

Sovereign debt guarantees and default: Lessons from the UK and Ireland, 1920-1938*

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Abstract

We study the daily yields on Irish land bonds listed on the Dublin Stock Exchange during the years 1920-1938. We exploit Irish events during the period and structural differences in land bonds to tease out a measure of investors' credibility in a UK sovereign guarantee. Using Ireland's default on intergovernmental payments in 1932, we find a premium of about 43 basis points associated with uncertainty about the UK government guarantee. We discuss the economic and political forces behind the Irish and UK governments' decisions pertaining to the default. Our finding has implications for modern-day proposals to issue jointly-guaranteed sovereign debt.

'Further, in view of all the historical circumstances, it is not equitable that the Irish people should be obliged to pay away these moneys' - Eamon De Valera, 12 October 1932

KEYWORDS: Irish land bonds, Dublin Stock Exchange, sovereign default, debt guarantees.

JEL CLASSIFICATION: N23, N24, G15

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1 Introduction

In the wake of the European sovereign debt crisis, there have been several proposals to issue jointly-guaranteed European bonds.¹ Under these proposals, guarantors would each take responsibility for the obligations issued under the joint guarantee, with the intention of allowing some countries to take advantage of the creditworthiness of other countries. These proposals typically assume that jointly-guaranteed sovereign debt would have near-zero spreads relative to the largest and most creditworthy participating sovereign, usually Germany. The assumption that jointly-guaranteed debt would be risk-free has made its way into a budding literature assessing the potential effects of issuing such debt, for example, Hatchondo, Martinez & Onder (2014).

Crucially, as noted by Gros (2011), the assumption that jointly-guaranteed debt is risk-free takes as given that investors have faith in the guarantee. But what evidence do we have that such guarantees are generally perceived as credible? One first-order test would be to measure accurately the market premia associated with investors' perception of the credibility in government guarantees. This is challenging because there are few examples of guaranteed sovereign debt, in a setting similar to Europe, in which it is possible to estimate such a premium. Some progress may be made by carefully studying historical cases.²

In this paper, we study *land bonds* introduced at the end of the nineteenth century specifically to address problems associated with the structure of land ownership in Ireland.³ Beginning in 1891, a sequence of parliamentary acts authorised the Treasury to issue government guaranteed bonds on international capital markets. The proceeds from the issuance were passed to the Irish Land Commission, which had been authorised

¹ For example, Delpa & von Weizsacker (2011) propose that states issue jointly-guaranteed ('blue') bonds up to a limit of 60 percent of their GDP, with any issuance above the limit in sole-guaranteed ('red') bonds. Bofinger, Feld, Franz, Schmidt & Weder di Mauro (2011) suggest that joint-guarantees be given to debt issued by states in excess of 60 percent of their GDP, while Hellwig & Philippon (2011) propose that the jointly-guaranteed debt should be in the form of short-term bills, rather than bonds. See also Jones (2010), Favero & Missale (2012) and Stiglitz & Basu (2013). Claessens, Mody & Vallée (2012) provide a helpful review of the proposals.

² In related work, Esteves & Tunçer (2016) study the moral hazard associated with debt guaranteed by Britain, France and Russia that were issued by Greece, Turkey, Egypt and China during the eighteenth and early part of the nineteenth centuries. And Collet (2014) studies the mutualisation of debt as part of Italian unification. In addition, an historical analogy to debt guaranteed by another sovereign is drawn by Winkler (2011) and passing mention of some examples is made by Phillips (2012).

³ The United Kingdom of Great Britain & Ireland was formed by the union of Britain (England, Wales & Scotland) and Ireland in 1801. From 1922, when Southern Ireland became independent with Dominion status, the United Kingdom was comprised of Great Britain and Northern Ireland. We use the term UK throughout and refer to southern Ireland as the Irish Free State or Ireland.

under the same parliamentary acts to administer state-funded mortgages. Tenant-farmers used these long-term state loans to purchase land from the incumbent land-owners, and promised to repay annuities twice a year for terms of up to 70 years into Irish government-administered funds. The holdings in these funds were transferred through the National Debt Commission to the Treasury, which held ultimate responsibility for upholding the government's guarantee to repay the interest and principal on the land bonds.⁴

In many ways, the historical setting we study is reminiscent of modern-day Europe. For example, Ireland and the UK had a de-facto single currency throughout the period of our study. In addition, the two countries were close trading partners and had integrated financial markets (Ó Gráda 1994). And, although Ireland was less-developed compared with the UK, both had relatively strong and advanced institutions and markets in comparison with the rest of the world. Undoubtedly, there are differences between the two economic environments but, as we will discuss, this is often to our advantage.

To tease out a measure of the investors' perception of the credibility of the guarantee, we exploit structural differences between land bonds. Prior to Ireland's independence in 1922, land bonds were guaranteed by the UK government. Following independence, the Irish government continued to implement land reform by issuing land bonds through the Irish Treasury.⁵ In all major respects, the pre- and post-independence land bonds were identical except that the pre-independence land bonds carried UK government guarantees.⁶ Part of the difference between the yield on benchmark government securities and the yields on land bonds reflects the market's perception of the value of government guarantees. Irish events during our period help to assess the credibility of government guarantees, using variation in the response of the yield spreads on different land bonds to the events.

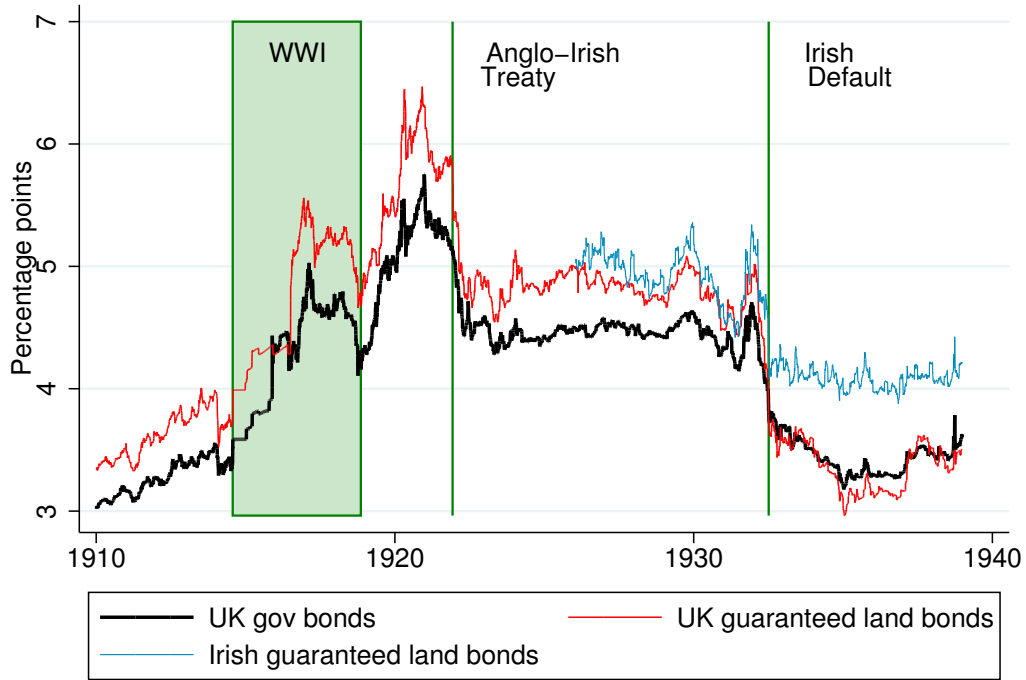
We study the daily yields to maturity on land bonds traded on the Dublin Stock Exchange during the years 1920-1938. We use the same analytical framework that is frequently applied to financial time-series to find historical events that were perceived as

⁴ For more details on institutional background, see Appendix A and Foley-Fisher & McLaughlin (2016).

