



Interest rate risk management with debt issues: Evidence from Europe

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ARTICLE INFO

Article history:

Received 29 November 2016
Received in revised form 17 January 2018
Accepted 19 January 2018

JEL Classification:

F36
G15
G32

Keywords:

Interest rate risk
Euro
Risk management

ABSTRACT

In comparison to bank financing, public debt market may allow firms to more readily match maturity and risk structures between their assets and liabilities. We test whether new issuers on the European corporate bond markets experience a change in their interest rate sensitivity upon their bond issuance. We find that stock returns have become significantly less sensitive to interest rate fluctuations for firms that enter the publicly traded bond market. Our findings support the notion that firms manage their interest rate risk with new debt issues.

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“... it is important to note that in a number of countries, the debt securities market for long-term maturities in their own currency was close to non-existent in the past. For example, 20 or 30 year debt issuance was available only in some currencies, at least with a fixed interest rate. These types of debt securities are now available across the euro area”

Speech by William F. Duisenberg, President of the European Central Bank, June 14, 1999

1. Introduction

While interest rate risk management is mostly studied within banking industry, non-financial firms also view interest rate exposures and hedging of them to be of utmost importance (Graham and Harvey, 2001; Bodnar et al., 2013). Fast growth of the European corporate bond markets since the euro introduction has provided European firms with an expanded set of opportunities to manage their interest rate exposures (Korkeamäki, 2011). We study whether European firms' interest rate sensitivity changes when they enter the corporate bond market.

Banks have traditionally been the dominant source of debt financing for European non-financial firms. In a bank-dominated financial market, firms' access to fixed rate funding tends to be

limited, as bank financing comes predominantly in floating rate (Altman et al., 2010; Vickery, 2008; Faulkender, 2005).¹ Limited access to fixed rate financing complicates firms' efforts to match the interest rate sensitivity of their liabilities with that of their assets.

Our work is related to the literature regarding the choice between bank financing and arm's length financing via public markets. Diamond (1991) and Bolton and Freixas (2000) emphasize the monitoring role of bank lenders. Both papers predict that high quality firms choose to use arm's length debt, whereas lower-quality firms use bank debt due to its monitoring benefits. In a more recent paper, Rauh and Sufi (2010) explore the parallel use of bank debt and public debt. Their results provide further support for the importance of bank monitoring. They find that firms with public debt access continue to use bank debt. However, bank lending may also change its character when banks face increased competition from public market lending. Boot and Thakor (2000) model suggests that with increased competition from the public capital market, banks reduce their investment in information acquisition. Part of that may be driven by banks' need to cut costs as they face pressure to lower the cost of their lending, due to capital market competition (Hale and Santos, 2009) Boot and Thakor (2000) even question

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<https://doi.org/10.1016/j.jfs.2018.01.003>

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¹ Beatty et al. (2012) report that US banks commonly require their corporate loan customers to obtain external protection against interest rate risk, which suggests both that interest rate risk is a concern, and that banks are reluctant to carry it on their own balance sheets.

whether relationship-based European banking model will survive the growth in corporate bond market.

Korkeamäki (2011) reports a significant change in interest rate sensitivity at the market level in Europe following the euro introduction, and he attributes the observation to the corporate bond market. We explore this issue further. Whereas Korkeamäki (2011) studies interest rate sensitivity of the European market indices and notes that a reduction in their interest rate sensitivity coincides with growth of European corporate bond issuance, our main contribution is that we use an identification strategy that specifically relates changes in interest rate sensitivity to bond IPOs at the firm level.

We measure firms' interest rate sensitivity by observing the connection between their stock returns and interest rate fluctuations. Smith and Stulz (1985) suggest that a firm's hedging activity is reflected in lower stock return sensitivity to the state variable, in our case interest rate changes. We thus focus on the absolute value of the coefficient that reflects stock returns' sensitivity to interest rate changes. If firms manage interest rate sensitivity when they enter the public debt market, then we should observe a reduction in their interest rate sensitivity upon bond issuance. We make two identifying assumptions. First, we assume that interest rate sensitivity of the asset side of the balance sheet is unaffected by the decision to use bond financing. Second, we assume that changes in interest rate sensitivity of the liability side of the balance sheet are reflected in stock return sensitivity to interest rates.

Several empirical features generate potential biases against findings when using our research design. First, entrance to the public bond issuance market rarely entails a full shift from bank financing to bond financing (Rauh and Sufi, 2010). This is particularly important in European markets, where banks have retained an important role in the financial system (Langfield and Pagano, 2016). Second, firms can use derivative contracts such as swaps to manage their interest rate risk, and those markets experienced a growth pattern parallel to that of corporate bond market (Remolona and Wooldridge, 2001). A reduction in interest rate sensitivity of stock returns could thus reflect increased use of derivatives, and such use could weaken the connection between loan types and interest rate risk. Third, as we note above, growth of public debt market affects banks' lending behavior as well, as they face capital market competition (Hale and Santos, 2009; Boot and Thakor, 2000). Thus, even the firms that continue to use banks as their exclusive choice of debt financing may experience a shift in their financing choices.

We observe changes in interest rate sensitivity of stock returns for bond issuers from EU-15 countries excluding Luxembourg, and Norway and Switzerland. We find that firms' interest rate sensitivity experiences a marked change when they enter the public debt market. Our results are robust to controlling for various firm-, industry-, time-, and country variables. Besides panel regression results, we present diff-in-diff evidence, and placebo tests that consider interest rate sensitivity of country-, industry-, and size-matched non-bond issuers. We further document that firms that commence bond issuance during our sample period tend to come from industries with greater exposure to interest rate fluctuation, which is consistent with the argument that bond issuance decision is made for hedging purposes.

The rest of the paper is structured as follows. Section 2 provides a brief background on measurement of interest rate exposure. Section 3 introduces the data sources used in this study. Section 4 the main results of this study, while section 5 concludes.

2. Interest rate exposure and its measurement

We study interest rate risk among European firms by using a market model regression similar to Stone (1974), Flannery and

James (1984) and many others, where interest rate sensitivity is measured by the regression coefficient of a factor for interest rate changes. Some authors refer to the estimate as equity duration (e.g. Leibowitz, 1986). In U.S. studies, the use of this method to estimate interest rate exposure is almost exclusive to studies of financial institutions. The few notable exceptions include Sweeney and Warga (1986), Ehrhardt (1991), and Reilly et al. (2007). Their results could explain why interest rate sensitivity is sparsely studied among non-financial firms in the U.S., as they find sensitivity of stock returns to interest rates to be concentrated only to utility and financial sectors. Interestingly, Bartram (2002) detects significant interest rate exposures for non-financial firms at the firm level during the late 1980s and early 1990s among German firms.

The most commonly used specification for regression-based detection of interest rate sensitivity follows the form given in Eq. (1).

