.8	300.6
Italy	191	1156	1347	31.3	587.5	618.8
Luxembourg	634	1126	1760	31.9	62.4	94.3
Netherlands	814	1417	2231	132.6	735.1	867.7
Spain	164	977	1141	31.3	710.3	741.5

Table A.4: Multinomial logit regression for non-financial firms. All issues.

	Outsider countries		Euro area			
Currency	USD	Euro	USD	Euro	USD	Euro
After EMU	-0.593**	0.955***	-0.726	1.177**	-0.842	1.740**
	(0.230)	(0.157)	(0.469)	(0.460)	(0.816)	(0.679)
Size					-1.329	-5.026
					(7.534)	(5.177)
Size*I(After EMU)					0.426	-3.443
					(3.109)	(3.459)
Issue amount	0.311***	0.105***	0.540**	0.560**	0.541**	0.565**
	(0.029)	(0.017)	(0.261)	(0.279)	(0.263)	(0.281)
I(bond rating	0.053	0.922*	0.746	1.425	0.743	1.427
is below IG)	(0.628)	(0.510)	(0.762)	(1.018)	(0.762)	(1.018)
Issue maturity	-0.016	-0.004	-0.016	0.034*	-0.016	0.034*
	(0.013)	(0.011)	(0.020)	(0.019)	(0.019)	(0.019)
Euro Area issue	-12.709***	4.766***	1.551	3.220***	1.547	3.202***
	(0.934)	(0.745)	(1.003)	(0.570)	(0.988)	(0.540)
U.S. gov. law	2.139***	0.651*	4.013***	1.474***	4.004***	1.474***
	(0.615)	(0.376)	(0.766)	(0.470)	(0.757)	(0.469)
U.K. gov. law	-0.054	0.035	0.970*	0.576**	0.961*	0.587**
	(0.516)	(0.376)	(0.553)	(0.237)	(0.535)	(0.238)
Germany govt. law	12.338***	-1.822	-0.447	-1.439**	-0.448	-1.416**
	(0.623)	(1.462)	(0.555)	(0.584)	(0.552)	(0.566)
USD int. rate	-0.156***	-0.089	-0.183	-0.099	-0.189	-0.105
	(0.055)	(0.058)	(0.206)	(0.156)	(0.204)	(0.156)
DM-USD int. rate	0.043	-0.022	-0.170	-0.315***	-0.172	-0.309***
	(0.038)	(0.078)	(0.136)	(0.111)	(0.137)	(0.109)
JY-USD int. rate	-0.073	-0.019	0.082	0.252	0.075	0.240
	(0.072)	(0.113)	(0.197)	(0.218)	(0.191)	(0.214)
BP-USD int. rate	-0.083	-0.027	-0.217	0.027	-0.216	0.026
	(0.067)	(0.059)	(0.185)	(0.173)	(0.185)	(0.171)
Selection	20.770*	-0.321	11.382	9.760	11.338	9.284
	(12.276)	(7.670)	(11.959)	(8.921)	(11.300)	(7.741)
CPI Inflation	-0.026	0.156*	0.036	0.021	0.040	0.025
	(0.074)	(0.082)	(0.246)	(0.137)	(0.248)	(0.139)
II rating	4.053**	13.256***	0.913	-0.487	1.332	-2.340
	(1.691)	(4.920)	(9.622)	(7.424)	(9.494)	(6.408)
ER volatility	-0.010	-0.015	0.019***	-0.007	0.018***	-0.007
	(0.031)	(0.019)	(0.007)	(0.005)	(0.007)	(0.005)
I(Fixed ER)	-0.755**	-0.919***	-0.024	-1.013**	-0.036	-0.442
	(0.367)	(0.318)	(0.325)	(0.482)	(0.558)	(0.802)