⁵ Fiscal responsibility was determined before independence and negotiations surrounding the debt were relatively transparent. For example, prior to the 1913 & 1920 *Government of Ireland* bills, there were several parliamentary publications regarding Irish contribution to UK national debt published which laid the foundation for the subsequent independence (B.P.P. 1912-13*b,-,-*, 1913, 1920*d,a,c,b*).

⁶ The presence of the gold standard and the de facto single currency between the UK and Ireland obviated the risks of inflation and exchange rate movements (e.g. see Daly (2011)). We discuss volatility and liquidity risks in Section 5. Moral hazard associated with the guarantee was limited by the strict connection between bond issuance and land reform.

Figure 1: Weighted average (nominal amount outstanding) yields to maturity



Source: Dublin Stock Exchange, authors' calculations

important at the time they occurred.⁷ We compute a weighted average of the individual yields to maturity, where the weights are the nominal amounts outstanding, shown in Figure 1 for UK government bonds (the thick black line), UK-guaranteed land bonds (the medium red line) and Irish-guaranteed land bonds (the thin blue line) from 1910 to 1938.

Our main finding is a significant break coinciding with the Irish government's decision to no longer make annuity transfers to the UK government. The reneging of a sovereign financial obligation to another state constitutes a sovereign default.⁸ The default event allows us to quantify the premium associated with investors' credibility about the UK government guarantee. We compare the effect of the default on the long-term spreads of both UK and Irish guaranteed land bonds. This analysis is akin to a difference-in-difference estimation, where the first difference is between land bond yields and

⁷ Some examples in European settings include Frey & Kucher (2000, 2001), Frey & Waldenström (2004), Waldenström & Frey (2008), and Brown & Burdekin (2002). Additional examples in U.S. settings include Davis & Pecquet (1990), Willard, Guinnane & Rosen (1996), Brown Jr. & Burdekin (2000), and Weidenmier (2002).

⁸ Default is the term used by the UK government 'Irish Situation Committee' and the Chancellor of the Exchequer, e.g. 21 June 1932: 'Irish Situation Committee', National Archives of Scotland, CAB27/523. However, largely because there was no actual loss for bondholders, this default is not recorded in established lists of sovereign defaults (Reinhart & Rogoff 2009, 2014).

government bond yields, and the second difference is between the periods before and after the default. The UK government’s decision to uphold the guarantee on the land bonds suggests a premium of about 45 basis points was attributable to uncertainty about the UK government guarantee.

Our findings suggest there was a significant risk premium associated with uncertainty about the commitment of the UK to the guarantee. In our concluding remarks, we discuss the implications for recent policy proposals to issue jointly-guaranteed sovereign debt. We argue that the similarities between our historical setting and modern-day Europe, combined with our relatively clean empirical strategy, offer some evidence that the proposed jointly-guaranteed European bonds might not be risk-free. When assessing the implications of proposals, academics and policymakers should not neglect a potentially large and significant risk premium associated with uncertainty about guarantees.

The remainder of our paper is divided into four sections. We briefly describe our data in Section 2, before setting out our empirical methodology and results in Section 3. And we offer some concluding remarks in Section 6.

2 Data

We collected our data on bond prices from the daily records of the Dublin Stock Exchange (Foley-Fisher & McLaughlin 2016).⁹ Financial markets treated Irish land bonds as sovereign debt, evidenced by their listing in contemporaneous stock exchanges in the same category as sovereign bonds.¹⁰ This distinguishes the land bonds from the quasi-government debt associated with specific utilities and infrastructure projects including, for example, the separate lists of state enterprises and municipal bonds. Table 1 lists the main characteristics of the six land bonds that appear in our database. The table reports

⁹ In addition to the Dublin Stock Exchange, early land bonds were listed on many stock exchanges throughout the UK and Ireland, while later land bonds were traded more narrowly. The location of trading was unrelated to credit ratings. According to Moody’s all outstanding land bonds in 1922 had AAA ratings. Issuance under the 1903 land act was listed on the London, Birmingham, Dublin, Glasgow, Liverpool and Manchester stock exchanges, whilst the subsequent issuance under the 1903/09 land acts was listed on the London, Cork, Dublin, Glasgow and Manchester stock exchanges. The relatively small issuance under the 1891 land act was solely listed on the Cork and Dublin Stock exchanges. The land bonds guaranteed by Ireland were quoted in Dublin and Cork and for some years also on the London Stock Exchange (Thomas 1986).

¹⁰ Since the underlying asset is a pool of long-term mortgages, land bonds are an early example of state-sponsored mortgage backed securities (MBS), such as those issued by US government-sponsored agencies Fannie Mae and Freddie Mac. Agency MBS trade at a premium to private label MBS in reflection of an implied government guarantee, but are not treated equivalent to US Treasuries. Indeed, during the 2007-2008 financial crisis, the US government had to affirm explicitly its support for GSE debt in response to elevated concerns that the GSEs might default (Hancock & Passmore 2010).

for each bond the annual coupon rate paid half-yearly, together with the coverage of prices in our database, and the maximum amount that was outstanding during the period. The first three land bonds were issued under Land Acts prior to Irish independence as full obligations of the British government (Blakemore 1922, p.49). The post-independence land bonds carried similar terms, the major exception being that they were obligations of the Irish government.¹¹ As was common for long-term bonds at the time, the redemption terms for all land bonds specified an initial period of about 30 years during which the bonds could not be called. Thereafter, the bonds were callable at the option of the government. Also similar to other long-term British bonds, the majority of obligations were perpetuities that carried no final maturity date.

Table 1: Dublin Stock Exchange: land bonds

	Coupon %	Coverage Window		Max Outst. £m	Gov. Guarantee	Redemption terms	
		First Date	Last Date			Earliest call	Maturity
Pre-independence							
Land Act 1891	2.75	1892/7/27	1938/12/30	13.20	UK	5 Aug 1921	1940
Land Act 1903	2.75	1904/7/19	1938/12/30	57.26	UK	1 Nov 1933	perpetuity
Land Act 1903/09	3	1910/12/19	1938/12/30	71.50	UK	3 Dec 1939	perpetuity
Post-independence							
Land Act 1923	4.5	1926/1/20	1938/12/30	24.88	UK/Irl.	30 years	perpetuity
Land Act 1925	4.5	1934/2/8	1938/12/30	.59	UK/Irl.	30 years	18 Dec 2004
Land Act 1934	4	1934/10/26	1938/12/30	2.81	Irl.	30 years	perpetuity

Source: National Archives records of the Dublin Stock Exchange, Blakemore (1922), Land Acts 1923:1; 1925:3; 1934:7

To calculate a yield spread for the land bonds, we construct yields on British sovereign bonds. To match the maturity of the land bonds, which were mostly perpetuities, we calculate a weighted average yield on British sovereign perpetuities.¹² These bonds are listed in Table 2, which reports coupon, database coverage, maximum outstanding and redemption terms for each bond. Over the period of time we are studying, British consols were being replaced with a variety of long-term bonds so it is important to consider alternatives to simply using the consol yield as benchmark (Homer & Sylla 2005, p.444).

¹¹ Although the British government offered a guarantee on bonds issued under the Land Act 1923 and Land Act 1925, the Acts included a clause specifying the repayment and penalty terms for the Irish government to reimburse the British government in the event that the guarantee was called (Land Act, 1923:2 and Land Act, 1925:2).

¹² One could interpret our methodology as matching the land bond yields to estimates of a parametric benchmark yield curve, where the parameters are pinned down at the long-end of the curve using the weighted average yield on British perpetuities (Nelson & Siegel 1987, Svensson 1994). Once the weighted average yield on perpetuities is accepted as the appropriate match for all land bonds, there is no difference between a weighted average of individual land bond spreads and the difference between the weighted average of land bond yields and the weighted average yield on perpetuities.