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \gamma_i R_{A,t} + \varepsilon, \quad (1)$$

where $R_{i,t}$ is the stock return, $R_{m,t}$ is the return on the market portfolio, and $R_{A,t}$ is the return on the underlying risk factor. In our case, the risk factor represents fluctuation in short term interest rates, and the regression is run for 36-month lagged rolling windows. The model in Eq. (1) is sometimes referred to as a two-factor APT model, or an augmented CAPM model. The use of this type of analysis is motivated by Stone (1974) for interest rate sensitivity and Adler and Dumas (1984) for foreign exchange exposure.

While the regression method is admittedly a noisy way to detect the extent of corporate hedging, it also has benefits over the method of observing the use of derivatives. As Guay and Kothari (2003) point out, operational hedges may play a bigger role than derivative usage in corporate financial management. By only observing derivative usage, researchers thus overlook a potentially important element in corporate risk management programs. Also, Chernenko and Faulkender (2011) report that interest rate swaps are often used for speculative rather than hedging purposes, especially among firms with performance sensitive executive compensation contracts. Kim et al. (2006) study the use of both operational hedging and derivatives in foreign exchange risk management of U.S. firms. Their findings support a hypothesis that the two hedging methods complement, rather than substitute, each other.

Graham and Harvey (2001) report survey evidence of importance of operational hedging in interest rate risk management. Among their respondents, 63.25% felt that matching debt and asset maturity was important. Consistent with the presence of economies of scale in hedging with derivatives, managers of small or non-public firms found operational hedging to be more important than what their colleagues in large or public firms responded. However, Covitz and Sharpe (2005) provide conflicting evidence in their study of interest rate risk management practices among U.S. firms. They find large firms to more commonly use debt issues to match asset and liability structures, whereas small firms tend to use derivatives more often in their data set. This may be explained by the less frequent new debt issues by small firms.

3. Data

We study interest rate sensitivity of stock returns at the firm level. Our sample contains the Datastream universe of firms from the EU-15 countries (excl. Luxembourg), and Norway, and Switzerland. For these firms, we obtain monthly stock returns from Datastream. We then limit our sample to firms for which we can estimate interest rate sensitivity at the end of each year by having at least 12 months of returns available in the three-year period preceding each year-end. Our sample period runs from 1990 to 2007, so that 1992 is the first year end for which we estimate interest

Table 1
Number of sample firms by year and country.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AUT	22	27	27	30	40	42	43	44	43	43	43	43	43	43	43	41
BEL	41	41	41	45	46	52	65	67	66	64	65	65	67	67	66	66
CHE	94	98	102	108	125	132	139	139	144	143	144	144	144	145	145	144
DEN	80	83	83	85	105	115	123	127	127	128	128	128	128	128	128	128
ESP	58	63	68	70	73	78	87	88	88	88	88	89	89	89	89	87
FIN	23	26	28	40	47	57	65	64	65	65	66	67	67	67	67	68
FRA	199	206	209	222	263	304	353	354	353	349	348	345	342	339	337	329
GBR	452	470	507	545	642	764	877	898	905	897	868	831	807	775	749	709
GER	192	220	224	231	282	331	353	346	346	335	326	319	313	308	295	291
GRC	53	57	61	74	107	110	116	135	142	141	141	142	142	143	141	141
IRL	37	38	38	40	44	43	47	47	46	48	47	47	46	46	45	44
ITA	74	74	74	78	92	98	108	109	111	111	112	112	112	112	112	112
NLD	65	71	74	77	83	86	94	93	93	93	93	93	93	93	93	93
NOR	30	37	39	41	49	54	73	73	74	76	76	76	76	75	76	76
POR	14	17	19	20	37	37	37	40	41	40	38	37	33	33	35	35
SWE	56	58	62	67	80	92	120	128	131	132	133	133	133	134	133	131
Total	1490	1586	1656	1773	2115	2395	2700	2752	2775	2753	2716	2671	2635	2597	2554	2495

The table reports the number of sample firms by year and country. To be included in the sample, the firm must have returns available from Datastream, and accounting data available from Worldscope.

Table 2
Number of sample firms by year and industry.

	AUT	BEL	CHE	DEN	ESP	FIN	FRA	GBR	GER	GRC	IRL	ITA	NLD	NOR	POR	SWE
Bus. Equip.	0	47	156	48	45	89	447	1197	280	12	10	29	155	106	26	256
Chemicals	16	64	60	80	38	13	152	271	156	72	12	44	64	0	16	16
Durables	28	0	32	48	26	0	179	325	243	9	0	126	32	22	16	91
Energy	16	0	0	0	32	0	115	447	16	0	62	22	15	101	0	16
Finance	172	297	608	755	394	117	1080	2105	1085	219	117	515	218	227	88	293
Health	0	26	62	71	28	5	125	378	138	55	32	16	12	0	9	78
Manufacturing	161	144	472	195	212	298	651	1404	1142	363	103	220	201	96	64	391
Non-durables	72	90	101	194	85	122	519	1127	483	403	120	194	163	86	53	111
Shops	15	117	217	88	61	79	509	1644	305	283	80	54	239	42	79	92
Telecom	0	32	0	13	32	0	63	217	27	52	0	37	13	0	12	46
Utilities	70	11	96	24	119	0	63	262	175	0	0	102	0	47	10	0
Other	67	96	286	308	220	159	949	2319	662	378	167	242	275	274	140	333

The table reports the number of sample firms by industry and country. The industry classification is based on each firm's primary SIC code from Worldscope, and the Fama-French 12 industry portfolio definition.

rate sensitivity for each firm. We end our sample period in 2007 in order to focus on the effects that the fast emerging arm's length debt financing market has on European firms' choice between bank debt and public debt. The financial crisis and the subsequent euro crisis have significantly altered banks' operating environment in Europe (Sander et al., 2016; Claessens et al., 2015). With both new regulations and new types of risks stemming from exposures to PIIGS countries, subsequently constrained bank lending has pushed firms to public debt markets. Thus, the choice of the corporate debt source is likely to have very different determinants after 2007.

Our sample contains 62,164 firm-year ends to analyze. We obtain accounting variables for our sample firms from Worldscope. Unfortunately, accounting data is available for a much smaller set of firms. When we require firms to have a positive value for total assets in Worldscope, our data set shrinks to 37,663 firm-years.

Table 1 shows the breakdown of our sample by country and year. The number of firms included in our study grows significantly during the sample years, from 1490 in 1992 to 2495 in 2007. Table 2 breaks down the sample by country and industry, where we use the Fama-French 12 Industry portfolio definition for industry identification, based on each firm's primary SIC code from Worldscope. The figures in the table represent firm-years for each industry/country.²

We use SDC Platinum to observe bond market activity for the firm. First, we obtain all corporate bond issues from 1985 forward

(straight and convertible bonds). We then match this bond issuance data with our firm variable data set, and define variable BONDISSUER as an indicator variable that takes the value of one if the firm has issued a publicly traded bond in the observation year or earlier, and zero otherwise. For example, a firm that issues its first bond captured by the database in 2002 will have a value of zero for BONDISSUER variable in years 1992–2001, and one for 2002 and subsequent years. Our aim is to observe whether access to public debt market affects firms' ability to manage interest rate risk. By using the BONDISSUER variable, we assume that the firm's access to public debt improves with its first public bond issue, even if it may not actively use that access. Santos and Winton (2008) proxy access to public debt market with a similar measure.