Table A.5: Multinomial logit regression for financial firms. All issues

	Outsider countries		Euro area			
Currency	USD	Euro	USD	Euro	USD	Euro
After EMU	-0.195	-0.235	0.251	0.221	0.026	-0.032
	(0.229)	(0.194)	(0.228)	(0.211)	(0.368)	(0.362)
Size					-5.284*	-14.904***
					(3.009)	(2.859)
Size*I(After EMU)					1.483	1.715
					(2.618)	(1.938)
Issue amount	0.584	1.368*	2.841***	4.002***	2.859***	4.021***
	(0.609)	(0.813)	(0.501)	(0.384)	(0.501)	(0.382)
I(bond rating	1.343	4.000***	-0.887***	15.714***	-0.885***	15.716***
is below IG)	(0.853)	(0.619)	(0.328)	(0.761)	(0.332)	(0.757)
Issue maturity	-0.048**	-0.079***	-0.048***	-0.038***	-0.048***	-0.039***
	(0.023)	(0.023)	(0.011)	(0.010)	(0.011)	(0.010)
Euro Area issue	-1.125	2.772***	1.748***	2.274***	1.745***	2.267***
	(1.111)	(0.952)	(0.453)	(0.389)	(0.453)	(0.392)
U.S. gov. law	0.441	-0.444	2.162***	-1.703***	2.159***	-1.707***
	(0.337)	(0.492)	(0.349)	(0.498)	(0.349)	(0.501)
U.K. gov. law	0.285	0.237	1.223***	0.699*	1.225***	0.700*
	(0.191)	(0.368)	(0.394)	(0.399)	(0.396)	(0.398)
Germany govt. law	0.380	-0.088	-0.548**	-0.684**	-0.542**	-0.671**
	(1.869)	(1.052)	(0.230)	(0.330)	(0.227)	(0.335)
USD int. rate	0.140	0.129**	-0.045	0.289***	-0.037	0.299***
	(0.124)	(0.065)	(0.102)	(0.050)	(0.102)	(0.047)
DM-USD int. rate	-0.271***	-0.298***	-0.497***	-0.239***	-0.496***	-0.237***
	(0.099)	(0.111)	(0.137)	(0.069)	(0.138)	(0.071)
JY-USD int. rate	0.184	0.202	0.397***	0.387***	0.406***	0.398***
	(0.135)	(0.132)	(0.125)	(0.052)	(0.113)	(0.055)
BP-USD int. rate	0.234***	0.199***	0.264***	0.138***	0.263***	0.135***
	(0.070)	(0.060)	(0.096)	(0.039)	(0.095)	(0.040)
Selection	8.137	5.503	0.974	-1.660	1.057	-1.398
	(4.978)	(5.842)	(5.228)	(4.094)	(5.022)	(3.869)
CPI Inflation	0.022	0.005	0.306***	-0.047	0.305***	-0.051
	(0.103)	(0.099)	(0.077)	(0.093)	(0.076)	(0.093)
II rating	8.066**	10.787***	3.106	0.660	3.840	1.500
	(3.240)	(2.206)	(6.240)	(3.376)	(5.277)	(3.118)
ER volatility	-0.063*	0.173***	0.021***	0.020***	0.021***	0.020***
	(0.034)	(0.019)	(0.002)	(0.003)	(0.003)	(0.003)
I(Fixed ER)	-1.204***	0.514**	0.306**	0.938***	0.049	0.630*
	(0.328)	(0.244)	(0.155)	(0.218)	(0.498)	(0.378)

Table A.6: Multinomial logit regression for non-financial firms. First issues.

