1. Introduction

What explains the differences in public debt issuance across advanced economies? Do demographics play a role? In an intriguing paper, Guibaud et al. (2013) found that the governments of countries with older populations face steeper yield curves and issue shorter maturity debt than younger countries. In this paper, we revisit these facts using a new database of public debt maturity and yields covering 20 advanced economy countries from 1960 to 2019.

We provide further evidence for, and some qualifications to, the finding that countries with older populations face steeper yield curves and issue shorter maturity debt. We confirm that the results continue to hold in our larger sample with more countries. We also find that the eurozone countries are the primary driver of the results. The result is also much stronger for the (future) eurozone countries in the years leading up to the adoption of the euro and the increased integration of eurozone capital markets. Including more recent data for the post-eurozone adoption years, we find that the relationship between population age, yield curve slopes, and the maturity of public debt disappears, even after excluding high-credit-risk countries. Including high-credit-risk countries, the patterns reemerge with the eurozone debt crisis, suggesting that eurozone capital markets have resegmented.

Our findings contribute to a growing literature on the role of demographic factors in accounting for the dynamics of macroeconomic variables. First, they are supportive of the closed-economy overlapping-generations model of Guibaud et al. (2013), in which a government issues more long-maturity debt to a younger population for risk sharing purposes. By showing that the results disappear after the adoption of the euro, our paper points to the importance of the closed-economy assumption.

In addition to Guibaud et al. (2013), there is a vast amount of research concerning the effects of demographic factors on other macroeconomic factors. To name a few, Higgins (1998), Ferrero (2010), Sposi (2019), and Auclert et al. (2021) analyze the effect of aging on national savings and global imbalances, while Favero et al. (2016), Carvalho et al. (2016), and Gagnon et al. (2016) discuss the effect of demographic changes on the interest rates. Moreover, Beaudry et al. (2005), Feyrer (2007), and Acemoglu and Restrepo (2017) examine the effect of demographics on productivity and economic growth.

2. Data

We briefly review those sources in this section and provide a detailed discussion of data sources and methods in Appendix A. Data on the median age of the population from 1960 to 2019 is taken from the 2019 edition of the United Nation's *World Population Prospects*. Data on long-term bond spreads—specifically, the difference between the 10-year bond and 3-month treasury bill rates—is primarily taken from the OECD website.[1] Data on the average maturity of countries' debt stock is combined from several sources including Missale (1999), OECD's *Central Government Debt Statistics*, *Bloomberg*, the European Central Bank, the Bank for International Settlements, and the International Monetary Fund, as described in the data appendix.

Following Guibaud et al. (2013), we exclude any country-year observation after 2007 when that country is rated below AA- by Standard and Poors (S&P), which results in the exclusion of all data for Greece and Mexico, together with some observations of Iceland (2007-2019), Ireland (2010-2019), Italy (2006-2019), Portugal (2009-2019), Spain (2012-2019), and Japan (2012-2019).

As shown in Table 1, our database of debt maturity and spread is larger than that used by Guibaud et al. (2013), due to the inclusion of data for earlier years derived from country-specific sources as well as data on years after 2009. This dataset may be of independent interest to researchers.

[1] Guibaud et al. (2013) uses the spread between 30-year and 10-year bonds, but due to lack of 30-year bond returns before 1998, we use the spread between the 10-year bond and 3-month treasury bill.