Table 3 summarizes our data on BONDISSUER by country and year. In the interest of space, we report the percentage of firms from each country with BONDISSUER = 1 for every third year in the sample. It can be noted from Table 3 that while corporate bond issuance has increased in most countries in our sample, some countries have not seen an increase in the proportion of bond-issuing firms.³ One should keep in mind that the sample size has also grown over time. While more bond-issuers have emerged from all countries except Greece, additions of new non-bond-issuing firms in

² The group "Other" captures all firms with no primary SIC code available in the Worldscope database, which explains the relatively large size of the group.

³ Most of the changes in the proportion of bond issuers are not statistically significant. When comparing the proportions between 1995 and 2007, the growth is statistically significant at the 10% level or better only for Switzerland, France, the U.K., Italy, and the Netherlands.

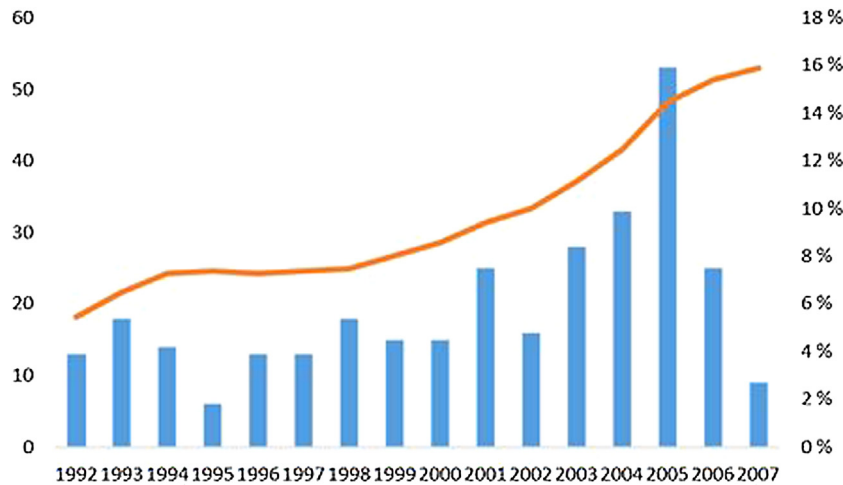


Fig. 1. Number of new bond issuers (left axis) and percentage of sample firms with publicly traded debt issues (right axis) by year.

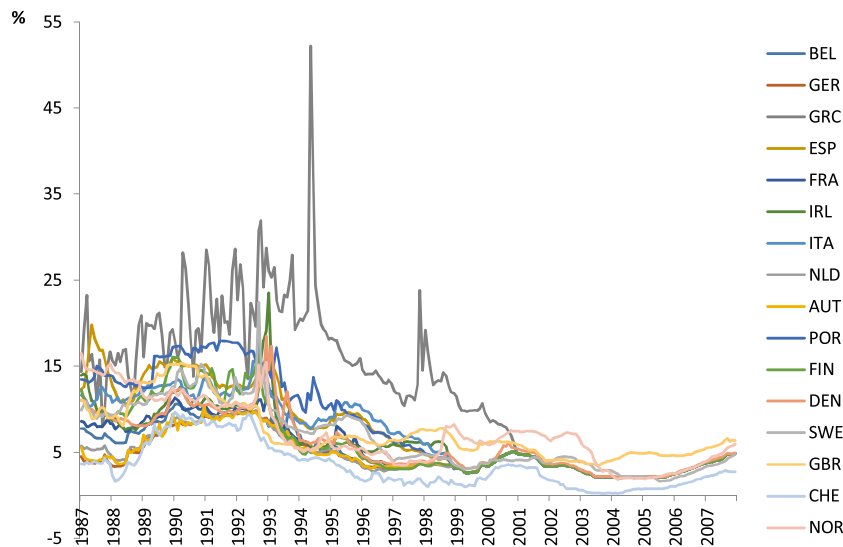


Fig. 2. Monthly three-month interest rates by country.

the sample explains the lack of growth in the percentage for some countries.

Fig. 1 further depicts the aggregate percentage of firms that have issued publicly traded bonds and the number of new bond issuers, by sample year. The figure indicates that after years of very moderate growth in the 1990s, a clear growth trend is present since year 2000. The percentage of firms with bond market experience reaches 15.9% in 2007. For comparison, Faulkender and Petersen (2006) report that 19% of U.S. firms have access to public debt markets, as indicated by the firm having a debt rating.⁴

Besides the public debt market, firms can manage their interest rate exposure with derivatives. Survey evidence suggests that among derivative types used in interest rate risk management, swaps play a central role (see e.g. Hakkarainen et al., 1997; Bodnar and Gebhardt, 1999). While we do not have data on swap usage at the individual firm level, we estimate firms' access to the swap market by using information on the local swap market size. We collect data from the BIS Triennial Central Bank Survey regarding the

size of the local swap markets. The BIS data is reported every three years. To obtain an annual time series, we interpolate the values for the years between the surveys, assuming that the size of the local markets changes linearly between the survey years. As Korkeamäki (2011) reports a growth of 220% and 350% from 1999 to 2006 for OTC and exchange traded euro-denominated interest rate derivative markets, respectively, the growth in derivative markets could alone explain a shift in interest rate sensitivity in the euro area. It is therefore important to include the swap market size as a control variable in our study.

The monthly interest rate data used in this study come from Eurostat.⁵ Eurostat provides historical data on both 3-month rates and 10-year rates for a number of countries. While our results are robust to using the 10-year rate as well, we use the 3-month rate as our main interest rate variable for two reasons. Firstly, many of the studies regarding corporate interest rate exposure focus on the effects of monetary policy on firm value, and most central banks use short rates as their main instrument (Clarida et al., 1998). Secondly, short-term money market rates are often used as reference rates in

⁴ One should keep in mind that while the Faulkender and Petersen (2006) sample includes effectively all publicly traded U.S. firms, our sample does not capture the entire European stock market due to data limitations.

⁵ Switzerland is not covered by Eurostat. Therefore, our Swiss interest rate data come from the OECD.



Fig. 3. Average interest rate sensitivity of European firms by year and bond market status.

floating rate lending, which makes them a likely source of corporate interest rate exposure.

Fig. 2 illustrates the evolution of 3-month rates for our sample countries during the sample period. As Fig. 2 shows, both level and volatility of interest rates experience a decreasing trend during the period of our study. Variation across countries decreases naturally also as the euro countries join the common currency. The clear differences in the interest rate environment between the pre-euro era, and the post-euro period may have very different implications for corporate interest rate risk management. In our regression analysis, we use either an indicator for the euro period, or year fixed effects to control for such effects. In some of our regressions, we also account for the level and the volatility of interest rates, to ensure that our results are not driven by differences in interest rate environment.