	Outsider countries		Euro area			
Currency	USD	Euro	USD	Euro	USD	Euro
After EMU	-0.681	1.285***	-0.927	1.433	-4.210**	0.357
	(0.643)	(0.169)	(1.238)	(1.016)	(1.929)	(1.565)
Size					-45.616**	-30.149**
					(20.290)	(15.326)
Size*I(After EMU)					22.011*	8.485
					(12.502)	(9.838)
Issue amount	0.297***	0.056***	0.231	0.259	0.216	0.258
	(0.012)	(0.018)	(0.385)	(0.362)	(0.384)	(0.362)
I(bond rating	-0.410	0.376	-0.668	0.233	-0.764	0.229
is below IG)	(0.451)	(0.522)	(0.927)	(0.939)	(0.985)	(0.937)
Issue maturity	-0.018**	-0.008	-0.068**	-0.013	-0.070**	-0.014
	(0.007)	(0.008)	(0.033)	(0.011)	(0.033)	(0.011)
Euro Area issue	1.078*	17.666***	1.032	2.510***	1.089	2.539***
	(0.568)	(0.806)	(1.364)	(0.679)	(1.432)	(0.690)
U.S. gov. law	3.025***	1.422***	5.358***	2.409*	5.413***	2.423*
	(0.489)	(0.494)	(1.874)	(1.389)	(1.884)	(1.377)
U.K. gov. law	0.042	-0.034	0.231	0.067	0.188	0.057
	(0.866)	(0.772)	(0.824)	(0.376)	(0.810)	(0.383)
Germany govt. law	-1.083*	-14.346***	1.397	0.155	1.383	0.156
	(0.599)	(2.263)	(1.014)	(0.649)	(1.042)	(0.665)
USD int. rate	-0.397***	-0.364***	0.359	0.179	0.357	0.179
	(0.151)	(0.072)	(0.614)	(0.538)	(0.556)	(0.495)
DM-USD int. rate	0.320***	0.204	-0.880*	-0.600	-1.001*	-0.646
	(0.066)	(0.154)	(0.504)	(0.453)	(0.526)	(0.477)
JY-USD int. rate	-0.400**	-0.425***	1.378*	0.955	1.440*	0.994
	(0.166)	(0.073)	(0.812)	(0.803)	(0.771)	(0.778)
BP-USD int. rate	-0.279**	-0.100**	-0.573*	-0.335	-0.499	-0.320
	(0.136)	(0.039)	(0.321)	(0.337)	(0.318)	(0.336)
Selection	12.057	2.813	55.535**	38.810*	61.732**	43.623*
	(14.087)	(6.515)	(22.780)	(21.807)	(26.068)	(25.323)
CPI Inflation	0.166	0.268***	-0.263	-0.265	-0.227	-0.261
	(0.109)	(0.052)	(0.401)	(0.302)	(0.416)	(0.297)
II rating	0.115	19.306***	21.235	10.093	30.579*	13.316
	(6.243)	(3.644)	(14.944)	(10.074)	(18.393)	(11.779)
ER volatility	0.117	-0.048	0.014*	-0.007*	0.014**	-0.007
	(0.104)	(0.042)	(0.008)	(0.004)	(0.006)	(0.004)
I(Fixed ER)	-1.653	-1.531***	-1.363	-1.712**	-5.165**	-3.418*
	(1.199)	(0.434)	(0.898)	(0.736)	(2.420)	(2.009)

Table A.7: Multinomial logit regression for financial firms. First issues.

	Outsider countries		Euro area			
Currency	USD	Euro	USD	Euro	USD	Euro
After EMU	0.174	-0.157	0.812	1.932**	0.587	2.354*
	(0.342)	(0.570)	(0.720)	(0.813)	(1.445)	(1.247)
Size					-5.574	-15.199
					(10.529)	(12.877)
Size*I(After EMU)					1.885	-3.069
					(6.182)	(3.274)
Issue amount	0.661	1.751**	6.351***	6.111**	6.337***	6.080***
	(1.316)	(0.680)	(2.252)	(2.385)	(2.205)	(2.334)
I(bond rating	-13.975***	3.803*	-2.286**	12.962***	-2.250**	12.316***
is below IG)	(1.853)	(2.275)	(1.056)	(1.128)	(1.050)	(1.125)
Issue maturity	-0.082***	-0.038	-0.052**	-0.002	-0.053**	-0.002
	(0.013)	(0.023)	(0.024)	(0.021)	(0.025)	(0.022)
Euro Area issue	-13.326***	5.483***	1.793	4.170***	1.808	4.228***
	(2.164)	(0.968)	(1.866)	(1.116)	(1.878)	(1.080)
U.S. gov. law	1.771	-3.016	4.536***	0.753	4.533***	0.801
	(1.425)	(2.298)	(1.465)	(1.002)	(1.442)	(0.988)
U.K. gov. law	0.429	0.284	2.702**	1.056	2.681**	1.079
	(0.865)	(0.460)	(1.305)	(0.816)	(1.304)	(0.804)
Germany govt. law	12.269***	-2.156*	1.337	-1.361*	1.286	-1.387*
	(2.509)	(1.107)	(0.889)	(0.766)	(0.896)	(0.751)
USD int. rate	-0.115	-0.472	0.750**	0.504	0.768**	0.482
	(0.405)	(0.320)	(0.382)	(0.460)	(0.333)	(0.451)
DM-USD int. rate	-0.612***	0.316	-0.778	-0.933*	-0.776	-0.934*
	(0.209)	(0.430)	(0.509)	(0.514)	(0.502)	(0.504)
JY-USD int. rate	0.415	-0.458	1.305*	1.257*	1.322**	1.223*
	(0.315)	(0.540)	(0.700)	(0.697)	(0.656)	(0.670)
BP-USD int. rate	0.149	-0.181	0.418	0.331	0.407	0.346
	(0.204)	(0.404)	(0.299)	(0.383)	(0.313)	(0.374)
Selection	-4.667**	1.729	42.688	14.889	46.102	11.793
	(2.284)	(8.489)	(31.855)	(29.310)	(35.022)	(28.789)
CPI Inflation	0.371*	0.343	0.109	0.391	0.099	0.393
	(0.198)	(0.271)	(0.318)	(0.315)	(0.314)	(0.310)
II rating	-13.443***	17.362**	-2.913	8.414	-2.204	6.396
	(2.900)	(7.688)	(13.067)	(11.714)	(11.154)	(12.959)
ER volatility	0.022	0.114	0.037***	0.050***	0.036***	0.049***
	(0.069)	(0.089)	(0.012)	(0.014)	(0.013)	(0.015)
I(Fixed ER)	1.002***	-1.414**	-0.523	-0.396	-0.900	0.199
	(0.320)	(0.575)	(0.471)	(0.464)	(1.239)	(0.551)