Table 1: Summary Statistics

Summary Statistics for Median Age, Maturity and Spread										
Country Name	Country Code	Median Age (mean)	Median Age (std.dev.)	Obs	Maturity (mean)	Maturity (std.dev.)	Obs	Spread (mean)	Spread (std.dev.)	Obs
Australia	AUS	32.36	3.66	60	6.39	1.89	46	0.34	1.45	51
Austria	AUT	37.32	3.19	60	6.73	1.42	39	1.07	1.09	30
Belgium	BEL	37.24	2.72	60	6.07	1.87	44	1.00	1.42	60
Canada	CAN	32.89	5.43	60	5.96	1.21	60	0.61	1.35	60
Switzerland	CHE	36.68	3.70	60				0.50	1.45	46
Germany	DEU	38.76	3.94	60	5.47	1.13	53	0.89	1.39	60
Denmark	DNK	36.70	3.24	60	5.18	1.92	42	0.62	1.65	33
Spain	ESP	34.60	4.78	60	5.83	2.83	58	0.95	1.77	40
Finland	FIN	35.83	5.06	60	4.68	0.88	35	0.98	1.46	32
France	FRA	35.70	3.40	60	6.63	0.59	30	1.06	1.30	50
United Kingdom	GBR	36.55	2.13	60	11.93	1.71	57	0.20	1.63	34
Greece	GRC	35.85	4.52	60	7.11	1.02	21	3.71	5.93	23
Ireland	IRL	30.03	3.69	60	8.38	2.36	58	0.96	3.15	36
Iceland	ISL	29.93	4.29	60	4.62	0.94	27			
Italy	ITA	37.69	4.76	60	4.53	1.85	60	1.71	1.50	29
Japan	JPN	36.69	6.91	60	6.42	1.42	30	0.59	0.50	18
Luxembourg	LUX	36.71	1.60	60	5.66	2.52	23			
Mexico	MEX	20.88	4.07	60				1.02	1.10	18
Netherlands	NLD	34.61	4.93	60	8.19	2.62	60	1.06	1.04	38
Norway	NOR	35.68	2.29	60	4.51	1.36	42			
New Zealand	NZL	31.19	4.29	60	4.94	1.17	28			
Portugal	PRT	34.93	5.43	60	5.02	0.99	25	2.25	2.65	27
Sweden	SWE	38.08	2.02	60	3.86	0.96	44	1.01	1.25	33
United States	USA	32.77	3.37	60	4.86	0.85	60	0.77	1.56	56
Total	TOTAL	34.57	5.51	1440	6.19	2.55	942	0.97	1.95	774

This table illustrates the summary statistics of the median age, average maturity, and the spread between 10-year and 3-month bonds of the OECD countries. In the sample, there are 22 countries with maturity data and 20 countries with spread data.

3. Results

In this section, we focus entirely on two dimensions of the relationship between median age and public debt markets: the average maturity of the outstanding stock of public debt and the slope of the long-run part of the yield curve given by the spread between 10-year bond and 3-month Treasury bills.

3.1. Panel Regressions

We begin our analysis by estimating the relationship between the median age and average maturity of the outstanding stock of public debt for different periods. Table 2 and Table 3 present the regression results for the OECD and eurozone countries, respectively. We start our analysis with the precrisis period in Panel B. The results in Panel B of Table 2 and Table 3 imply that there is a strong negative relationship between median age and average maturity. Higher significance and the larger absolute value of the regression coefficient in the eurozone sample implies that the results are mainly driven by the eurozone countries. It may seem surprising at first due to the long convergence efforts that culminated in the introduction of the euro. However, there are indications that eurozone financial markets were less integrated than other OECD countries before the 1990s,[2] which justifies a stronger relationship between median age and average maturity. Lastly, between effects regression is significant at the 1% level in the eurozone sample, which also suggests that our results are not driven by a time trend in the median age data but rather by cross-country differences. Comparing these results with Guibaud et al. (2013), we find that the coefficients and their significance are very similar regarding both magnitude and significance.[3]

In Panel A of Table 2 and Table 3, we conduct our analysis with years spanning from 1960 to 1998. In this case, the absolute value of coefficients is larger, especially for the eurozone countries.[4]

[2] See the Chinn-Ito financial liberalization index in Figure A1.

[3] See Appendix B.1 for further analysis.

[4] This would have been of potential concern for all but one country in the sample (Ireland); the median age increases gradually and monotonically over time, indicating that the age variable might be acting as a proxy time trend for secular changes in debt issuance. However, this concern is alleviated as the coefficient of the between-effects regression is still significant and larger in absolute terms for the 1960-1998 eurozone sample.

We finalize our regression analysis of median age and maturity using the overall sample between the years 1960-2019. Panel C of Table 2 and Table 3 reports the regression results for the OECD countries and eurozone countries, respectively. These tables illustrate that when we extend the data till 2019, even though the median age coefficient has the same sign as before, it is insignificant. In line with this finding, when we only consider the post-1998 sample in Panel D, the sign of the median age coefficient reverts to positive.