Recognising the initial 30-year no-call period on land bonds, we also experimented with yields on all British bonds that had a maturity of at least 30 years and found similar results.

Table 2: Benchmark long-term UK government bonds

	Coupon %	Coverage Window		Max Outst. £m	Redemption terms	
		First Date	Last Date		Earliest call	Maturity
2.5% stock	2.5	1890/1/6	1938/9/26	33	5 Jan 1905	perpetuity
Consol	2.5	1890/1/6	1938/12/30	592	5 Apr 1923	perpetuity
2.75% stock	2.75	1890/1/9	1938/9/26	5	5 Jan 1905	perpetuity
3.5% war	3.5	1932/12/1	1938/12/1	2085	1 Dec 1952	perpetuity

Source: National Archives records of the Dublin Stock Exchange, Blakemore (1922)

We compute the yield to maturity on all bonds using the procedure described in Appendix B, taking into account any no-call periods and using realised rates of redemption as a proxy for investors' expected probability that the government would call their bonds. For each trading day, we use the last price recorded in the Dublin Stock Exchange reported in the daily stock and share list. We construct clean bond prices whenever they are quoted inclusive of accrued dividends, assuming for simplicity a discount rate of 3 percent. In addition, we follow the methodology of Klovland (1994) when calculating the yields on UK consols. We then calculate the daily weighted average yields to maturity for benchmark UK government bonds, UK guaranteed and Irish guaranteed land bonds, where each bond's yield is weighted by its nominal value outstanding.

3 Structural breaks in land bond spreads

We begin our analysis by applying the structural break search methodology pioneered by Willard et al. (1996) and employed by Zussman, Zussman & Nielson (2008). The underlying statistical model incorporates structural shifts into an autoregressive process for land bond spreads. The central idea is that we want to locate sudden and long-lasting changes in land bond spreads. The use of an autoregressive process obviates the need to model slow changes in institutional structures and macroeconomic environment.¹³ We then map our findings of sharp changes in the spreads on land bonds to the historical

¹³ This simplification is commonly employed in historical studies of both bond prices and bond yields, see for example Willard et al. (1996) and Oosterlinck & Landon-Lane (2006).

narrative. By contrasting movements in different land bond spreads, and comparing with the historical narrative, we can learn why market perceptions of the value of government guarantees changed.¹⁴

3.1 Methodology for finding structural breaks

We use a recursive search algorithm to find long-lived shifts in the perceived value of sovereign guarantees, measured as the spread in land bond yields over UK government bond yields. We look for shifts in the mean of the spread, since no trend term is expected in typical models of sovereign bond spreads in non-crisis times (Aguiar & Amador 2014). In the first stage of the algorithm, given a time series of land bond spreads (y) indexed by time (t) we estimate the following model for the first 600 sequential daily observations:¹⁵

$$y_t = \alpha + \sum_{l=1}^L \beta_l y_{t-l} + \gamma D_t, \quad t \in \{1, \dots, 600\} \quad (1)$$

$$\text{where } D_t = \begin{cases} 0, & \text{if } t < 300 \\ 1, & \text{otherwise} \end{cases} \quad (2)$$

We compute the F-statistic associated with the test of the null hypothesis that $\gamma = 0$, i.e. that there is no structural break in the land bond spread on date $t = 300$. Then the subsample is advanced by one period, $t \in \{2, \dots, 601\}$, and the model is re-estimated. By collecting the statistics from testing the significance of γ parameters from each estimated model, we can construct a time series of tests for structural breaks in the yield spread on land bonds.

In the second stage of the search algorithm, we use the largest significant γ statistic to identify a window that is most likely to contain a structural break.¹⁶ That window

¹⁴ We follow the Willard et al. (1996) methodology because it is frequently used in historical studies of structural breaks. As a robustness check on our overall methodology, we also used the approach developed by Bai & Perron (1998) and Bai & Perron (2003). In Appendix C, we describe that process in detail, and summarise our findings, which are very similar to those reported below.

¹⁵ We repeated the analysis using 400 and 800 sequential observations as a robustness check and find similar results. The lag length L is determined by estimating over the full sample the model excluding the dichotomous variable and sequentially removing lags according to the Akaike information criterion.

¹⁶ The overlapping data samples in the first stage invalidate the use of standard critical values for tests of significant structural breaks. Instead, we estimate the critical values using 5000 Monte Carlo simulations of an artificial time series without structural breaks: $y_t = 0.9y_{t-1}$. For a window of 600 days, the 90- 95- and 99-percent critical values are 6.4, 8.4, and 12.9, respectively.

is extended by 25 days at both ends and is removed from the time series. Repeating this process yields a set of non-overlapping windows that are likely to contain structural breaks. In each enlarged window, we sequentially search for structural breaks within the narrower window by estimating the following model for $s \in \{26, \dots, 625\}$:¹⁷

$$y_t = \alpha + \sum_{l=1}^L \beta_l y_{t-l} + \gamma D_t^s \quad (3)$$

$$\text{where } D_t^s = \begin{cases} 0, & \text{if } t < s \\ 1, & \text{otherwise} \end{cases} \quad (4)$$

3.2 Results

Figures 2a and 2b show the results over the period 1921-1938 from applying the algorithm described above to UK and Irish guaranteed land bond spreads, respectively.¹⁸ The solid (red) lines in each panel show the time series of the weighted average land bond spreads over UK government bonds. The short-dashed (yellow) lines show the sequential first stage γ statistics and the long-dashed (black) spikes show the structural breaks identified by the second stage of the algorithm.

We find three significant structural breaks in land bond spreads, all of which are in the spread on UK guaranteed land bonds.¹⁹ The first break in 1921 occurred on the UK-backed land bond spread at roughly the same time that the Anglo-Irish Treaty was signed. This finding is consistent with an elevated risk that farmers would default during the Anglo-Irish War, when an effort to enforce payment by the UK government might escalate the War. Unfortunately, we cannot be certain that this was the case without comparing to the spread on Irish-guaranteed land bonds, which did not exist at that time. Nevertheless, the UK-backed land bond spread remained positive after the treaty was signed, suggesting that investors might have still perceived some uncertainty about the value of the UK guarantee relative to other long-term UK government debt.

The second break occurred in the first half of 1932, corresponding to the default

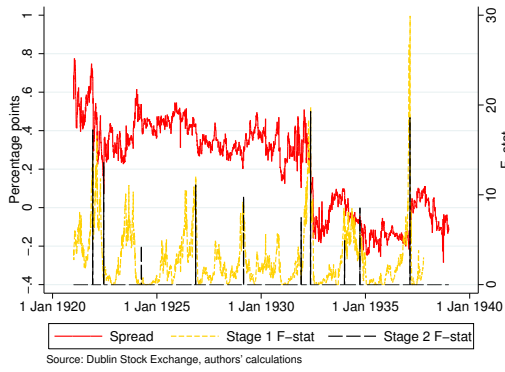
¹⁷ We use the same null model to simulate statistics for the second stage of the algorithm, to obtain 90- 95- and 99-percent critical values of 16.5, 18.8, and 24.6, respectively. These critical values are consistent with those reported in Table 2 of Banerjee, Lumsdaine & Stock (1992).

¹⁸ We exclude from our analysis all trading pre-1918, as the Dublin Stock Exchange imposed price floors for most of the First World War and was closed from August 1914 until January 1915.