Table A.8: Multinomial logits for nonfinancial firms. Seasoned issuers.

	Outsider countries		Euro area			
Currency	USD	Euro	USD	Euro	USD	Euro
After EMU	-0.750***	-0.303	-1.224***	0.111	-0.090	0.556
	(0.261)	(0.301)	(0.360)	(0.396)	(0.859)	(0.780)
Size					19.916	-19.428***
					(12.924)	(3.811)
Size*I(After EMU)					-5.775	-2.476
					(3.808)	(3.466)
Issue amount	1.610	1.643	0.267	0.306	0.264	0.305
	(1.603)	(1.556)	(0.218)	(0.227)	(0.220)	(0.226)
I(bond rating	1.934**	2.958***	1.619*	14.490***	1.517	14.456***
is below IG)	(0.892)	(0.439)	(0.861)	(1.393)	(0.943)	(1.415)
Issue maturity	-0.087**	-0.146***	-0.014	-0.006	-0.014	-0.006
	(0.042)	(0.042)	(0.009)	(0.015)	(0.009)	(0.015)
Euro Area issue	-15.155***	4.917***	2.593***	4.323***	2.625***	4.306***
	(1.258)	(0.957)	(0.461)	(0.461)	(0.418)	(0.433)
U.S. gov. law	3.840***	2.066*	5.404***	2.324***	5.591***	2.343***
	(0.909)	(1.149)	(0.937)	(0.564)	(1.051)	(0.583)
U.K. gov. law	2.023***	2.340***	2.784***	2.178***	2.920***	2.201***
	(0.701)	(0.891)	(0.580)	(0.486)	(0.680)	(0.503)
Germany govt. law	16.318***	-1.586	1.266	-0.666	1.373	-0.641
	(1.067)	(1.024)	(1.176)	(0.611)	(1.213)	(0.603)
USD int. rate	0.169	0.173**	-0.080	0.033	-0.116	0.014
	(0.135)	(0.075)	(0.432)	(0.210)	(0.400)	(0.180)
DM-USD int. rate	-0.201	-0.298	-0.001	-0.500***	0.041	-0.489***
	(0.175)	(0.219)	(0.232)	(0.124)	(0.211)	(0.113)
JY-USD int. rate	0.300	0.365**	0.148	0.675*	0.080	0.647*
	(0.189)	(0.174)	(0.636)	(0.380)	(0.593)	(0.344)
BP-USD int. rate	0.022	-0.076	-0.358***	-0.039	-0.356***	-0.038
	(0.103)	(0.278)	(0.113)	(0.162)	(0.117)	(0.162)
Selection	21.628	-3.084	72.861	-36.444	90.331**	-30.075
	(35.016)	(18.341)	(45.249)	(22.172)	(43.951)	(20.077)
CPI Inflation	-0.190***	0.006	-0.273***	0.011	-0.281***	0.012
	(0.065)	(0.061)	(0.072)	(0.119)	(0.082)	(0.119)
II rating	5.663	16.204**	-10.597	6.294	-14.663	4.975
	(5.203)	(6.460)	(16.402)	(7.008)	(14.347)	(5.301)
ER volatility	-0.094***	0.193***	0.126***	0.005	0.121***	0.004
	(0.015)	(0.026)	(0.010)	(0.006)	(0.004)	(0.006)
I(Fixed ER)	-0.224	-2.513***	0.548**	-0.620*	1.282*	-0.260
	(0.408)	(0.442)	(0.230)	(0.365)	(0.674)	(0.684)