We continue our analysis by estimating the relationship between the median age and spread between 10-year and 3-month government bonds. Table 4 and Table 5 present the regression results for the OECD and eurozone countries, respectively. The results in Panel B of Table 4 and Table 5 show that our findings are in line with the previous analysis: there is a strong positive relationship between median age and spread. Higher significance and the larger value of the regression coefficient in the eurozone sample implies that the results are mainly driven by the eurozone countries. Moreover, between effects regression is significant at the 1% level in the eurozone sample, which also suggests that our results are not driven by a time trend in the median age data but rather by cross-country differences.[5]

Lastly, the results in Panel A, Panel C, and Panel D of Table 4 and Table 5 are in line with the maturity analysis: the value of coefficients is still significant and positive, and when we extend the data till 2019, the median age coefficient becomes smaller.

[5]In Appendix B.2, we compare these results with those of Guibaud et al. (2013), using the spread between 30-year and 10-year government bond yields. In these analyses, we find that the magnitude and the significance of coefficients are similar.

Table 2: Regression Results for Maturity and Median Age
OECD Countries

Panel A: Regression Results: OECD Countries (1960-1998)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.283**	-0.197	-0.367***	-0.356***
	(-2.52)	(-1.39)	(-9.53)	(-9.58)
Constant	15.43***	12.37**	18.21***	17.81***
	(4.08)	(2.54)	(14.17)	(13.31)
Number of observations	480	480	480	480
R^2	0.136	0.092	0.166	

Panel B: Regression Results: OECD Countries (1960-2007) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.185**	-0.206	-0.130***	-0.133***
	(-2.18)	(-1.58)	(-5.36)	(-5.56)
Constant	12.30***	12.84**	10.40***	10.26***
	(4.05)	(2.77)	(12.30)	(11.04)
Number of observations	666	666	666	666
R^2	0.081	0.116	0.043	

Panel C: Regression Results : OECD Countries (1960-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.0512	-0.106	0.0157	0.0133
	(-0.70)	(-0.80)	(0.85)	(0.73)
Constant	7.955***	9.716*	5.552***	5.383***
	(2.94)	(2.00)	(8.33)	(6.91)
Number of observations	857	857	857	857
R^2	0.007	0.032	0.001	

Panel D: Regression Results : OECD Countries (1999-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.223***	0.147	0.520***	0.499***
	(2.93)	(0.89)	(12.72)	(12.50)
Constant	-2.468	0.387	-14.16***	-13.35***
	(-0.84)	(0.06)	(-8.80)	(-8.23)
Number of observations	377	377	377	377
R^2	0.064	0.040	0.313	

This table shows the relationship between median age and average maturity in the OECD countries. In all panels, Greece is excluded, together with some observations of Iceland (2007-2019), Ireland (2010-2019), Italy (2006-2019), Portugal (2009-2019), Spain (2012-2019), and Japan (2012-2019). The t- and z-statistics are reported in parentheses. Errors are clustered by country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Regression Results for Maturity and Median Age
Eurozone Countries

Panel A: Regression Results: Eurozone Countries (1960-1998)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.489***	-0.388**	-0.514***	-0.501***
	(-5.33)	(-2.39)	(-8.51)	(-8.91)
Constant	22.30***	19.18***	23.14***	22.98***
	(6.65)	(3.41)	(11.46)	(11.56)
Number of observations	254	254	254	254
R^2	0.395	0.389	0.230	

Panel B: Regression Results: Eurozone Countries (1960-2007) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.301***	-0.379***	-0.183***	-0.206***
	(-3.45)	(-3.51)	(-4.73)	(-5.64)
Constant	16.39***	19.18***	12.29***	13.00***
	(4.89)	(4.95)	(9.09)	(9.73)
Number of observations	351	351	351	351
R^2	0.238	0.577	0.062	

Panel C: Regression Results : Eurozone Countries (1960-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.121	-0.213	-0.0224	-0.0331
	(-1.32)	(-1.79)	(-0.78)	(-1.18)
Constant	10.53**	13.80**	6.966***	7.198***
	(2.93)	(3.14)	(6.63)	(6.55)
Number of observations	442	442	442	442
R^2	0.055	0.263	0.001	

Panel D: Regression Results : Eurozone Countries (1999-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.187*	0.0624	0.479***	0.393***
	(1.86)	(0.56)	(8.42)	(7.56)
Constant	-1.121	3.785	-12.83***	-9.367***
	(-0.28)	(0.86)	(-5.62)	(-4.48)
Number of observations	188	188	188	188
R^2	0.106	0.034	0.287	