4. Empirical results

We begin the analysis by estimating stock return sensitivity to interest rate fluctuations separately for each sample firm. Several authors have noted that interest rate time series contain predictable components. We confirm the pattern, and find that an ARIMA (1,1,1) model can predict monthly fluctuations in interest rates quite well. Since firms' interest rate risk management should be concerned with the unexpected changes in interest rates, we will focus on the unexpected part of interest rate changes. Thus, we follow Saunders and Yourougou (1990) and use the residuals from the ARIMA (1,1,1) model as our main proxy for interest rate fluctuation.⁶ We denote it ΔI . Then, we employ the regression model in Eq. (2) separately for each sample firm.

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \gamma_i \Delta I_{i,t} + \varepsilon \quad (2)$$

In Eq. (2), $R_{i,t}$ is the stock return for each firm i in month t , and $R_{m,t}$ represents the MSCI Country Index for each firm i . The regression is run at each year-end, using rolling 36-month windows. As mentioned, ΔI captures the unexpected change in three-month interest rates in each country. We also consider a richer model that includes the Fama-French style factors, but since such factors are not readily available for the full sample period for all our sample countries, we use the model in Eq. (2) when estimating interest rate exposure.⁷ In Fig. 3, we plot the average interest rate sensitivity (γ) of our sample firms by year. We separate firms with bond issuance

⁶ The main findings of this paper are robust to using the raw changes in interest rates, in place of the unexpected changes. Using non-linear transformations of the interest rate series, as suggested by Bartram (2002) provides also inferences that are very similar to those reported in our regression tables.

⁷ It should be noted that inclusion of the Fama-French factors has a very limited effect on our results for those countries that have the factors available from either MSCI or S&P.

Table 3
Percentage of sample firms with bond market presence by year and country.

	1995	1998	2001	2004	2007
AUT	3.33	2.33	2.33	4.65	12.20
BEL	6.67	4.62	10.94	13.43	13.64
CHE	8.33	13.67	18.18	20.83	22.92
DEN	4.71	3.25	3.13	4.69	5.47
ESP	5.71	4.60	6.82	7.87	12.64
FIN	20.00	13.85	15.38	14.93	17.65
FRA	4.95	5.95	7.74	9.65	13.37
GBR	10.09	9.92	12.82	17.84	24.54
GER	5.19	5.95	6.87	10.86	12.71
GRC	0.00	0.00	0.00	0.00	0.00
IRL	17.50	19.15	20.83	28.26	29.55
ITA	3.85	3.70	6.31	8.93	11.61
NLD	6.49	7.45	8.60	10.75	15.05
NOR	12.20	9.59	11.84	15.79	17.11
POR	10.00	8.11	7.50	12.12	11.43
SWE	2.99	2.50	2.27	3.76	6.11

The table reports the number of sample firms with BONDISSUER = 1. BONDISSUER is an indicator variable that takes on the value of one if the firm has appeared at least once as an issuer of bonds or convertible bonds in the SDC New Issues data base, zero otherwise. The data is reported by country for every third year during the sample period.

Table 4
Comparison of firm variables between bond issuers and non-bond issuers.

		non-issuers	bond issuers
Leverage	mean	0.2217	0.2409
	median	0.0878	0.1458***
Total Assets	mean	9625.0	32739***
	median	240.0	1283***
Capex/Sales	mean	0.3818	0.2617
	median	0.0390	0.0417***
Profit Margin	mean	-0.0260	-0.5600
	median	0.0805	0.0946***

The table reports the means and the medians for firms with bond issues, and those without bond issues. LEVERAGE is long-term debt/total assets, CAPEX is capital expenditures/sales, PROFIT MARGIN is EBIT/sales. Asterisks indicate that the statistic is greater than that of the comparison group at 10%(*), 5%(**), and 1%(***) levels, respectively, using the two-sided t -test (means) or the Wilcoxon rank sum test (medians).

experience from those without such experience. While Fig. 3 indicates some differences between the two groups through the years, none of the differences are statistically significant.

We further compare the bond issuers and the non-bond issuers in our sample in Table 4, where we report the means and the medians of the accounting variables used in our regressions, by the aforementioned groupings. Table 4 suggests that our sample includes severe outliers, as the means differ significantly from the medians. While the mean of only Total Assets is statistically significantly different between the issuers and the non-issuers, the medians exhibit more clear differences. It is no surprise that bond issuers are larger than non-bond issuers. According to the Wilcoxon rank sum test, the issuers are also more levered, more profitable, and have greater capital expenditures. The apparent outliers motivate us to use winsorizing in our regressions.

Table 5 offers a look at differences in interest rate sensitivity at the firm level between pre-euro and post-euro periods. The table shows the proportion of firms with statistically significant interest rate exposure by country. Significance is defined as coefficient γ_i being different from zero at the 10% level or better. In the column labeled 1992–1998, the sample includes all months from January 1990 to December 1998. We have included all firms with a minimum of 12 months of returns. Overall, about 8.3% of firms in the sample exhibit a negative and significant exposure to interest rates in the 1992–1998 time period, but marked differences exist between countries. In Finland and Italy, over 20% of the

Table 5
Interest rate exposure of non-financial firms.

Panel A: Percentage of firms with statistically significant exposure by country				
	1992–1998		1999–2007	
	neg	pos	neg	pos
AUT	2.40	7.78	3.96	6.47
BEL	2.19	8.77	3.01	6.52
CHE	1.74	19.16	2.31	15.20
DEN	5.81	10.86	8.02	10.25
ESP	6.14	2.34	3.24	17.45
FIN	20.42	2.08	3.43	12.57
FRA	8.29	3.03	4.01	11.44
GBR	9.76	5.05	1.30	21.22
GER	5.43	5.50	4.66	10.05
GRC	3.17	6.75	1.51	5.88
IRL	10.33	6.61	6.40	17.44
ITA	22.73	1.01	6.38	17.39
NLD	2.40	10.70	1.83	11.95
NOR	10.84	5.62	4.00	8.00
POR	13.61	3.40	4.32	7.19
SWE	12.98	5.92	1.72	13.93
Average	8.34	6.03	2.99	14.61

firms exhibit negative exposure to interest rate fluctuations. In the column labeled 1999–2007, the percentage of firms with negative interest rate exposure has declined for most countries, and country-by-country proportions of firms with negative exposure at the 10% level are not far from what could be expected from a random draw. Our results are consistent with Korkeamäki (2011), who reports a dramatic shift in interest rate sensitivity around the euro introduction at the country index level, especially for the euro countries that experienced a currency crisis during the early 1990s (Finland, Italy, Ireland, Portugal, and Spain). Also, Bessler and Kurmann (2014) report a similar shift in interest rate sensitivity for both European and U.S. banks. They note increases in provision of adjustable rate loans, use of market-based refinancing and derivatives usage, and a shift towards more fee-based income among potential explanations. The explanation of increased hedging with derivatives is the most relevant one for industrial firms, and it motivates our controls for it in our regression analysis.