Table A.9: Multinomial logits for financial firms. Seasoned issuers

	Outsider countries		Euro area			
Currency	USD	Euro	USD	Euro	USD	Euro
After EMU	-0.076	-0.115	0.369	0.008	-0.310	-0.458
	(0.268)	(0.383)	(0.273)	(0.273)	(0.345)	(0.423)
Size					-10.976*	-9.503*
					(6.011)	(5.183)
Size*I(After EMU)					4.541*	3.444
					(2.583)	(2.169)
Issue amount	2.124***	3.016***	3.832***	4.556***	3.879***	4.597***
	(0.540)	(0.775)	(0.269)	(0.350)	(0.263)	(0.367)
I(bond rating	-18.700***	3.531***	0.378*	12.621***	0.381*	11.873***
is below IG)	(0.835)	(1.090)	(0.216)	(1.083)	(0.211)	(1.088)
Issue maturity	-0.041	-0.091***	-0.083***	-0.042**	-0.083***	-0.042**
	(0.029)	(0.020)	(0.020)	(0.018)	(0.020)	(0.018)
Euro Area issue	-0.951	1.981**	2.484***	3.312***	2.455***	3.287***
	(1.172)	(0.876)	(0.784)	(0.506)	(0.783)	(0.507)
U.S. gov. law	0.260	-0.261	2.260***	-0.842***	2.246***	-0.849***
	(0.480)	(0.192)	(0.518)	(0.315)	(0.516)	(0.327)
U.K. gov. law	0.269	0.336	1.469**	1.525***	1.469**	1.521***
	(0.291)	(0.450)	(0.654)	(0.559)	(0.659)	(0.564)
Germany govt. law	0.341	0.804	-1.264***	-0.894	-1.236***	-0.864
	(1.909)	(0.929)	(0.393)	(0.663)	(0.391)	(0.665)
USD int. rate	0.233*	0.185*	-0.208*	0.110	-0.183	0.126
	(0.133)	(0.097)	(0.123)	(0.102)	(0.122)	(0.084)
DM-USD int. rate	-0.309***	-0.382**	-0.486**	-0.054	-0.485**	-0.051
	(0.118)	(0.156)	(0.223)	(0.105)	(0.224)	(0.106)
JY-USD int. rate	0.255	0.330	0.270	0.143	0.302	0.165
	(0.158)	(0.202)	(0.223)	(0.168)	(0.205)	(0.152)
BP-USD int. rate	0.261***	0.248***	0.328***	0.025	0.314***	0.013
	(0.058)	(0.071)	(0.114)	(0.064)	(0.112)	(0.068)
Selection	13.868	15.174	6.051	-2.997	5.398	-2.868
	(11.395)	(11.175)	(4.838)	(3.590)	(5.410)	(3.117)
CPI Inflation	-0.025	-0.025	0.330***	-0.113	0.326***	-0.119
	(0.131)	(0.116)	(0.121)	(0.078)	(0.125)	(0.075)
II rating	9.048***	11.091***	3.817	-3.301	5.659	-2.163
	(3.296)	(3.168)	(8.684)	(3.581)	(7.170)	(2.740)
ER volatility	-0.005	0.261***	0.056	0.069***	0.064	0.073**
	(0.030)	(0.012)	(0.039)	(0.024)	(0.050)	(0.030)
I(Fixed ER)	-1.457***	0.466	0.227	0.916**	-0.562	0.259
	(0.322)	(0.285)	(0.278)	(0.359)	(0.630)	(0.529)