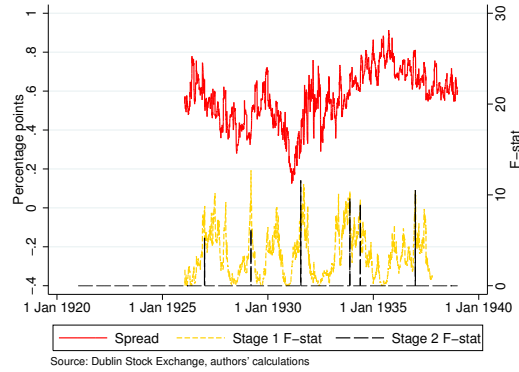
¹⁹ We estimate the model over the full sample of UK-backed land bond spreads, but we report the results only for 1921 onwards. Results for the full sample are available from the authors on request.

Figure 2: Structural breaks in the spread on land bonds over UK bonds

(a) UK guaranteed land bonds



(b) Irish guaranteed land bonds



(c) UK guaranteed land bonds

Date	Stage 1 F-stat	Stage 2 F-stat
4/2/1920	7.64	4.57
5/12/1921	16.6	17.25
15/6/1922	11.08	13.61
4/4/1924	5.02	4.37
11/11/1926	12.05	11.12
27/2/1929	9.21	9.87
3/12/1931	5.69	7.48
16/5/1932	19.72	19.3
1/1/1934	8.5	4.92
27/9/1934	1.3	8.56
19/2/1937	29.92	18.61

(d) Irish guaranteed land bonds

Date	Stage 1 F-stat	Stage 2 F-stat
31/12/1926	1.76	5.27
14/3/1929	12.7	6.27
24/7/1931	11.2	11.6
21/11/1933	10.37	9.64
21/5/1934	3.51	9.07
29/12/1936	10.48	10.53

episode.²⁰ A real possibility that Ireland might default on its intergovernmental obligations began to emerge towards the end of 1931, but negotiations and responses to the actual default event occurred throughout 1932. In February 1932, reversing the allocation of seats between the top two parties, Fianna Fáil defeated the incumbent party Cumann na nGaedheal by 72 seats to 57, after campaigning on a platform that included withholding annuity payments. Shortly after the election of the Fianna Fáil government, a bill to remove the oath of allegiance was introduced in parliament and De Valera made a series of public announcements in March that the Free State would not honour the bi-annual payments due under various financial agreements between Ireland and the UK.²¹ The prospect of the Irish government's withholding of annuity payments increased at the same time that it became clear that the UK government would not default on the bondholders. On 30 June, one day before the dividend payment on the land bonds, *The Times* announced that the British government considered the Free State to intend to default and that the British Treasury would cover the payment.²² The following day, the British government made the interest payment on those bonds.²³

The third and final structural break occurred towards the end of the sample, at the beginning of 1937 when the spread on UK government guaranteed land bonds rose significantly. One possibility is that this break is related to the constitutional crisis associated with the abdication of Edward VIII, which had implications for the wider British Empire and Commonwealth. In particular, uncertainty that the British government would retain its overseas possessions may have called into question the

²⁰ The Irish default occurred in the same year that the self-governing Dominion of Newfoundland defaulted on its own obligations. Although Newfoundland and Ireland shared certain similarities, a key difference was political: Ireland was an independent state. Thus, unsurprisingly, the UK government's reaction to the defaults was quite different. Newfoundland was forced to resort to aid from the UK on condition that it 'voluntarily reverted to the status of a crown colony' and gave up its status of a self-governing Dominion under the Statute of Westminster (MacKay 1934, p.895). In addition, a key economic difference was that the Irish Free State had not defaulted on its own sovereign obligations. Rather, the Irish Free State had defaulted on an inter-governmental agreement related to debts that had pre-dated the Irish Free State, and could thus be portrayed by the Irish government as odious. In the case of Newfoundland, the debts, although also guaranteed by the UK, were incurred by the government of the Dominion itself and thus could not be characterised as odious. Defaulting on such a large debt burden demonstrated that the Dominion itself was financially unstable. The UK government was able to use Newfoundland's need of a bailout as political leverage, eventually forcing it into confederation with Canada.

²¹ Hancock (1964, p.334) cites several newspapers, *the Observer* 21 February 1932, *the Manchester Guardian*, 16 March 1932 and the *New York Times* on 18 March 1932.

²² *The Times*, 30 June 1932.

²³ The British Prime Minister compared the Irish decision to not make obligations to contemporaneous defaults throughout the world. He noted that 'On the question of the Land Annuities, on which default might be expected in June 1932, the feeling of the Committee was that this issue, serious as were the financial loss and the breach of faith involved, was transcended by the issue of allegiance. The default might be compared to the cases which had occurred in other parts of the world of failure to meet loan obligations. (ISC (32) 24, 2nd Meeting, 12 April 1932).

government's willingness to guarantee bonds contracted explicitly in relation to those possessions. Greater doubt about the value of the guarantees could result in the observed higher spreads.

While this is a testable hypothesis, given more data on other Commonwealth bond yields, we are hesitant to place any emphasis on this finding. A glance at the spreads in Figures 2a and 2b suggests that the identified change could be due to few observations at the end of the sample. Our methodology may be vulnerable when the sample grows short towards the end of the period for which our data are available. Consistent with this view, Appendix C shows that the alternative methodology of Bai & Perron (1998) and Bai & Perron (2003) finds structural breaks closely matching only the first two breaks. For these reasons, we prefer to focus the remainder of our paper on the major structural break that occurred in 1932.

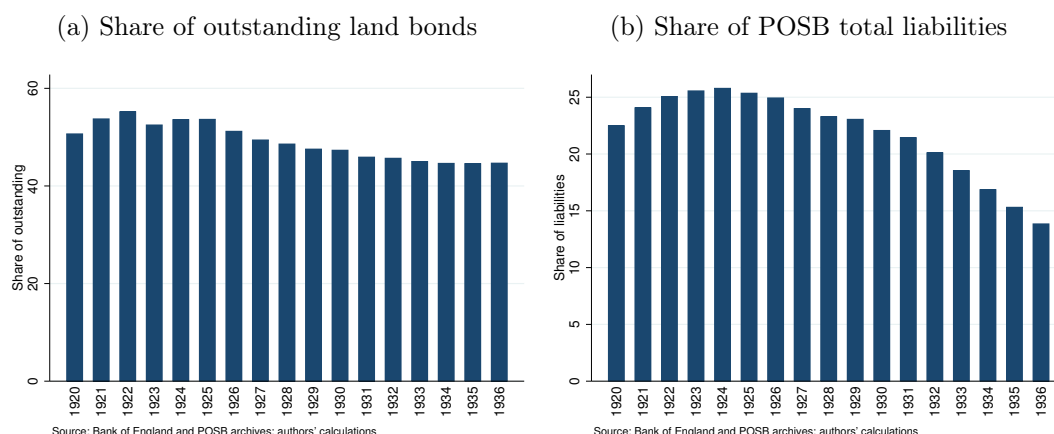
4 Why did the UK not default on the land bonds?

A natural question arising from the default episode is why the UK did not place the blame on the Irish government and default on the bondholders. Although there are a number of possible explanations, we find the weight of evidence supports the idea that the government was unwilling to default because the bonds were held domestically (Broner, Martin & Ventura 2010, Gennaioli, Martin & Rossi 2014). A default on the bonds would have hurt large UK government-owned institutional investors at a time when the government wanted their assistance.