We find that the proportion of firms with positive and significant interest rate exposure has increased from 6% to over 14%, with some countries exhibiting very large shifts. However, in observing the proportions of firms with significant exposures, we should keep in mind that the size and the composition of the sample have also changed through time.

4.1. Determinants of interest rate sensitivity

As the sudden growth in availability of bond financing in Europe makes interest rate risk management through new issues more feasible, we hypothesize that firms' use of bond financing is connected with interest rate sensitivity of their stock returns. In this section, we pursue that hypothesis more formally by studying the firm-level determinants of interest rate exposure in a regression setting. We employ a research strategy similar to that used in a number of studies on interest rate exposure of financial institutions (e.g. Flannery and James, 1984). The analysis is performed in two stages. First, we run the regression in equation (2) with three-year rolling windows at the end of each year, starting in 1992. Then in the second stage, we use the absolute value of the estimated series of annual firm-specific γ -coefficients as the dependent variable in an effort to find variables that determine extent of the exposure.⁸

⁸ We follow hedging literature since Smith and Stulz (1985), and focus on the absolute value of the gamma coefficient under the premise that a firm's hedging

Regression setting allows us to control for various firm- and country-specific variables that potentially affect firms' interest rate sensitivity. In our choice of firm-specific controls, we follow Faulkender (2005), and control for LEVERAGE (measured as book value of long-term debt over book value of assets), size ($LN(ASSETS)$), capital expenditures over sales (CAPEX), and profitability ($PROFIT\ MARGIN$). The size effect is set to capture firm size-related variation in ability and motives to manage interest rate risk. Firm size is an interesting control for various reasons. First, Graham and Harvey's (2001) survey evidence suggests that large firms deviate from small firms in their interest rate risk management practices, and Covitz and Sharp (2005) find small firms to be more likely to use operational hedging in their interest rate risk management. Second, small firms may, in general, have stronger incentives to manage their interest rate exposure, as suggested by Froot et al. (1993) and Vickery (2008). Third, Rajan and Zingales (2003) argue that the increasing prevalence of arm's length financing in Europe would benefit mostly large firms that have a better ability to provide information demanded by the financial markets. Given the conflicting predictions of these previous papers, the effect of firm size on interest rate sensitivity patterns is an empirical issue.

Firms with high capital expenditures may be concerned about variation in interest expenditures causing cuts to their investment programs, which would motivate them to reduce their interest rate sensitivity (Froot et al., 1993). We control for that effect with the CAPEX (capital expenditures/sales) variable. Faulkender (2005) posits that less profitable firms may choose floating rate debt due to its cost benefits. Unlike Faulkender (2005) who defines profit margin as EBITDA/Sales, we use EBIT/Sales, due to poor availability of data on depreciation expenses on Worldscope. Because of data constraints, we also drop two additional control variables used by Faulkender (2005), namely Advertising over sales, and R&D over sales.⁹ While we exclude the financial firms from our reported regressions, our main findings are robust to their inclusion as well. The reported t-statistics in all of the OLS regressions in this paper are two-way clustered by firm and year, as suggested by Petersen (2009).¹⁰

We begin with a model where, besides country- and industry fixed effects, we only include the BONDISSUER dummy and the dummy for the POST 1998 time period. The latter variable is motivated by Korkeamäki (2011) and Bessler and Kurmann (2014) findings of a shift in interest rate sensitivity in the European markets upon the euro introduction. Also, Galati and Tsatsaronis (2003) report that the euro introduction caused the emphasis of the European fixed income investors to shift from local interest rate risk to credit risk and industry characteristics of individual borrowers. Furthermore, as the currency of the euro adopting countries changes with the euro introduction, the local interest rate series used to estimate interest rate sensitivity switch from legacy currencies to the euro at the beginning of 1999. The results are consistent with our hypothesis that firms use the public debt market to reduce their exposure to interest rate fluctuations. Size-wise, the coefficient on BONDISSUER is comparable to the coefficients on the non-tabulated industry indicators, suggesting that the economic impact of bond issuance on interest rate sensitivity is comparable to that of cross industry differences.¹¹ It is important to note that the change in

activity will be reflected in lower stock return sensitivity to the state variable, in our case interest rate changes.

⁹ These variables are set to capture an effect similar to that of CAPEX in the Faulkender (2005) study.

¹⁰ We thank Mitchell Petersen for providing the Stata code for two-way clustering at <http://www.kellogg.northwestern.edu/faculty/petersen/html/papers/se/se-programming.htm>.

¹¹ In comparison to the coefficient value of -0.2690 , the absolute value of the coefficients of the industry indicators varies between 0.0218 and 0.3588.

Table 6
The determinants of interest rate sensitivity.

Dep. variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	γ	γ	γ	γ	γ	γ	γ
BONDISSUER	-0.2690*** (-3.782)	-0.2545*** (-4.103)	-0.1211** (-2.035)	-0.1775** (-2.029)	-0.1240** (-2.009)	-0.1556* (-1.683)	
POST 1998	0.6094*** (4.819)						
PLACEBO							0.0082 (0.135)
LEVERAGE			0.0288*** (4.879)	-0.0050** (-2.102)	0.0275*** (4.981)	-0.0098*** (-3.375)	0.0270*** (5.056)
LN(ASSETS)			-0.0591*** (-5.727)	-0.0307 (-0.983)	-0.0640*** (-5.493)	-0.0129 (-0.347)	-0.0689*** (-5.619)
CAPEX			0.0011 (1.205)	0.0006* (1.697)	0.0012 (1.183)	0.0005 (1.301)	0.0012 (1.178)
PROFIT MARGIN			-0.0013 (-1.594)	0.0002 (0.280)	-0.0017* (-1.705)	0.0000 (0.046)	-0.0016* (-1.661)
TAX					0.0020 (1.053)	0.0030** (2.307)	0.0021 (1.092)
YIELD CURVE					-0.0005*** (-8.005)	-0.0005*** (-3.240)	-0.0005*** (-7.938)
RATE LEVEL					0.0494 (1.034)	0.0687*** (4.852)	0.0487 (1.016)
RATE STDV					-0.0568** (-2.261)	-0.0557*** (-12.184)	-0.0568** (-2.257)
LN(SWAP MKT)					-0.2805** (-2.063)	-0.2637*** (-10.919)	-0.2818** (-2.065)
CONSTANT	0.7201*** (4.095)	0.6127*** (4.252)	1.2504*** (7.755)	1.0207*** (6.142)	4.9115*** (3.722)	4.3300*** (12.410)	4.9523*** (3.722)
country effects	yes	yes	yes	no	yes	no	yes
industry effects	yes	yes	yes	no	yes	no	yes
firm effects	no	no	no	yes	no	yes	no
year effects	no	yes	yes	yes	yes	yes	yes
Observations	29,373	29,373	27,164	27,164	22,625	22,625	22,625
Adj. R ²	0.157	0.175	0.178	0.052	0.185	0.067	0.184

