

# 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 structural differences in bonds guaranteed by the UK and Irish governments to find Irish events that had long term effects on the credibility of government guarantees. We document two major events: The Anglo-Irish Treaty of 1921 and Ireland's default on intergovernmental payments in 1932. We discuss the political and economic forces behind the Irish and UK governments' decisions. 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: Ireland, Irish land bonds, Dublin Stock Exchange, sovereign default, debt mutualization.

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 that joint-guarantees could be applied to European bond issuance (Delpla and von Weizsacker 2011, Stiglitz and Basu 2013). Under these proposals, the guarantors would each take individual responsibility for the obligations issued under the joint guarantee, allowing countries with high spreads to take advantage of the creditworthiness of other countries. These proposals may be taken to suggest that jointly-guaranteed sovereign debt would have almost-zero spreads (Hatchondo et al. 2014). However, there is virtually no studies of existing or historical cases where states have jointly guaranteed sovereign debt.<sup>1</sup>

In this paper, we exploit structural differences between *land bonds* introduced fiscal policies specifically to address problems associated with the structure of land ownership in Ireland.<sup>2</sup> Prior to Ireland's independence in 1922, land bonds were guaranteed by both the Irish and the UK governments. Following independence, the Irish government continued to implement land reform by issuing land bonds through the Irish Treasury. In all major respects, the pre- and post-independence land bonds were identical except that the pre-independence land bonds carried UK government guarantees. Fiscal responsibility was determined well before independence and negotiations surrounding the debt were relatively transparent.<sup>3</sup> Moreover, 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)).<sup>4</sup> We thus 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. Hence, we can use the yield spreads on land bonds to find events that had a long-term effect on the *credibility* of government guarantees.

Beginning in 1891, a sequence of parliamentary acts authorised the Treasury to issue government guaranteed *land bonds* on international capital markets. The proceeds from

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<sup>1</sup> Analogy is drawn to US commercial banks by Winkler (2011) and passing mention of some examples is made by Phillips (2012).

<sup>2</sup> 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.

<sup>3</sup> 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*).

<sup>4</sup> We discuss volatility and liquidity risks in Section 3.4.

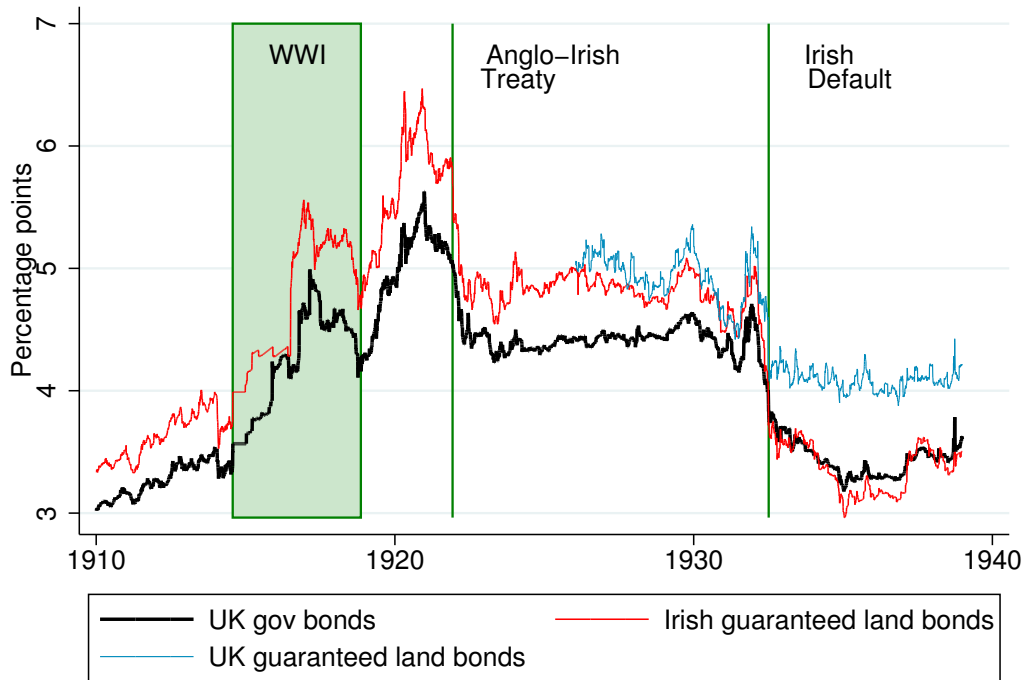
the issuance were passed to the Irish Land Commission, which had been authorised under the same parliamentary acts to administer state-funded mortgages. Tenant-farmers used these long-term state loans to purchase land from the incumbent land-owners, and promised to repay annuities twice a year for terms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