First, the UK government guaranteed land bonds were mostly held by UK government-owned institutional investors. Figures 3a and 3b show the holdings of UK guaranteed land bonds by the Post Office Savings Bank (POSB) from 1920 to 1936, as a share of total land bonds outstanding and as a share of the POSB balance sheet, respectively. At the time of the default, the POSB was the single largest holder of UK guaranteed land bonds, with just over £60 million, or about 50 percent of the nominal outstanding amount. The land bond holdings accounted for about 20 percent of the POSB balance sheet, so a default would likely have raised concerns about the solvency of the bank. This was important because the POSB played a major role in the emergence of state banking over the period of our study and was viewed as part of the UK government's strategic

development of the banking system (Ferguson 2006).²⁴

Figure 3: Post Office Savings Bank Holdings of UK Guaranteed Land Bonds



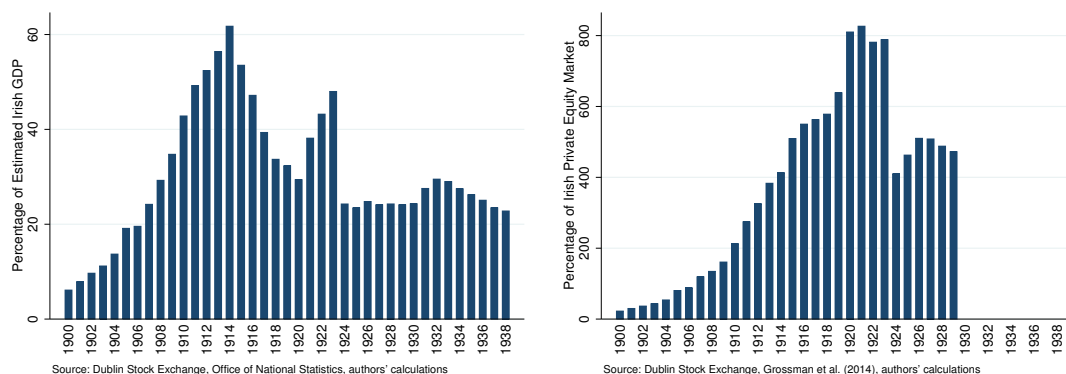
Second, the default on the land bonds was more likely to have been strategic because the actual fiscal burden on the Irish government was small. Figures 4a and 4b show that the nominal value of all land bonds outstanding was a significant liability relative to the Irish economy. Land bonds peaked at over 60 percent of estimated Irish GDP in 1914 and was worth about 40 percent of Irish economic output at the time of independence. The nominal value of outstanding land bonds was massive relative to the private company equity listed on the Irish equity market, peaking at around eight times the entire market capitalization during the early 1920s.²⁵ However, the burden to the Irish government came only when land owners defaulted on their annuity payments. And the threat of losing the land meant that default rates on the annuities was small, with only 10-15 percent in arrears in the year before the default event (Foley-Fisher & McLaughlin 2016). Since the actual liability for the Irish government amounted only to about 1 percent of its annual expenditure, the fiscal burden was small. The strategic behaviour of the Irish government has two implications for the question of why the UK government did not default. To convince bondholders that the blame resided with the Irish government, the UK government would have had to confront the reasons for the strategic default. And a strategic default suggests the Irish government had considered the response of the UK government to its action.

²⁴ Other UK institutional investors also held land bonds, including the National Insurance Fund, which we estimate accounted for a further 5-10 percent of the outstanding UK guaranteed land bonds. Additional details on the holders of land bonds is available in Foley-Fisher & McLaughlin (2016).

²⁵ We are indebted to the authors of Grossman, Lyons, O'Rourke & Ursu (2014) for sharing their data on the Irish equity market.

Figure 4: Outstanding land bonds

(a) As a share of estimated Irish GDP (b) As a share of Irish private equity market



Third, primary evidence indeed suggests the Irish government was aware that holdings in the UK would likely force the UK government to avoid default. In the House of Commons, the Secretary for the Dominions stated that there was no hesitation to meet the obligations, since a default would have affected holders in the UK.²⁶ During the same debate, David Lloyd George, the former UK Prime Minister, accused the Irish Prime Minister of strategically defaulting because he knew the UK government would not allow a default.²⁷ Thus, in summary, the available evidence consistently suggests that the UK government knew that the land bonds were held in domestic institutions which would be detrimentally affected by a default.²⁸

²⁶ We knew a few weeks ago that we were not to receive this money. We had budgeted for this amount, and we knew that unless steps were taken there would be a deficit of that amount. We had to say, “What shall we do? Shall we repudiate our obligations? Shall we on the 1st July say, ‘Ah, well, we have not received it, and, although we guaranteed it to you, we do not propose to pay it?’” The people who would have been affected by that action are not only in England but in Ireland. There was no question. There was no doubt. We did not hesitate a moment, and we said, “No, although we have not received the money, although we have budgeted for the money, we will meet our obligations on the 1st July.” The cheques to all those who were entitled to their interest were sent and have been received. That was the position. (Hansard Debate 17 June 1932)

²⁷ ‘Mr. De Valera says, “We are not going to pay. I am going to collect the money, but I will not pay these holders, it may be in Britain, it may be Ireland, it may be in America.” He knows that we will not break faith and that we will pay. He says, “I am not going to pay.” I do not believe that the Irish people will subscribe to that libel upon their fundamental integrity. Let him bear in mind the lesson of Australia. Great peoples do not show their love of freedom and their national self-respect by playing the parts of debtors of that kind. I know the difficulties the Government have – gigantic difficulties outside and great difficulties here and in Ireland. I hope, whatever the difficulties, they are not going to allow themselves to be nagged into consenting to a breach of faith or the initiation of a policy in Ireland which will be a source of danger both to this country and to Ireland.’ Former UK Prime Minister Lloyd George (Hansard Debate 17 June 1932).

²⁸ The weight of evidence suggests that domestic holdings were the dominant concern, but other factors may have contributed to the UK government’s decision not to default. For example, the land bonds were not a significant fiscal burden, accounting for less than 3 percent of total UK public debt. Also, the UK cabinet was aware of the internal political situation in Ireland and may have hoped that a trade war would inflict electoral losses on Fianna Fáil and see a return to power of the main opposition party (ISC (32) 27, 9 May 1932). (If so, this was a considerable misjudgement, especially in light of the eventual favourable settlement of the trade war in 1938 (Ó Gráda & Neary 1991, O’Rourke 1991).)

5 The premium associated with uncertainty about the guarantee

We use the effect of the default on the yield spread of UK-guaranteed land bonds to estimate the premium associated with market uncertainty about the guarantee. Circulating rumours and the gradual development of major political events imply that the impact on bond spreads is diffused. We look at the statistical properties of yield spreads in the years prior to the default in comparison with the years afterwards. Any movement in spreads could be attributable in part to a fall in the volatility of returns or a rise in the liquidity for UK-backed land bonds relative to Irish-backed land bonds. To address these concerns, we also calculate return volatility and a proxy for liquidity. Return volatility is measured using a 250-day rolling standard deviation of daily returns. Our liquidity proxy is measured at an annual frequency and uses, for each year, the ratio of days on which the bonds were traded relative to the number of days on which the bonds could have been traded.

Table 3: Descriptive Statistics: UK and Irish Guaranteed Land Bonds

	Yield Spread		St. Dev. of Returns		Yearly Liquidity	
	<u>UK</u>	<u>Irl.</u>	<u>UK</u>	<u>Irl.</u>	<u>UK</u>	<u>Irl.</u>
N	3391	3378	5218	3301	13	13
Median	4	4.35	.0033	.0036	.84	.98
Mean	4.08	4.51	.0032	.0038	.84	.98
St Dev	.73	.45	.0013	.0009	.04	.02

Note: The data sample is 1926 and onwards.

Table 3 reports summary statistics for each of these variables separately for UK and Irish guaranteed land bonds. To make a clean comparison between the two types of land bonds, we restrict our sample to the period from 1926 onwards when both types were traded. The table shows the number of observations, median, mean and standard deviations for the variables. To estimate the long-term effect of the default, we estimate the following model for each variable:

$$y_t = \alpha + \beta D_t + \epsilon_t$$

where the variable D_t takes the value 1 in the periods following the default event and 0

otherwise.