The table reports firm-level regression results where the dependent variable is the absolute value of the γ -coefficient from equation 2. LEVERAGE is long-term debt/total assets, LN(ASSETS) is log(total assets), CAPEX is capital expenditures/sales, PROFIT MARGIN is EBIT/sales, POST 1998 is an indicator for years 1999–2007 BONDISSUER is defined in Table 3, PLACEBO is a country-, industry-, and size-matched non-bond-issuer, LN(SWAP MKT) is log(size of interest rate swap markets) in the home country of the firm, TAX is tax expenses/EBIT, YIELD CURVE is the difference between the local 10-year and 3-month interest rates, RATE LEVEL is the level of the 3-month rate, RATE STDV is the standard deviation of the 3-month rate during the year. The sample excludes financial firms. Column (3) reports panel estimation results with firm fixed effects and t-statistics are clustered at the firm level. All other columns report OLS estimates, and the t-statistics are two-way clustered by firm and year. The asterisks indicate statistical significance at 10%(*), 5%(**), and 1%(***) levels, respectively.

interest rate sensitivity indicates a shift above and beyond the market-level change reported by Korkeamäki (2011), as we control for it with a separate euro era indicator. That POST 1998 indicator enters with a positive and significant sign. This finding may reflect a shift to more positive exposures, which was evident in Table 5 results. In Column (2) and in subsequent columns of Table 6, we replace the POST 1998 indicator with year dummies, in order to capture any time-specific unobserved heterogeneity.

In Column (3) of Table 6, we introduce the firm-level control variables discussed above. By requiring availability of accounting variables, we lose about 2000 firm-year observations from our sample. Our findings regarding BONDISSUER are robust to using this richer empirical model. Among control variables, leverage increases interest rate sensitivity, and larger firms are less sensitive to interest rate fluctuations. In Column (4) of Table 6, we use firm fixed effects to control for omitted firm-level variables. While the evidence regarding firm size weakens significantly, and the coefficient on leverage even changes sign, the coefficient on BONDISSUER retains its strength.

In the fifth column of Table 6, we introduce further control variables to our model. A firm-level control for the level of corporate income tax, TAX (tax expense/EBIT) is motivated by studies that suggest a role for corporate taxation in risk management decisions (e.g. Smith and Stulz, 1985; Graham and Rogers, 2002). Our YIELD CURVE variable is defined as the difference between 10-year rates and 3-month rates. It is motivated by Faulkender (2005) finding that the shape of the yield curve affects firms' choice of interest

rate sensitivity in their new issues. Also, Barry et al. (2008) report that firms increase their use of debt financing when interest rates are low. Recall from Fig. 2 that both interest rates and their volatility experience a decreasing trend through our sample period. To control for the effect of interest rate level on firms' borrowing behavior, we include RATE LEVEL (level of local three-month interest rate) in our specification. As firms may be more concerned about interest rate risk when interest rate volatility is high, we include RATE STDV, which is the standard deviation of local short-term interest rates within the preceding year. We further include variable LN(SWAP MKT), which is the natural log of interest rate swap market size in the home country of the firm, as reported by the BIS Triennial Central Bank Survey. As mentioned above, we interpolate values for years between the surveys. Our variable captures the size of the entire interest rate swap market, while using swaps to non-financial firms leads to very similar inferences (results not reported).¹²

Results in column (5) of Table 6 indicate that higher yield spreads are connected with lower interest rate exposure, which is inconsistent with Faulkender (2005) finding that firms tend to take on more interest rate exposure during times of a steep yield curve. Both interest rate volatility and the size of the swap market reduce firms' interest rate sensitivity. The coefficients on the account-

¹² We also obtain very similar results when we run the model in column (5) of Table 6 with only those observations that exhibit statistically significant stock return sensitivity to interest rates.

Table 7
Difference-in-difference estimates.

	(1)	(2)	(3)
Sample	bondissuers & placebos	bondissuers & placebos	all
Dep. variable	$ \gamma $	$ \gamma $	$ \gamma $
ISSUING FIRM	0.0419 (0.464)	0.0496 (0.564)	0.0289 (0.344)
BONDISSUER X ISSUING FIRM	−0.2592** (−2.259)	−0.1954* (−1.778)	−0.2874** (−2.355)
POST 1998	0.7034*** (2.822)	0.7246*** (2.962)	0.6177*** (3.217)
LEVERAGE	0.0460*** (14.924)	0.0252*** (10.259)	0.0031** (2.023)
LN(ASSETS)		−0.0614*** (−4.130)	
CAPEX		0.0058*** (7.506)	
PROFIT MARGIN		−0.0014 (−1.249)	
TAX	0.0039*** (2.841)	0.0048*** (3.378)	0.0004 (0.493)
YIELD CURVE	0.0002 (1.304)	0.0002 (1.385)	−0.0001** (−2.298)
RATE LEVEL	0.0432 (0.940)	0.0402 (0.881)	0.0093 (0.309)
RATE STDV	−0.0295 (−1.492)	−0.0287 (−1.460)	−0.0369** (−2.349)
Constant	0.6046 (1.509)	1.1904*** (2.997)	0.8081*** (3.173)
country effects	yes	yes	yes
industry effects	yes	yes	yes
Observations	9893	9608	27,469
Adj. R ²	0.144	0.146	0.160

The table reports firm-level regression results where the dependent variable is the absolute value of the γ -coefficient from equation 2. The independent variables are defined in Table 6. The sample excludes financial firms. Columns 1&2 include firms that receive either the BONDISSUER dummy or the PLACEBO dummy during the sample period. Column 3 includes all firms. Firm- and year clustered robust t-statistics are reported in the parentheses, and asterisks indicate statistical significance at 10%(*), 5%(**), and 1%(***) levels, respectively.

ing controls are generally not affected by the additional variables (when compared to column (3)), and the added variables do not affect our finding regarding the connection between bond market issuance and interest rate risk either. In column (6) of Table 6, we repeat column (5) analysis with firm fixed effects. The BONDISSUER dummy loses some of its statistical significance, while the variables capturing market-level variation in interest rates, taxes, and swap market development gain strength.

In the final column of Table 6, we replace the BONDISSUER indicator with a PLACEBO indicator. The placebo firms are non-bond issuers that are matched to our bond issuers by country, industry, and size.¹³ We conduct our placebo test by replicating the regression in column (5). The PLACEBO indicator obtains a coefficient that is very close to zero, and statistically insignificant, which lends support for our argument that bond issuance has an effect on the observed reductions in interest rate sensitivity.