A.2 Benchmark comparative statics

In this section, we derive the comparative static relationships of the model. Differentiating (5) and (6), we obtain the partial derivatives

$$\frac{\partial \xi^*_{u,i}}{\partial V_u} = c'(V_u) \leq 0, \tag{A.1}$$

$$\frac{\partial \xi^*_{u,i}}{\partial V_e} = -[1+\eta(m-1)]c'([1+\eta(m-1)]V_e) \geq 0, \tag{A.2}$$

$$\frac{\partial \xi^*_{u,i}}{\partial \eta} = -c'([1+\eta(m-1)]V_e)(m-1)V_e \geq 0, \tag{A.3}$$

and

$$\frac{\partial \xi^*_{e,i}}{\partial V_u} = -c'(V_u) \geq 0, \tag{A.4}$$

$$\frac{\partial \xi^*_{e,i}}{\partial V_e} = [1+\eta(m-1)]c'([1+\eta(m-1)]V_e) \leq 0. \tag{A.5}$$

$$\frac{\partial \xi^*_{e,i}}{\partial \eta} = c'([1+\eta(m-1)]V_e)(m-1)V_e \leq 0. \tag{A.6}$$

The determinant of the system satisfies

$$D = m + [f(\xi^*_{u,i})U + f(\xi^*_{e,i})mE]\{mc'(V_u) + [1+\eta(m-1)]c'([1+\eta(m-1)]V_e)\}. \tag{A.7}$$

Stability requires that the determinant is positive. From the above equation, this requires that the economies of scale, $c'(\cdot)$, are not "too large." By (7) and (8), the comparative statics of the system are then as specified in (9) and (10).

A.3 3-country model comparative statics

In this appendix, we derive the determinant of the 3-country model and the comparative static relationships. Recall that for the 3-country version, we make the simplifying assumption that $c(V)$ is linear, leaving c' a constant, $c' \leq 0$. By equation (21)

$$\frac{\partial \xi^*_{u,i}}{\partial V_u} = c', \tag{A.8}$$

$$\frac{\partial \xi^*_{u,i}}{\partial V_e} = -\eta c', \tag{A.9}$$

$$\frac{\partial \xi^*_{u,i}}{\partial V_g} = -c'. \tag{A.10}$$

By equation (23)

$$\frac{\partial \xi^*_{g,i}}{\partial V_u} = -c', \tag{A.11}$$

$$\frac{\partial \xi^*_{g,i}}{\partial V_e} = \eta c', \tag{A.12}$$

$$\frac{\partial \xi^*_{g,i}}{\partial V_g} = c', \tag{A.13}$$

and

$$\frac{\partial \xi^*_{e,i}}{\partial V_u} = -c', \tag{A.14}$$

$$\frac{\partial \xi^*_{e,i}}{\partial V_e} = c', \tag{A.15}$$

$$\frac{\partial \xi^*_{e,i}}{\partial V_g} = \eta c'. \tag{A.16}$$

Let conditions (24), (25), and (26) be referred to as Ω_1, Ω_2, and Ω_3 respectively. Moreover, to simplify the notation let $\widehat{j} \equiv f(\xi^*_{j,i}) J c'$, where $j = u, g, e$ and $J = U, G, E$, and let $K \equiv \widehat{u} + \widehat{e} + \widehat{g}$. Substituting and differentiating with respect to V_u, V_e, and V_g, we obtain

$$\frac{\partial \Omega_1}{\partial V_u} = 1 + K, \tag{A.17}$$

$$\frac{\partial \Omega_1}{\partial V_e} = -K + (1 - \eta)(\widehat{u} + \widehat{g}), \tag{A.18}$$

$$\frac{\partial \Omega_1}{\partial V_g} = -K + (1-\eta)\widehat{e}, \tag{A.19}$$

$$\frac{\partial \Omega_2}{\partial V_u} = -K + (1-\eta)\widehat{e}, \tag{A.20}$$

$$\frac{\partial \Omega_2}{\partial V_e} = K - (1-\eta)[\widehat{u} + \widehat{e} + \widehat{g}] \tag{A.21}$$

$$\frac{\partial \Omega_2}{\partial V_g} = 1 + K - (1-\eta^2)\widehat{e}, \tag{A.22}$$

$$\frac{\partial \Omega_3}{\partial V_u} = -K + (1-\eta)\widehat{g}, \tag{A.23}$$

$$\frac{\partial \Omega_3}{\partial V_e} = 1 + K - (1-\eta)\widehat{u} - (1-\eta^2)\widehat{g}, \tag{A.24}$$

and

$$\frac{\partial \Omega_3}{\partial V_g} = K - (1-\eta)(\widehat{e} + \widehat{g}). \tag{A.25}$$