In this paper, we study the daily yields on land bonds traded on the Dublin Stock Exchange during the years 1920-1938. The aforementioned government guarantee on the land bonds acted as credit enhancement for the underlying tenant-farmers' debt. Markets treated the land bonds as sovereign debt, evidenced by their listing in contemporaneous stock exchanges in the same category as sovereign bonds. 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. The period we study covers several important events for Ireland, including the Anglo-Irish Treaty that gave rise to Irish independence, the introduction of the first Irish Free State Land Act, and the Anglo-Irish trade war.

Our study follows in the tradition of using financial time-series to find historical events that were perceived as important at the time they occurred. In European settings, previous studies have examined the effect of war-time events on the Swiss stock exchange (Frey and Kucher 2000, 2001) and the Scandinavian stock exchanges (Frey and Waldenström 2004, Waldenström and Frey 2008), while Brown and Burdekin (2002) study German bonds traded in London. The ability of bond prices to reflect political events is exploited by Oosterlinck (2003) and Ferguson (2006). In the U.S., Civil War events have been studied using bond prices by Davis and Pecquet (1990), Willard et al. (1996), Brown Jr. and Burdekin (2000) and Weidenmier (2002). Lastly, Oosterlinck and Landon-Lane (2006), when investigating events following the Soviet default of 1918, note the absence of studies of bond prices over a period of sovereign secession. More generally, the use of structural differences in otherwise similar bonds to learn something about changing market perceptions is also present in the work of Collet (2013).

To evaluate which historical events were important to market perceptions of the

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



Source: Dublin Stock Exchange, authors' calculations

government's commitment to sovereign guarantees during this turbulent period, we agnostically search for long-lasting structural breaks in our time-series. 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.

We detect several significant long-lived shifts in the spreads. First, we find a decline in the spread on UK-guaranteed land bonds roughly coinciding with the signing of the Anglo-Irish Treaty. At that time, only land bonds guaranteed by the UK government were traded and our result is consistent with an elevated risk of default during the Anglo-Irish War, when an effort to enforce payment by the UK government might escalate the War. However, the UK-backed land bond spread remained positive after the treaty was signed. This suggests that investors might still have perceived some uncertainty about the value of the UK guarantee relative to other long-term UK government debt. In the absence of data on the spread on Irish-guaranteed land bonds, which did not exist at that time, we cannot be certain that this was the case.

Second, we detect another significant break coinciding with the Irish government’s decision to no longer make annuity transfers to the UK government. The renegeing of a sovereign financial obligation to another state constitutes a sovereign default.<sup>5</sup> However, largely because there was no actual loss for bondholders, this default is not recorded in established lists of sovereign defaults (Reinhart and Rogoff 2009, 2014). In response to the Irish default, the UK government instructed its Treasury to continue making interest and principal repayments, so no bond holders suffered any loss. Unsurprisingly, then, we find a reduction in the spread on UK-backed land bonds during 1932, while there is no reduction in the spread on Irish-backed land bonds. The implication is that once the UK government demonstrated that it would deliver on its guarantee, the risk premium (spread) on the land bonds it had guaranteed fell to about zero. Although Figure 1 suggests that the yield to maturity fell below the weighted average bond yield in 1935-36, the consol yield remained below the land bond yield throughout the period.

Natural questions raised by this finding are why the UK government allowed the Irish government to renege on its commitment and why the UK government chose to repay bondholders. We discuss in detail the major economic and political forces behind the UK government’s decision. We argue that the available primary evidence supports the idea that the government was unwilling to default because the bonds were held domestically (Broner et al. 2010, Gennaioli et al. 2014). We document that land bonds were predominantly held by UK-owned institutional investors. In addition, UK politicians publicly stated that a key reason for not defaulting was their concern for domestic holders.