In Table 7, we use the difference-in-difference approach to study further whether bond issuance is connected with lower interest rate sensitivity. Our specifications include two dummy variables, one (ISSUING FIRM) that equals one for all firms that issue bonds at any time during our sample period, and another one (BONDISSUER), which has been used in our earlier tests, and takes the value of one once the first bond has been floated by the firm. In the first two columns of Table 7, we use a sample that contains firms that become

either bond issuers or placebo firms during our sample period. Consistent with Table 6, the results indicate that interest rate sensitivity decreases for the bond issuing firms after they access the public debt market. In the third column, we repeat column (1) analysis for our full sample, and obtain results that are very similar to those based on the smaller sample of only bond issuers and placebo firms.

4.2. Causality between bond issuance and changes in interest rate sensitivity

We argue in this paper that bond-issuing firms use the broadened European corporate bond markets in order to manage their interest rate sensitivity, and we present evidence consistent with that argument. However, our BONDISSUER variable may be capturing firms that commence public bond issuance for reasons other than interest rate risk management concerns. Our findings could merely reflect the lower interest rate sensitivity of bond financing, while the corporate bond issuance decisions may not be driven by interest rate risk management.¹⁴ Faulkender (2005) tackles this issue by arguing that firms with assets that are more sensitive to interest rate fluctuations are more likely to consider interest rate management issues in their choice between fixed and floating rate financing. He estimates interest rate sensitivity of his sample firms' assets by regressing their quarterly cash flows on interest rate changes. Unfortunately, data constraints limit our ability to follow the same research design with our sample. By requiring five years of

¹³ Within each country, we use the Fama-French 12 industry classification, and for each bond issuer, we select a matching firm that is closest to it in terms of total assets. We require that the matching firms do not issue bonds during the entire sample period. It should be noted that even with the coarse industry classification, we end up with a placebo group with a significantly smaller asset size, as particularly in smaller countries, potential matches within each industry are limited.

¹⁴ Hale and Santos (2008) report that in the U.S., issuer specific variables such as credit worthiness, firm size, and investment opportunities are important drivers of firms' decision to enter the public bond market.

Table 8
Likelihood to commence bond financing.

	(1)	(2)	(3)
INDUSTRY EXPOSURE (-1)	0.1302*** (4.232)		
INDUSTRY EXPOSURE (-2)		0.0867*** (3.998)	
INDUSTRY EXPOSURE (-3)			0.0655* (1.851)
LEVERAGE	0.0149*** (3.076)	0.0152*** (3.242)	0.0152*** (3.225)
LN(ASSETS)	0.1192*** (12.175)	0.1210*** (11.690)	0.1197*** (10.417)
CAPEX	0.0002 (0.956)	0.0002 (0.787)	0.0005 (1.448)
PROFIT MARGIN	-0.0006* (-1.955)	-0.0006* (-1.922)	-0.0006* (-1.825)
RATE LEVEL	-0.0255** (-1.962)	-0.0823*** (-4.282)	-0.1044*** (-5.106)
YIELD CURVE	0.0014** (2.082)	0.0010*** (5.046)	0.0011*** (5.940)
CONSTANT	-6.9004*** (-29.365)	-6.6665*** (-26.590)	-6.5896*** (-25.194)
country effects	yes	yes	yes
industry effects	yes	yes	yes
Observations	27,230	24,884	22,288
Pseudo R ²	0.0766	0.0841	0.086

The table reports probit regression results where the dependent variable takes the value of one for the year when the firm issues its first publicly-traded bond. Industry exposure is the mean interest rate sensitivity for the observation year for the firm's two-digit SIC code, with lags indicated in the parentheses. All other independent variables are defined in Table 6. The sample excludes financial firms. Industry-level clustered robust z-statistics are reported in the parentheses, and asterisks indicate statistical significance at 10%(*), 5%(**), and 1%(***) levels, respectively.

quarterly cash flow data, our sample size shrinks from over 33,000 (including financial firms) to about 4000. Even quarterly income statement items such as EBIT and Net Income have very limited availability for European firms in Worldscope. Therefore, we elect to pursue an alternative method to test whether hedging considerations play a role in the firm's switch to bond financing. Under the assumption that interest rate sensitivity of assets contains an important industry-specific component, we argue that if the firm is in an industry with high sensitivity to interest rate fluctuations, it is more likely that its decision to use fixed rate financing is motivated by hedging reasons. We use lagged values of the absolute value our γ -coefficients at the industry level (determined by primary 2-digit SIC code), and argue that firms from industries with higher interest rate sensitivity are more likely to issue bonds for hedging reasons.

The results are reported in Table 8. We use probit regressions, where the dependent variable takes the value of one for firms that commence bond financing (in other words issue their first publicly-traded bond) during the observation year. We employ one-, two-, and three-year lagged industry mean values of the absolute value of γ -coefficients in respective columns. The reported t-statistics are clustered at the industry level. All three lagged industry interest rate sensitivity measures enter with positive and statistically significant coefficients, indicating that commencement of bond financing is more likely in industries with more significant relation between stock returns and interest rate fluctuation. These results support the view that interest rate sensitivity motivates firms to enter public bond markets.

Our control variables in Table 8 yield some interesting inferences. Larger firms are more likely to commence bond financing, suggesting that smaller European firms continue to have access barriers to the corporate bond market during our sample period. The likelihood to enter bond markets increases with leverage, which could be explained by levered firms wanting to diversify their lending sources and also wanting to reduce their interest rate sensitivity. Less profitable firms are also more likely to issue bonds, which is consistent with a concern for financial distress among those firms. Low current interest rates seem to discourage

commencement of bond financing. That finding is consistent with floating rate debt being relatively more attractive during periods of low interest rates. Finally, the YIELD CURVE variable enters with a positive and highly significant coefficient. The finding is opposite to Faulkender (2005), who finds that market timing is the major consideration for U.S. bond issuers. Steeper yield curves do not seem to be sufficient to entice European firms to stay with bank financing. Hale and Santos (2008) report that U.S. firms are less likely to make their first bond issues during recessionary periods. However, adding either a country-level GDP change, or a recession indicator that takes the value of one for country-years when GDP growth is negative has no effect on the findings reported in Table 8, while neither of the two variables enters with a statistically significant coefficient. If we add year fixed effects to Table 8 regressions, the Column (1) specification fails to converge, while the coefficients for lagged industry exposure gain statistical significance considerably in Columns (2) & (3).

4.3. Changes in leverage and interest rate exposure

Our results could be affected by endogeneity. Several of our independent variables are likely determinants of leverage, which in turn is an obvious determinant of interest rate sensitivity, as our results indicate. The fact that Faulkender and Petersen (2006) find that access to public debt market causes higher leverage among U.S. firms raises additional concerns for endogeneity. Bris et al. (2014) finding of increased debt issuance in euro countries after 1999 further heightens this concern. In the first two columns of Table 9, we use simultaneous equations to account for potential endogeneity. In our leverage model, we include firm size, cash reserves, profitability, corporate tax level, and interest rate level as determinants of leverage. Our model of interest rate sensitivity follows by large our earlier specifications. The results reported in the second column of Table 9 indicate that our findings regarding the connection between bond issuance and the firm's interest rate sensitivity are robust, and actually strengthen in this setting.