The matrix of the system then satisfies

$$\begin{array}{l} M = \frac{\partial \Omega_1}{\partial V_u}\left[\frac{\partial \Omega_2}{\partial V_e}\frac{\partial \Omega_3}{\partial V_g} - \frac{\partial \Omega_2}{\partial V_g}\frac{\partial \Omega_3}{\partial V_e}\right] \\ -\frac{\partial \Omega_1}{\partial V_e}\left[\frac{\partial \Omega_2}{\partial V_u}\frac{\partial \Omega_3}{\partial V_g} - \frac{\partial \Omega_2}{\partial V_g}\frac{\partial \Omega_3}{\partial V_u}\right] \\ +\frac{\partial \Omega_1}{\partial V_g}\left[\frac{\partial \Omega_2}{\partial V_u}\frac{\partial \Omega_3}{\partial V_e} - \frac{\partial \Omega_2}{\partial V_e}\frac{\partial \Omega_3}{\partial V_u}\right]. \end{array}$$

After a bit of algebra, with no monetary union ($\eta = 0$) the determinant of M satisfies

$$D = -(1+2K) - \widehat{e}(2\widehat{u} + 3\widehat{g}), \tag{A.26}$$

while the determinant of the system with a monetary union ($\eta = 1$), the determinant satisfies

$$D = -(1+3K). \tag{A.27}$$

Note that as c' approaches zero, $\widehat{u}, \widehat{g}$, and $\widehat{e}$ all go to zero as well, and hence so does K. A sufficient condition for the determinant to be negative in both cases is then that c' is sufficiently small, or $\mid c' \mid \leq \mid 3[f(\xi^*_{u,i})U + f(\xi^*_{g,i})G + f(\xi^*_{e,i})E)]^{-1} \mid$. We next move to determine the comparative

statics for V_e and V_g. Differentiating (24), (25), and (26) with respect to η yields

$$\frac{\partial \Omega_1}{\partial \eta} = -[(\widehat{u} + \widehat{g})V_e + \widehat{e}V_g], \tag{A.28}$$

$$\frac{\partial \Omega_2}{\partial \eta} = (\widehat{u} + \widehat{g})V_e + \eta\widehat{e}V_g - [1 - F(\xi^*_{e,i})]E, \tag{A.29}$$

and

$$\frac{\partial \Omega_3}{\partial \eta} = (\widehat{u} + \eta\widehat{g})V_e + \widehat{e}V_g - [1 - F(\xi^*_{g,i})]G. \tag{A.30}$$

The comparative static for $\partial V_e/\partial \eta$ is equal to D_e/D where D is the determinant of the matrix of the system above, and D_e is the determinant of the numerator matrix from Cramer's rule, which satisfies

$$\begin{array}{l} M_e = \frac{\partial \Omega_1}{\partial V_u}\left[-\frac{\partial \Omega_2}{\partial \eta}\frac{\partial \Omega_3}{\partial V_g} + \frac{\partial \Omega_2}{\partial V_g}\frac{\partial \Omega_3}{\partial \eta}\right] \\ +\frac{\partial \Omega_1}{\partial \eta}\left[\frac{\partial \Omega_2}{\partial V_u}\frac{\partial \Omega_3}{\partial V_g} - \frac{\partial \Omega_2}{\partial V_g}\frac{\partial \Omega_3}{\partial V_u}\right] \\ +\frac{\partial \Omega_1}{\partial V_g}\left[-\frac{\partial \Omega_2}{\partial V_u}\frac{\partial \Omega_3}{\partial \eta} + \frac{\partial \Omega_2}{\partial \eta}\frac{\partial \Omega_3}{\partial V_u}\right]. \end{array}$$

Substituting and simplifying, with no monetary union ($\eta = 0$) the determinant satisfies

$$\begin{array}{l} D_e = [(\widehat{u} + \widehat{g})(\widehat{u} + \widehat{e}) - (1 + K)\widehat{u}]\left[(\widehat{u} + \widehat{g})V_e - [1 - F(\xi^*_{e,i})]E\right] \\ -[(\widehat{u} + \widehat{g})V_e + \widehat{e}V_g]\left[-(\widehat{u} + \widehat{g})\widehat{u} + (1 + \widehat{u} + \widehat{g})(\widehat{u} + \widehat{e})\right] \\ +\left[(1 + \widehat{e})(1 + \widehat{u} + \widehat{g}) + (\widehat{u} + \widehat{g})\right](\widehat{u}V_e + \widehat{e}V_g - [1 - F(\xi^*_{g,i})]G). \end{array}$$

The first two terms are negative, but the third term is of ambiguous sign. However, with c' sufficiently small, the third term is unambiguously negative, leaving the entire expression negative.