As a second step, we estimate the effect of these structural breaks on long-term spreads. This analysis is akin to a difference-in-difference estimation, where the first difference is between land bond yields and government bond yields, and the second difference is between the periods before and after the structural breaks suggested by the search procedure. We find that spreads on UK-guaranteed land bonds fell by about 50 basis points in response to the UK government’s decision to uphold the guarantee on the land bonds.

Our findings are consistent with a significant risk premium associated with uncertainty about the commitment of the UK to the guarantee. Until it was clearly demonstrated that

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<sup>5</sup> 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.

the UK would act on its guarantee, the spread between the UK guaranteed land bonds and other long-term UK government debt remained positive, even after independence. The spread fell to zero when the guarantee was tested and was proven good, while Irish-backed land bonds retained a premium only slightly wider than had been exhibited before the default.

In our concluding remarks, we discuss the implications of our findings for recent policy proposals to issue jointly-guaranteed sovereign debt. Our findings suggest that, while a joint guarantee could reduce spreads from their current levels, it may not return the spreads to their pre-crisis levels.

The remainder of our paper is divided into four sections. We review the institutional background in Section 2. We set out our empirical methodology and results in Section 3. And we offer some concluding remarks in Section 4.

## 2 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.<sup>6</sup> 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 1 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.

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<sup>6</sup> 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.

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 policy freedom provided by the 1931 Statute of Westminster (McMahon 1984).<sup>7</sup>

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*).<sup>8,9</sup> After independence the newly created Free State was obligated for four principal sources of

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<sup>7</sup> 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).

<sup>8</sup> 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.

<sup>9</sup> 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).

Table 1: 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

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.<sup>10</sup>

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.<sup>11</sup>

At the same time, the governments' guarantee was beneficial to the tenant farmers, 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 and McLaughlin 2015). 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. Figures 2a and 2b show that the nominal value of all land bonds outstanding was a significant liability relative to the Irish economy. Land bonds peak at over 60 percent of estimated Irish GDP in 1914 and are 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.<sup>12</sup> Furthermore, the annuity repayment to the UK Treasury by the Irish Free State amounted to about 11 percent of all public expenditure in 1931, the year before the default, underscoring the scale of the fiscal liability.

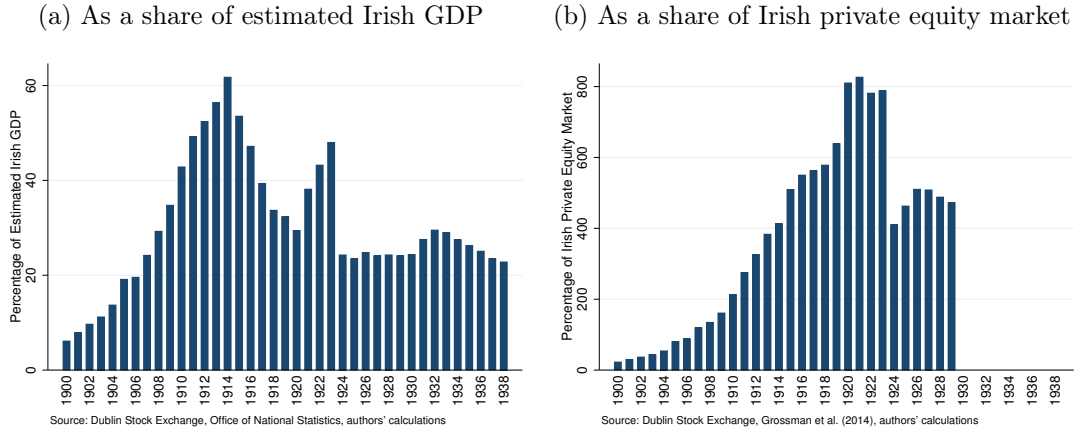
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<sup>10</sup> We are grateful to Aidan Kane for pointing this out.

<sup>11</sup> Since the underlying asset is a pool of long-term mortgages, this kind of credit enhancement is 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 and Passmore 2010).

<sup>12</sup> We are indebted to the authors of Grossman et al. (2014) for sharing their data on the Irish equity market.

Figure 2: Outstanding land bonds



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.<sup>13</sup> Some of the land bonds carried UK government guarantees, while others carried Irish government guarantees. As reported in Table 2, 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.<sup>14</sup> 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.<sup>15</sup>

Land bonds had a long maturity, matching the farmers’ long mortgage repayment terms. This means that we need to use long-term UK sovereign bonds when calculating

<sup>13</sup> 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 and McLaughlin 2015).