Table 9
Leverage and interest rate sensitivity.

Method	3SLS		OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
Dep. Variable	LEVERAGE	γ	γ	γ	γ
LEVERAGE		−0.5555** (−2.389)	−0.0519*** (−11.692)	0.0296*** (4.743)	0.0297*** (4.714)
LN(ASSETS)	0.0004 (0.160)	−0.0618*** (−12.210)	−0.0637*** (−7.322)	−0.0593*** (−5.197)	−0.0592*** (−5.200)
CAPEX OVER SALES		0.0048*** (3.609)	0.0014 (1.259)	0.0012 (1.156)	0.0012 (1.156)
PROFIT MARGIN	0.0000 (0.002)	−0.0011** (−2.185)	−0.0013 (−1.456)	−0.0013 (−1.498)	−0.0013 (−1.496)
BONDISSUER		−0.1078*** (−3.089)	−0.0865* (−1.686)	−0.1031* (−1.720)	−0.0992* (−1.669)
TAX	−0.0032 (−1.547)		0.0013 (0.511)	0.0014 (0.714)	0.0014 (0.713)
YIELD CURVE		−0.0005** (−2.312)	−0.0005*** (−3.662)	−0.0005 (−0.000)	−0.0005 (−0.000)
RATE LEVEL	0.0033 (1.215)	0.0729*** (8.450)	0.0743*** (6.634)	0.0710 (1.592)	0.0709 (1.589)
RATE STDV		−0.0584*** (−12.067)	−0.0523*** (−13.137)	−0.0587*** (−2.581)	−0.0587*** (−2.579)
SALES GROWTH	−0.0615*** (−4.313)				
LEVERAGE(−1)			0.1660*** (28.544)		
LEVERAGE(−2)			0.0308*** (6.686)		
NET DEBT ISSUANCE (−1,0)				−0.0000 (−1.536)	−0.0000 (−1.543)
NET DEBT ISSUANCE X BONDISSUER CONSTANT					−0.0000** (−2.261)
	0.1136** (2.482)	0.3106** (2.278)	1.5563*** (11.810)	0.5618 (1.323)	0.5624 (1.323)
country effects	no	yes	yes	yes	yes
industry effects	yes	no	yes	yes	yes
year effects	no	yes	yes	yes	yes
Observations	24,233	24,233	22,474	24,277	24,277
Ad. R ²	0.002	0.086	0.201	0.191	0.191

The table reports firm-level regression results where the dependent variable is as indicated. Columns 1–2 report 3SLS results, the other columns use the OLS. The sample excludes financial firms. Besides the variables that are defined in Table 6, NET DEBT ISSUANCE is change in long term debt in the previous year, lagged terms are indicated by (parentheses). Firm-level (in columns (1) and (2)) or firm and year clustered robust t-statistics are reported in the parentheses, and asterisks indicate statistical significance at 10%(*), 5%(**), and 1%(***) levels, respectively.

In the remaining columns of Table 9, we consider further the possibility that changes in firms' indebtedness affect their interest rate sensitivity and drive our earlier findings. In column 3, we include two lag terms of leverage into our main specification. While contemporaneous leverage has exhibited a strong positive relation to interest rate exposure coefficient in most specifications considered thus far, inclusion of lagged leverage reveals that the positive relation stems to a large extent from past leverage, and current leverage actually switches to a negative sign in this specification. However, our findings regarding BONDISSUER remain intact. In column 4, we include net debt issuance from year -1 to year 0 (defined as long term debt₀–long term debt₋₁). The variable has a negative effect on interest rate sensitivity, while the BONDISSUER also remains statistically significant at the 10% level. In the final column of Table 9, we consider whether increases in indebtedness among the firms with bond market presence explains our earlier results. Indeed, an interaction variable between net debt issuance and BONDISSUER enters with a negative sign, suggesting that increased borrowing in form of public debt reduces interest rate sensitivity.

5. Conclusions

We study the effects of the rapid growth in corporate bond financing, which has been attributed to the introduction of the euro (Rajan and Zingales, 2003). Korkeamäki (2011) reports that

the move to euro has reduced corporate exposure to interest rate fluctuation. This reduction is consistent with the suggestion that deeper markets in home-currency corporate debt allow firms to better manage their interest rate exposures. This notion receives further support as many of the countries that exhibit the shift in interest rate sensitivity are countries where the local markets were relatively segmented prior to the euro (Korkeamäki, 2011). At the firm level, we find that besides affecting firms' capital structure (Faulkender and Petersen, 2006), the source of debt also seems to affect their interest rate risk management, as firms entering the public debt markets experience a significant shift in their interest rate exposure.

As such, our results suggest that euro is having an intended consequence on firm's financing, as market depth and the consequently increased market completeness were among the proposed benefits of the common currency in the pre-euro era. Studying the time period that straddles the regime shift provides us with a unique opportunity to observe whether opening up of the corporate bond markets indeed has an effect on firms' interest rate sensitivity. As we not only find that interest rate sensitivity decreases upon a bond IPO, but also that firms from more interest rate sensitive industries appear to be more drawn to the bond market, our evidence lines up well with the suggestion that interest rate risk management plays a role in the firm's decision to issue publicly traded debt. It is interesting to note that our results differ from prior evidence, in particular from the U.S. It is possible that the effects of bond issuance on inter-

est rate sensitivity are more concealed in countries where markets are more established and differences between debt sources perhaps less marked.

Our analysis builds upon an assumption that our observed changes in interest rate sensitivity arise exclusively from the liability side of the balance sheet, whereas interest rate risk of the asset side remains constant. However, access to public debt may also have an effect also on the firm's investment activity and thus also on its assets. For instance, Blomkvist et al. (2017) report that European firms' activity in the M&A market is affected by their access to the corporate bond market. Further inquiries into the interplay between the two sides of the balance sheet, and its effects on interest rate sensitivity are left to future research. Also, our results could also be a factor behind the observed reductions in the cost of capital among euro area firms (Bris et al., 2009). A more formal exploration of that connection makes for another interesting area of future study.

Acknowledgements

We wish to thank Vikas Agarwal, Jan Antell, Bo Becker, Jess Corraggia, Mike Faulkender, Iftekhar Hasan (editor), Esa Jokivuolle, Markku Kaustia, Lars Norden, James Vickery and anonymous referees seminar participants at the 2011 INFINITI conference in Dublin, Ireland and the 2012 FMA Meetings for helpful comments and suggestions. We also thank Annika Syrjänen for excellent research assistance. Financial support from the OP Pohjola Foundation is gratefully acknowledged.

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