Table 4: Effect of Default on UK and Irish Guaranteed Land Bonds

	Yield Spread		St. Dev. of Returns		Yearly Liquidity	
	UK	Irl.	UK	Irl.	UK	Irl.
Const.	0.341*** (0.00)	0.478*** (0.00)	0.003*** (0.00)	0.004*** (0.00)	0.840*** (0.02)	0.964*** (0.01)
Default	-0.432*** (0.00)	0.187*** (0.00)	0.001*** (0.00)	-0.001*** (0.00)	0.007 (0.02)	0.021* (0.01)
Obs.	3130	3117	3040	3040	12	12
Adj. R^2	0.87	0.43	0.19	0.28	-0.09	0.34

Note: Robust standard errors are reported in parentheses. The variable ‘Default’ equals zero before, and one after, the default event. The data sample is from 1926 and onwards. Data during the years of independence and default are omitted. ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent level, respectively.

The first two columns of Table 4 show the long-term change in the yield spread on land bonds over UK government bonds that occurred during the default year. The constant term is the average spread in percentage points in the benchmark period (1926-1932). Thus, during the benchmark years, UK- and Irish-backed land bonds had spreads of about 35 and 50 basis points over long-term UK government bonds, respectively.²⁹ The coefficient on the dummy variable for the years following default indicates that the spread on UK-backed land bonds fell about 43 basis points during 1932 while the spread on Irish-backed land bonds rose by about 19 basis points.

The absence of a spread in the yield on UK guaranteed land bonds after 1932 indicates that investors ceased to treat the land bonds as risky investments relative to UK government bonds. Although the spread was not large in the years prior to the default, it was significantly different from zero, indicating that investors perceived positive credit risk despite the guarantees that the bonds carried from the UK government. After the Irish government defaulted, and the UK guarantee was upheld, investors re-evaluated the risk associated with the UK-backed land bonds and began to treat them as if they

²⁹ For some context, Eichengreen (1989) report cross-country yield spreads in the 1930s had a mean of 46 basis points and a standard deviation of 120 basis points. In Ireland, the spread-implied credit risk is low compared with similar countries (for example, Bulgaria and Hungary) without the assistance of well-placed underwriters, and the League of Nations in the case of post-war economies (Eichengreen 1989, Flandreau & Flores 2009). In part, this may have been due to its inheritance of institutions that were well-known to British investors.

were identical to other long-term UK government bonds. At the same time, there was a slight rise in the perceived credit risk associated with Irish-backed land bonds, which was already higher than that of UK guaranteed land bonds. This was perhaps due to investors updating their assumptions about the willingness of the Irish government to default on at least some of its obligations, if the economic and political circumstances justified the action.

As noted above, the movement in spreads could be attributable in part to a fall in the volatility of returns on UK-backed land bonds relative to Irish-backed land bonds, or a rise in the liquidity of UK-backed land bonds relative to Irish-backed land bonds. However, the remaining columns of the same table show that the return volatility and the liquidity of land bonds moved in the opposite direction from that needed to explain the movement in the spreads. The third and fourth columns of Table 4 report the change in return volatility, indicating that the return volatility of UK-backed land bonds increased significantly in the years after the default while the return volatility on Irish-backed land bonds decreased. The fifth and sixth columns report the change in our annual liquidity proxy. Albeit with few datapoints, the available evidence suggests that there was no change in the liquidity of UK-backed land bonds while the liquidity of Irish-backed land bonds actually rose. These volatility and liquidity findings are not consistent with the relative decline in the credit risk associated with UK guaranteed land bonds and imply that the relative movement reported in Table 4 is a lower bound on the movement due to the default.

A further concern is that the movement in the spread on land bonds may be attributable to UK government policies. Although the yields on land bonds moved broadly in step with UK government bonds throughout 1931 (even as the UK government announced its emergency budget and abandoned the gold standard in September 1931) it is possible that the land bonds were reacting to the removal of an elevated risk of restructuring, perhaps related to a widely-anticipated conversion of the gigantic 5 percent War Loan.³⁰ On one hand, uncertainty about the conversion of the War Loan may have

³⁰ The interest payments on the burdensome War Loan accounted for almost 14 percent of UK fiscal revenue in 1932 and were viewed by the UK government as an economic drag to recovery from the Great Depression. Although the conversion had been signalled in the previous year, with technical and legal preparations included in the National Debt (War Loan Conversion and Redemption) Bill and in the Finance (No. 2) Act 1931, the details of the conversion were not publicised until mid-way through 1932, thus closely aligned with the Irish government's failure to make the mid-year annuities transfer. There were five modifications to the terms: (i) the coupon was cut to 3½ percent, (ii) with three months' notice, the bonds could optionally be redeemed at

kept the yield elevated relative to other UK government bonds. On the other hand, anticipation of the conversion may have moved the yields on other UK debt in expectation that the fiscal burden on the UK government would fall. Our weighted average yield of benchmark UK perpetuities is a way to even out these opposing forces. However, as a robustness test, we repeated all the analysis above using only the yield on the pre-war consol when computing the spread on land bonds to avoid underestimating the spread prior to the conversion of the war loan. While we do find evidence that the yield on war loans was elevated relative to other benchmark UK government debt, we nevertheless find similar results for the timing of structural breaks.

Previous studies (Nevin 1963, Ó Gráda 1994) have focused on yield spreads between UK and Irish government bonds; in both cases excluding land bonds. In Nevin (1963)'s view the war loan conversion had a significant impact on yield spreads and that this 'was not paralleled by anything comparable in Ireland.' On the other hand, Ó Gráda (1994) argues instead that it was the coming to office of Fianna Fáil in February 1932 that spooked markets and pushed Irish flat yields up. We offer a nuanced view: the war loan conversion was certainly important to UK yields (and spreads based on them), but we cannot ignore the impact of Fianna Fáil policy on yield spreads.

6 Concluding remarks

In this paper, using daily data from the Dublin stock exchange, we study the yields on land bonds, issued with joint-guarantees to finance Irish land reform in the nineteenth and twentieth centuries. We document historical events that had long-lasting effects on the spread between different types of land bonds and matched-maturity benchmark British government bonds. We use major historical events, together with structural differences between UK-guaranteed land bonds and Irish guaranteed land bonds, to assess market participants' views on the commitment of the UK government to their guarantee.

We find that uncertainty about government guarantees, even after the establishment of the Irish Free State, were responsible for a non-trivial secondary market risk premium. The risk spread on UK-guaranteed land bonds disappeared when the Irish government

par any time after 1 December 1952, (iii) the right to tender the issue to pay death duties was to lapse, (vi) the Depreciation Fund would cease to exist and (v) the name of the bond would change to 3¹/₂ per cent War Loan (Wormell 2000).

defaulted on its intergovernmental agreement (land bond annuity transfers) and the UK government upheld its guarantee. Contrasting the response of different land bonds to the Irish default allows us to estimate the market premium associated with uncertainty about the UK government guarantee. Our results show that a statistically and economically significant uncertainty premium of about 43 basis points persisted until the UK government guarantee was tested.

Our findings contribute to a recent literature and policy discussion on the issuance of jointly-guaranteed debt by European countries. We offer some evidence for the argument that the rate on jointly guaranteed European debt may not be risk-free. The institutional factors in our historical setting were not capable of eliminating all uncertainty about the guarantee. There was uncertainty despite having a majority of the debt owned by UK institutions, a currency union, free and substantial trade relations, integrated factor markets, strong political and economic institutions, a realised expectation that sanctions might be imposed in the event of default, and a guarantee from the most important financial economy of the time. So, it is ambitious to claim that current European institutional arrangements are capable of eliminating all uncertainty related to the guarantee. Contemporary academics and policymakers should note that market credibility is not a foregone conclusion and that, while the issuance of jointly-guaranteed European debt might remove some credit risk, the premium associated with uncertainty about the credibility of the joint guarantee may be large.³¹

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³¹ By way of comparison, a debt-weighted average of European peripheral 10-year sovereign spreads over the benchmark German bond indicates that spreads were about 103 basis points in 2014. If the debt to GDP ratios are used as alternative weights, the weighted average peripheral spreads were 287 basis points in 2014. We include spreads for Greece, Ireland, Italy, Portugal and Spain in the calculation.