<sup>14</sup> 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.

<sup>15</sup> 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 and all were ‘full obligation of British government’ (Blakemore 1922, p.49). 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). The Dublin stock exchange was closed from August 1914 until 30 December 1914. In addition, price floors were introduced in 1914 which placed minimum prices on trading.

Table 2: Dublin Stock Exchange: land bonds

	Coupon %	Coverage Window		Max Issuance £m	Gov. Guarantee
		First Date	Last Date		
Pre-independence land bonds					
Gtd. land stock, red. 1921	2.75	1892/7/27	1938/12/30	13.20	UK
Gtd. land stock from 1903 land act	2.75	1904/7/19	1938/12/30	57.26	UK
Gtd. land stock from 1903/09 land act	3	1910/12/19	1938/12/30	71.50	UK
Post-independence land bonds					
Land bonds	4.5	1926/1/20	1938/12/30	24.88	UK/Irl.
New land bonds	4.5	1934/2/8	1938/12/30	.59	Irl.
Land bonds (land bond act 1934)	4	1934/10/26	1938/12/30	2.81	Irl.

Source: National Archives records of the Dublin Stock Exchange

Table 3: Benchmark long-term UK government bonds

Bond	Coverage		Coupon	Max Issue £m
	First Date	Last Date		
2.5% stock	1890/1/6	1938/9/26	2.5	33
Consol	1890/1/6	1938/12/30	2.5	592
2.75% stock	1890/1/9	1938/9/26	2.75	5
2.75% war	1900/5/14	1910/5/11	2.75	30
Exch. (1905)	1901/11/21	1905/12/6	3	14
Exch. (1909)	1905/6/15	1909/10/13	3	6
Exch. (1915)	1913/3/12	1915/7/15	3	21
War (1925-28)	1915/4/16	1928/2/7	3.5	350
War (1925-45)	1915/8/30	1932/10/26	4.5	900
4% victory	1919/9/16	1938/12/30	4	360
Exch. bills	1922/6/22	1930/3/3	3	4
3.5% war	1932/12/1	1938/12/1	3.5	2085

Source: National Archives records of the Dublin Stock Exchange

Note: All long-term bonds have a maturity of at least 30 years.

the yield spread on land bonds over benchmark UK sovereign debt. We include in our calculations UK government bonds that have a maturity of at least 30 years (listed in Table 3). For all bonds, we compute the yield to maturity, accounting for lottery provisions whenever present, following the procedure described in Appendix A. 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.

Given the institutional structure described in this section, we can use changes in the spreads of land bonds over benchmark UK government bonds to indicate times as a proxy

for changes in the credibility of government guarantees. We interpret the co-movement in the spreads of both UK and Irish guaranteed land bonds as reflecting common factors, such as changes in the risk of tenant farmer default, macroeconomic conditions, and government policy. More importantly, idiosyncratic movement in the government-backed land bond spread reflects changes in credibility about the government guarantee. In the next section, we look for significant changes in the spreads on land bonds and compare our findings with the historical narrative to develop intuition for changes in perceived uncertainty about the government’s commitment to uphold the guarantee.

### 3 Structural breaks in land bond spreads

In this section, we apply the structural break search methodology pioneered by Willard et al. (1996) and employed by Zussman et al. (2008). With land bond spreads that reflect UK and Irish guarantees, our objective is to identify significant structural breaks in the time series of land bond spreads over UK government bond yields. We can then use these structural breaks to learn about changes in the market perception of government guarantees.

#### 3.1 Methodology

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 (Aguar and 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:<sup>16</sup>

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

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

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<sup>16</sup> As a robustness check, we repeated the analysis using 400 and 800 sequential observations 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.