This table shows the relationship between median age and average maturity in the eurozone countries. In all panels, Greece is excluded, together with some observations of Iceland (2007-2019), Ireland (2010-2019), Italy (2006-2019), Portugal (2009-2019), Spain (2012-2019), and Japan (2012-2019). The t- and z-statistics are reported in parentheses. Errors are clustered by country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Regression Results for Spread and Median Age
OECD Countries

Panel A: Regression Results: OECD Countries (1960-1998)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.0621**	0.0485	0.102*	0.0621**
	(2.90)	(1.29)	(1.96)	(2.24)
Constant	-1.617**	-1.252	-2.956*	-1.617*
	(-2.27)	(-0.96)	(-1.68)	(-1.71)
Number of observations	358	358	358	358
R^2	0.014	0.100	0.011	

Panel B: Regression Results: OECD Countries (1960-2007) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.0702***	0.0640**	0.0884***	0.0713***
	(5.67)	(2.43)	(3.15)	(3.76)
Constant	-1.840***	-1.650	-2.480**	-1.882***
	(-4.14)	(-1.73)	(-2.50)	(-2.79)
Number of observations	515	515	515	515
R^2	0.028	0.270	0.020	

Panel C: Regression Results : OECD Countries (1960-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.0652***	0.0517**	0.0775***	0.0652***
	(5.66)	(2.77)	(4.36)	(4.93)
Constant	-1.637***	-1.164	-2.087***	-1.637***
	(-3.78)	(-1.67)	(-3.19)	(-3.35)
Number of observations	682	682	682	682
R^2	0.034	0.325	0.028	

Panel D: Regression Results : OECD Countries (1999-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.0154	-0.00318	-0.0773*	-0.0284
	(-0.52)	(-0.10)	(-1.90)	(-1.14)
Constant	1.666	1.212	4.130**	2.192**
	(1.36)	(1.00)	(2.55)	(2.20)
Number of observations	324	324	324	324
R^2	0.002	0.001	0.012	

This table shows the relationship between median age and spread in the OECD countries. In all panels, Greece and Mexico are excluded, together with some observations of Ireland (2010-2019), Italy (2006-2019), Portugal (2009-2019), Spain (2012-2019), and Japan (2012-2019). The t- and z-statistics are reported in parentheses. Errors are clustered by country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Regression Results for Spread and Median Age
Eurozone Countries

Panel A: Regression Results: Eurozone Countries (1960-1998)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.128**	0.124**	0.0919	0.128**
	(2.77)	(2.55)	(0.98)	(2.51)
Constant	-3.786*	-3.777*	-2.540	-3.786**
	(-2.24)	(-2.21)	(-0.78)	(-2.13)
Number of observations	192	192	192	192
R^2	0.032	0.448	0.005	

Panel B: Regression Results: Eurozone Countries (1960-2007) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.0918**	0.0961***	0.0860**	0.0918***
	(2.90)	(3.47)	(1.97)	(3.01)
Constant	-2.508*	-2.691**	-2.299	-2.508**
	(-2.08)	(-2.67)	(-1.46)	(-2.27)
Number of observations	280	280	280	280
R^2	0.032	0.602	0.014	

Panel C: Regression Results : Eurozone Countries (1960-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	0.0691**	0.0789***	0.0663**	0.0691***
	(2.29)	(4.56)	(2.48)	(3.31)
Constant	-1.679	-2.071**	-1.575	-1.679**
	(-1.47)	(-3.20)	(-1.57)	(-2.14)
Number of observations	359	359	359	359
R^2	0.030	0.722	0.017	

Panel D: Regression Results : Eurozone Countries (1999-2019) (Excluding High-Risk Country-Year Observations)				
	OLS	Between Effects	Fixed Effects	Random Effects
Median Age	-0.0473*	-0.0275	-0.0677	-0.0473*
	(-2.18)	(-1.02)	(-1.38)	(-1.84)
Constant	3.087***	2.315*	3.907*	3.087***
	(3.55)	(2.15)	(1.97)	(2.97)
Number of observations	167	167	167	167
R^2	0.020	0.115	0.012	