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A Institutional background

The political background to this paper is dominated by the Irish nationalist movement that during the nineteenth century adopted land reform as a major element in its identity (Lyons 1971, Boyce 2005, Dooley 2004). In an effort to curb this movement, the UK government introduced several pieces of legislation specifically to address problems associated with the structure of land ownership in Ireland. Beginning in 1891, a sequence of parliamentary acts endorsed the use of land bonds to finance state mortgages that were granted to tenant-farmers so that they could purchase the land they occupied.³² The political motive for land redistribution was seen as crucial to counter the Irish nationalist movement. So the UK government was prepared to offer both generous mortgage terms to tenant-farmers and generous land bond terms to investors, effectively transferring resources from taxpayers to farmers and bondholders. Table 5 shows the timing of these land acts in the context of other key events in the process of Irish land reform and Anglo-Irish political relations.

However, these land reform efforts did not halt the nationalist movement, which eventually achieved independence following the Anglo-Irish War through the signing of the Anglo-Irish Treaty in December 1921. Under the terms of this treaty, the Dominion of the Irish Free State was formed, comprising 26 of the 32 historic counties of Ireland. But a number of clauses within the text, such as the permanent partition of the island (section 11), an oath of allegiance to the King (section 4), and permanent ports for the use of ‘His Majesty’s Imperial forces’ (section 7), were anathema to hardline republicans. The ratification of the treaty by the newly formed parliament (Dáil) of the Irish Free State led to a split within nationalist ranks and resulted in Civil War. The division of Irish politics ever since has been along civil war lines and not along traditional right-left lines as in other countries (Garvin 1981). This is important because De Valera’s Fianna Fáil party, founded in 1926, was on the anti-treaty side and during its time in office in the 1930s it attempted to unilaterally re-write the treaty, taking advantage of the trans-national

³² In addition, the land acts contained provisions for landlords to avail themselves of state credit (Gailey 1987). To the many small landlords heavily burdened with mortgaged estates, the low interest and long lifespan terms of the state loans were attractive and persuaded many of them to remain in Ireland, thereby alleviating the social tension associated with absentee landlordism. This generosity towards landlords was subsequently criticised by the Irish party at the same time that concerns arose that the land acts had been seriously underfinanced. Even UK political parties began to criticise the land acts for committing scarce Treasury resources to a strictly political gesture of conciliation, with no apparent formation of a prosperous agricultural society.

Table 5: Timeline of key events in Irish land reform

Date	Event
August 1891	First use of land bonds under the Land Act 1891
August 1896	[Balfour] Land Act - second act to implement land reform using land bonds
August 1903	[Wyndham] Land Act - largest land act in terms of money raised via bond issue
December 1909	[Birrell] Land Act - additional issuance of land bonds with a higher coupon than 1903
August 1914	Outbreak of World War I
September 1914	Government of Ireland act - enactment of home rule bill giving Ireland devolved powers but act suspended due to outbreak of WWI
April 1916	Uprising by Nationalists in Dublin
January 1919	Beginning of the Anglo-Irish war
December 1920	Government of Ireland Act
December 1921	Anglo-Irish Treaty signed
April 1922	Irish Civil War begins
April 1923	Ceasefire ends Irish Civil War
August 1923	[Irish Free State] Land Act - first land reform act passed by Irish Free State
November 1924	First meeting of commission to settle boundary between Irish Free State & Northern Ireland
December 1931	Statute of Westminster grants greater legislative independence to Commonwealth Dominions
February 1932	Fianna Fáil win general election and form government
June 1932	Irish government misses deadline for payment of annuities
December 1934	Coal-Cattle Pact - agreement on quotas for coal & cattle
April 1938	Anglo-Irish trade agreement - resolution to trade war following default

policy freedom provided by the 1931 Statute of Westminster (McMahon 1984).³³

The treaty is also important because it overrode the 1920 Government of Ireland Act that had intended to annul the repayment of land bonds (B.P.P. 1920*d*).^{34,35} After

³³ The Statute of Westminster gave self-governing dominions of the Commonwealth constitutional and legislative equality with the UK. For the first time since its creation, Fianna Fáil were able to directly challenge UK rule from within the Irish parliament, despite the instructions passed to the then Irish High Commissioner in London, T. J. Kiernan, that ‘whatever the legal powers which the statute of Westminster might confer on the Irish Free State Parliament, the moral obligation to abide by the Articles of Agreement [the Treaty] remained...and such an oral obligation was a higher sanction than any legal safeguard’ (McMahon 1984, p.29). Contemporary debate argued that the Statute should include a limitation clause in relation to Ireland should it try to alter the terms of the treaty. At the time, Churchill, and other diehard conservatives, argued that ‘if the imperial parliament passed the bill which was before it without inserting into it the proposed amendment, it would be leaving itself without legal protection against the bad faith and the ill will of some future Irish government’ (Hancock 1964, p.330). During debates an amendment was introduced that aimed to deny Ireland access to the Statute but this was not incorporated in the final Act (Daly 2011, p. 30).

³⁴ It was later claimed in a press statement that this was purely for ‘administrative convenience’. Under the Government of Ireland Act, both the Northern and Southern Irish governments were required to make an ‘imperial contribution’, fixed at £18 million a year. Against this each of the new governments was to receive ‘a grant to assist her in setting up a subordinate Government which, merely as a matter of administrative convenience, was to have been fixed at the amount equivalent to the existing Land Purchase Annuities. It cannot be consistent to claim the benefits of the treaty of 1921 which gave the Irish Free State Dominion Status and also the benefits (without the obligations) of the Act of 1920 which would have regulated the position of Southern Ireland as a subordinate part of the United Kingdom.’ ISC (Sub)(32) 6, 10 August 1932.

³⁵ It is unclear why the annuities were not included as part of the treaty. A later letter written by Liam S. Gogan and sent to the Minister for Finance 1932 suggested that there was confusion and the decision to include annuities in the treaty was the unilateral decision of a Treasury mandarin, indicating that the official involved ‘had ambitions for colonial governorship and that the surrender of the annuities had no other origin. The view was of course that they had been completely overlooked in the treaty legislation and that consequently we were entitled to retain them. A wrong decision having given them to London the precedent became stereotyped.’ (Letter from Attorney General, S 2002/16/336).

independence the newly created Free State was obligated for four principal sources of debts: Irish Republic bond-certificates (issued to fund the War of Independence); land bonds; a share of the UK public debt; and new issuance. Section 5 of the 1922 Irish Free State (Agreement) Act stated that the Free State was liable for a portion of the UK public debt (Lee 1989). The Free State was subsequently released from this obligation under the 1925 Confirmation of Agreement Act, widely believed to have been a concession for accepting permanent partition of the island, with 6 counties remaining within Northern Ireland (Lee 1989, p.145 and Ferriter 2004, p.294).