Under monetary union ($\eta = 1$) the determinant of the numerator matrix satisfies

$$D_e = [1 - F(\xi^*_{e,i})]EK - (1 + 2K)[1 - F(\xi^*_{g,i})]G + (\widehat{u} + \widehat{g})V_e + \widehat{e}V_g \leq 0. \tag{A.31}$$

The comparative static for $\partial V_g/\partial \eta$ is equal to D_g/D where D is the determinant of the matrix of the system above, and D_g is the determinant of the numerator matrix from Cramer's rule, which satisfies

$$M_g = \frac{\partial \Omega_1}{\partial v_u}\left[-\frac{\partial \Omega_2}{\partial v_e}\frac{\partial \Omega_3}{\partial \eta} + \frac{\partial \Omega_2}{\partial \eta}\frac{\partial \Omega_3}{\partial v_e}\right]$$
$$-\frac{\partial \Omega_1}{\partial v_e}\left[-\frac{\partial \Omega_2}{\partial v_u}\frac{\partial \Omega_3}{\partial \eta} + \frac{\partial \Omega_2}{\partial \eta}\frac{\partial \Omega_3}{\partial v_u}\right]$$
$$-\frac{\partial \Omega_1}{\partial \eta}\left[\frac{\partial \Omega_2}{\partial v_u}\frac{\partial \Omega_3}{\partial v_e}\frac{\partial \Omega_2}{\partial v_e}\frac{\partial \Omega_3}{\partial v_u}\right].$$

Substituting and simplifying, with no monetary union ($\eta = 0$) the determinant satisfies

$$D_g = [(1+K) + (1+\widehat{g})\widehat{e}]\,(\widehat{u} + \widehat{g} - [1 - F(\xi^*_{e,i})]E)$$
$$+\widehat{e}(\widehat{u} + \widehat{g})(\widehat{u}V_e + \widehat{e}V_g - [1 - F(\xi^*_{g,i})]G)$$
$$-[(\widehat{u} + \widehat{g})V_e + \widehat{e}V_g](\widehat{u} + \widehat{g})(1 + \widehat{e}).$$

As above, this term becomes unambiguously negative with c' sufficiently small.

Under monetary union ($\eta = 1$) the determinant of the numerator matrix M_g satisfies

$$D_g = -[(\widehat{u} + \widehat{g})V_e + \widehat{e}V_g](\widehat{u} + \widehat{g})(1 + \widehat{e}) \leq 0. \tag{A.32}$$

It follows that the volume of issues in currencies e and g are increasing with the launch of the union. Moreover, since the volume of total issues is fixed, it follows that the volume of issues in currency u decreases after the launch of the union.

Lastly, we are interested in assessing the relative magnitudes of the increases in V_e and V_g. By that analysis above, these will be equal to D_e/D and D_g/D respectively. Again, we consider conditions both before and after the launch of the union. Prior to the formation of the monetary union ($\eta = 0$), $(D_e - D_g)/D$ satisfies

$$(D_e - D_g)/D = -[(1 + 2\widehat{u} + 3\widehat{g})\widehat{e}V_g - (1 + 2\widehat{u} + 3\widehat{e})\widehat{g}V_e + 2\widehat{e}\widehat{u}V_e$$
$$+(1 + K + \widehat{u} + \widehat{e})[1 - F(\xi^*_{e,i})]E - (1 + K + \widehat{u} + \widehat{g})[1 - F(\xi^*_{g,i})]G]/[(1 + 2K) + \widehat{e}(2\widehat{u} + 3\widehat{g})],$$

while subsequent to the launch of the monetary union ($\eta = 1$), $(D_e - D_g)/D$ satisfies

$$(D_e - D_g)/D = \{[1 - F(\xi^*_{g,i})]G - [1 - F(\xi^*_{e,i})]E\} \geq 0. \tag{A.33}$$