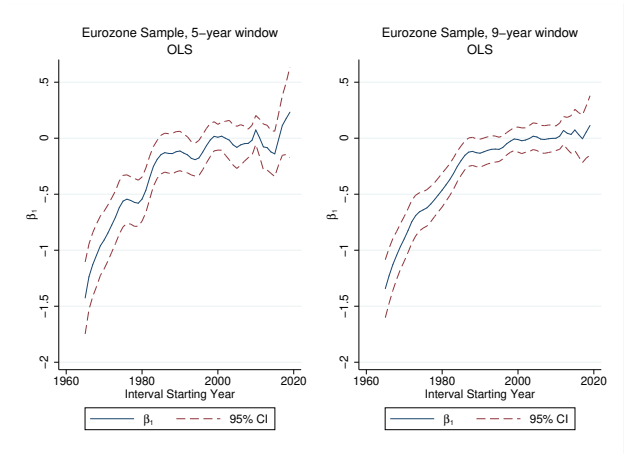
This table shows the relationship between median age and spread in the eurozone countries. In all panels, Greece and Mexico are excluded, together with some observations of Ireland (2010-2019), Italy (2006-2019), Portugal (2009-2019), Spain (2012-2019), and Japan (2012-2019). The t- and z-statistics are reported in parentheses. Errors are clustered by country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.2. Rolling Window Regressions

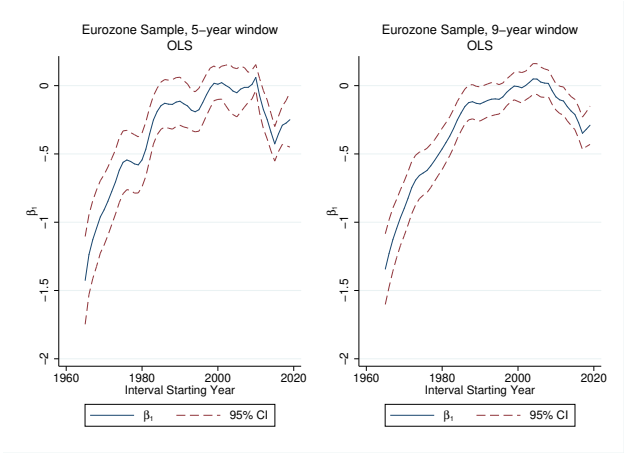
We continue our analysis with rolling-window regressions to understand the evolution of these results. Figure 1 plots the coefficients from a series of regressions of average maturity on median age for rolling 5- and 9-year windows, along with the 5% confidence interval. Figure 1a is constructed by excluding the high-risk country-year observations, while in Figure 1b, we use the whole eurozone sample. In both figures, at the beginning of the sample, the negative relationship between age and maturity is clear, as is the fact that this relationship weakens as we approach the year 2000 and the formation of the eurozone. Interestingly, the point estimate for the relationship turns negative again in the years after the eurozone debt crisis. Moreover, comparing Figure 1a and Figure 1b after 2013, the results indicate that the high-risk countries drive the reemergence of the negative relationship as these countries become more isolated from the financial markets.

We continue our rolling-window analysis with the spreads illustrated in Figure 2. In line with our findings in Figure 1, in Figure 2, at the beginning of our time series, the positive relationship between age and spread is significant in the 5-year-window regressions, as is the fact that this relationship weakens significantly before the 1980s, reemerges during the early 1990s, and becomes insignificant as we approach the year 2000 amid the formation of the eurozone. Interestingly, in the 5-year-window regressions, the point estimate for the median age turns positive again in the years after the eurozone debt crisis. Moreover, in Figure 2b, as compared to Figure 2a, the point estimate for the median age becomes significant after the eurozone debt crisis, confirming our previous findings that the high-risk countries drive the reemergence of the positive relationship as these countries become more isolated from the financial markets.