Nevertheless, after this agreement, the Irish Free State remained obligated to transfer annuity payments to the UK exchequer as part of the complex process of repaying bondholders. Tenant farmers who had received loans from the Land Commission repaid annuities twice a year into Irish government administered funds: the Purchase Annuities Fund received payments on loans that were issued as part of the land reform acts pre-1923 and the Land Bond Fund received the payments on loans issued as part of the land reform acts post-1923. The holdings in these funds were transferred to the National Debt Commission (NDC)/Treasury, which made interest and principal repayments to bond-holders. Although these funds were segregated from other accounts of the Irish government, if either fund could not meet the expected transfers to the NDC/Treasury the Irish government would cover the shortfall using the Guarantee Fund, which was itself funded from local taxation taken from the Irish government's central fund.³⁶

The Irish and UK government guarantees enhanced the value of the farmers' debt to investors. In the event that the farmers were to default on their annuity payments, the state would step in to ensure that the bondholders would remain whole. This credit enhancement allowed market participants to treat the debt as sovereign, evidenced by the listing of the bonds in the UK sovereign debt subsection of daily stock market reports, distinct from the lists of colonial, foreign government, and semi-state corporation debts. We follow contemporaneous market participants by treating the land bonds as de-facto sovereign debt, and attribute any difference between the yield on benchmark government securities and the yields on land bonds as reflecting the market's perception of the value of government guarantees.

At the same time, the governments' guarantee was beneficial to the tenant farmers,

³⁶ We are grateful to Aidan Kane for pointing this out.

allowing them access to large amounts of credit relatively cheaply. By intermediating between tenant farmers and capital markets, the government allowed farmers to borrow at lower rates and for longer terms than on private credit markets (Foley-Fisher & McLaughlin 2016). Unsurprisingly, farmers took advantage of these generous terms and borrowed significantly. By the time of independence in 1921, the nominal amount of land bonds outstanding was almost £60 million, rising to about £80 million by the end of our sample.

Differences in the sovereign guarantees attached to the land bonds allow us to identify changes in the value of the guarantees over time. Although all the land bonds were ‘backed’ by a stream of annuity payments from Irish farmers, credit enhancement from the sovereign was the major factor ensuring the high value (low coupon) of the bonds.³⁷ Some of the land bonds carried UK government guarantees, while others carried Irish government guarantees. As reported in Table 1 of the main text, the first three issues of land bonds were made prior to Irish independence with UK government guarantees. After independence, the Irish government guaranteed the issuance of three additional land bonds, one of which was co-guaranteed by the UK government.³⁸ We can measure changes in market participants’ views on the value of the sovereign guarantees by looking at the change in the spread on the land bonds over UK sovereign bonds, considered at that time to be the benchmark risk-free bonds on the Dublin Stock Exchange.

B Computing perpetual bond yields with no-call periods

In this appendix, we derive the formula equating the price of a perpetual bond to its present discounted value to find the yield to maturity. Consistent with the bond characteristics reported in Tables 1 and 2, we allow for a no-call window followed by a perpetual callable period. We then show that the yield to maturity can be found by solving the formula using Newton’s method. To represent the lottery provisions present in the terms of a callable bond, we assume that the par value of the bond is repaid (and the bond ceases to exist) with probability q in each period. The table below summarizes the notation that will be used throughout this appendix.

³⁷ The bonds were sold at a discount in the primary market. Nevertheless, the secondary market yield to maturity was competitive with other contemporaneous UK sovereign bonds (Foley-Fisher & McLaughlin 2016).

³⁸ Although the coupons are higher on the land bonds guaranteed by the Irish government, the offer needs to be taken in the context of other sovereign debt issued at that time.

Table 6: Notation

Price of bond	p	Periods of no-call	d
Coupon on bond	c	Yield to maturity	r
Prob. of repayment	q		

The general formula for the price of a perpetual bond with a no-call window of d periods, followed by a callable provision in perpetuity can be expressed as the present discounted value of (probabalistic) cash flows:

$$p = \underbrace{\frac{c}{r} \left(1 - \left(\frac{1}{1+r} \right)^d \right)}_{\text{no-call period}} + \underbrace{\left(\frac{1}{1+r} \right)^d \left[q \left(\frac{c+100}{1+r} \right) + (1-q) \left[\frac{c}{1+r} + q \left(\frac{c+100}{(1+r)^2} \right) + \dots \right] \right]}_{\text{perpetual callable period}}$$

We re-write the formula as a function $f(r) = 0$ where:

$$f(r) = p - \frac{c}{r} \left(1 - \left(\frac{1}{1+r} \right)^d \right) - \left(\frac{1}{1+r} \right)^d \left(\frac{c+100q}{r+q} \right)$$

We can apply Newton-Raphson-Simpson's method of solving a function to find the yield to maturity r that minimises $f(r)$ to within an error ϵ close to zero. This method iterates from an initial guess r_0 according to the following well-known formula:

$$r_{n+1} = r_n - \frac{f(r_n)}{f'(r_n)}$$

Where the derivative of the function is simply:

$$f'(r) = \frac{c}{r^2} \left(1 - \left(\frac{1}{1+r} \right)^d \right) + \frac{c+100q}{(r+q)^2} \left(\frac{1}{1+r} \right)^d + \left(\frac{c+100q}{r+q} + \frac{c}{r} \right) d \left(\frac{1}{1+r} \right)^{d+1}$$

Note that $f(r)$ is globally convex, so there is a unique global minimum. A solution can be obtained quickly given a good initial guess because the Newton-Raphson method converges quadratically. Since we have a time-series of observations, we can use the yield to maturity from the previous day as an initial guess. We obtain the values of the parameters in the function for each bond from the prospectuses and from the observed rates of repayment.

C Bai-Perron Analysis

As a robustness check on the methodology employed to locate structural breaks in this paper, we implement the alternative methodology developed by Bai & Perron (1998) and Bai & Perron (2003). For each land bond spread over benchmark UK government bonds, we specify a series of auto-regressive models that allow for multiple structural breaks at different points in the univariate time-series.

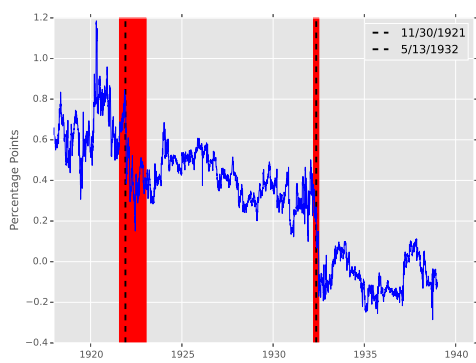
In simple terms, the Bai-Perron methodology proceeds by forming a matrix of residual sum of squares (RSS). Each additional row in the matrix adds a structural break to the model, while each column of the matrix considers a different location in the time-series for the additional break. This matrix is used to select the number and location of structural breaks that minimize the residual sum of squares. Within the class of models considered, the selected structural breaks are those that best fit the time-series, without any need for information outside of the univariate time-series. We implement the Bai-Perron methodology using the R-code “strucchange”. The number of lags in the auto-regressive process is determined by minimizing the Bayesian information criterion.

Figures 5a and 5b show the time-series of spreads as blue lines for the UK guaranteed and Irish guaranteed land bonds, respectively. The estimated structural breaks are shown as dashed black vertical lines, together with associated 95 percent confidence intervals as red shaded regions. Structural breaks in the UK guaranteed land bond spread are estimated to have occurred on Nov 11, 1921 and May 13, 1932. We calculate the supF statistic associated with the final model to be 14.45, which is significant at the 1 percent level when compared with the critical values reported by Bai & Perron (2003). By contrast, there is no structural break in the Irish guaranteed land bond spread that has a narrow confidence interval over the entire sample period. Consistent with the idea that there was no meaningful structural break in that spread, we found a model supF statistic of 3.81, which is not statistically significant.

In summary, the structural breaks we find using the Bai-Perron methodology are very similar to two of the breaks we find using the methodology of Willard et al. (1996). Thus, the data consistently suggest that long-term shifts in the spread on UK guaranteed land bonds occurred around the times when Ireland signed the Anglo-Irish Treaty and when the Irish government defaulted on its inter-governmental obligations.

Figure 5: Bai-Perron Structural Breaks

(a) UK guaranteed land bonds



(b) Irish guaranteed land bonds