Figure 1: Evolution of Regression Coefficient β_1
OLS Regression Results for Average Maturity
(Eurozone Countries)



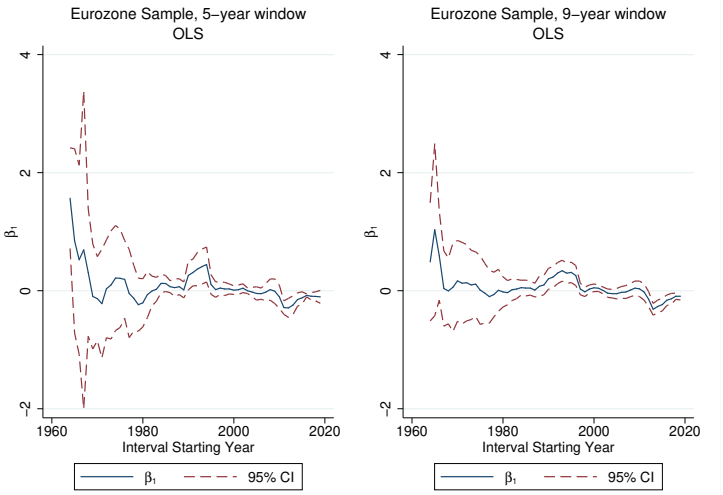
(a) Eurozone Countries
(Excluding High-Risk Country-Year Observations)



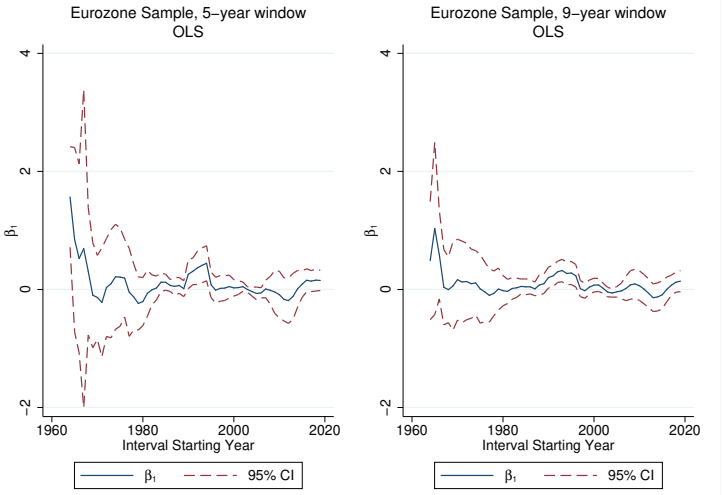
(b) Eurozone Countries (Whole Sample)

Notes: This graph shows the evolution of the coefficient β_1 for rolling-window regressions of maturity on median age for the eurozone countries. The blue line displays the point estimate of the coefficient while the red lines illustrate the 5% coefficient interval. The left panel is with respect to the regressions on a 5-year rolling window while the right panel is with respect to a 9-year rolling window.

Figure 2: Evolution of Regression Coefficient β_1
OLS Regression Results for Spread (Eurozone Countries)



(a) Eurozone Countries
(Excluding High-Risk Country-Year Observations)



(b) Eurozone Countries (Whole Sample)

Notes: This graph shows the evolution of the coefficient β_1 for rolling-window regressions of spread on median age for the eurozone countries. The blue line displays the point estimate of the coefficient while the red lines illustrate the 5% coefficient interval. The left panel is with respect to the regressions on a 5-year rolling window while the right panel is with respect to a 9-year rolling window.

3.3. Market Segmentation

These analyses show that the eurozone countries drive the relationship between population age, yield curve slopes, and public debt maturity. Moreover, these results were particularly strong before adoption of the euro when markets for public debt were not well integrated. Following adoption of the euro, these relationships disappear only to reemerge after the eurozone debt crisis as public debt markets disintegrate.

These findings are consistent with a naïve preferred habitat theory and provide suggestive evidence, although not proof, of market segmentation by itself. In other words, these results suggest that the clientele effect was more robust prior to the 2000s, disappeared after the introduction of the euro as markets got more integrated, and reappeared after the eurozone debt crisis due to resegmentation of the markets.

4. Conclusion

In this paper, we presented a new dataset of public debt maturity and yield curves and used it to reassess the finding of Guibaud et al. (2013) that countries with older populations face steeper yield curves and issue shorter maturity debt. We confirm these relationships but show that the eurozone countries before 2000 drive the result. Following adoption of the euro, these patterns disappear for the countries with low credit risk. However, when we include the high-credit-risk countries, the patterns reemerge after the eurozone debt crisis, suggesting that eurozone capital markets have resegmented.

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