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  $\gamma$  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  $\gamma$  statistic to identify a window that is most likely to contain a structural break.<sup>17</sup> That window 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  $s \in \{26, \dots, 625\}$ :<sup>18</sup>

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

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

### 3.2 Results

Figures 3a and 3b show the results over the period 1921-1938 from applying the algorithm described above to UK and Irish guaranteed land bond spreads, respectively. 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  $\gamma$  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.<sup>19</sup> The first break in 1921 occurred on the

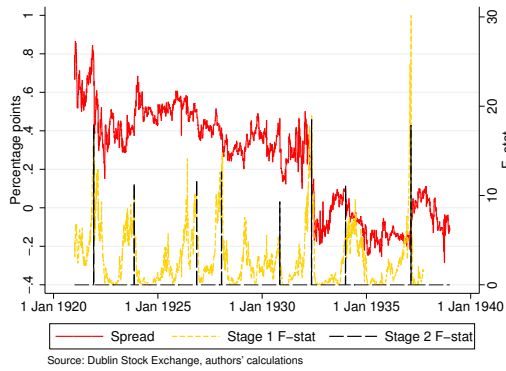
<sup>17</sup> The overlapping data samples in the first stage invalidate the use of standard critical values for tests of significant structural breaks. Instead, we estimate the critical values using 5000 Monte Carlo simulations of an artificial time series without structural breaks:  $y_t = 0.9y_{t-1}$ . For a window of 600 days, the 90- 95- and 99-percent critical values are 6.4, 8.4, and 12.9, respectively.

<sup>18</sup> 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 et al. (1992).

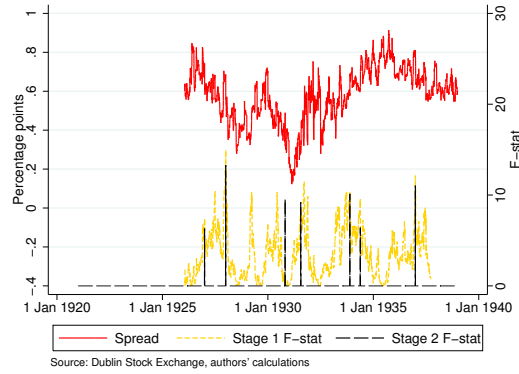
<sup>19</sup> We estimate the model over the full sample of UK-backed land bond spreads, but we report the results only for 1921 onwards. Results for the full sample are available from the authors on request.

Figure 3: 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	7.32	4.92
<b>5/12/1921</b>	<b>16.66</b>	<b>17.95</b>
13/11/1923	10.09	11.39
11/11/1926	14.14	11.78
20/1/1928	14.8	12.66
6/11/1930	5.58	9.32
<b>16/5/1932</b>	<b>19.07</b>	<b>18.52</b>
1/1/1934	9.57	11.19
<b>19/2/1937</b>	<b>30.18</b>	<b>17.9</b>

(d) Irish guaranteed land bonds

Date	Stage 1 F-stat	Stage 2 F-stat
31/12/1926	3.04	6.31
2/1/1928	14.95	13.3
27/10/1930	6.89	9.54
24/7/1931	11.46	9.22
21/11/1933	10.39	10.13
21/5/1934	4.17	6.41
29/12/1936	12.14	11.04

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 episode.<sup>20</sup> 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 were strung out 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.<sup>21</sup> 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.<sup>22</sup> On 30 June, one day before the dividend payment on

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<sup>20</sup> 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 individual 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 leverage, eventually forcing it into confederation with Canada.

<sup>21</sup> 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.

<sup>22</sup> At the same time as it considered 'various courses of action which might be taken by the United Kingdom Government to recoup themselves for [the anticipated Irish default]', negotiated with the Irish government in an effort to ensure that the £1,250,000 due from the Irish Free State on Account of the Land Annuities before the 1st July would be made (ISC (32) 31, 6th meeting, 21 June 1932). Although no final deal was reached, negotiations continued throughout the first half of the year, including meetings between De Valera and the UK government on June 10, and an agreement was reached whereby the annuities would continue to be collected and held in a

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.<sup>23</sup> The following day, the British government made the interest payment on those bonds.<sup>24</sup>

The third and final structural break occurred towards the end of the sample, at the beginning of 1937. A glance at the spreads in Figures 3a and 3b suggests that the identified change is probably due to few observations at the end of the sample. Our data sample ends at the same time that negotiations conclude the trade war between Ireland and the UK. We think it is unlikely that the opening of negotiations were sufficient to cause a structural break in the yield spread and there were no other major events in the UK or Ireland around that time. For these reasons, we focus the remainder of our paper on the first two structural breaks.

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suspense account pending arbitration. The Treasury was reluctant to open the payments to arbitration, noting that ‘Before, however, committing ourselves to accept arbitration in the case of the financial issues, including the Land Annuities, we should be very careful to see that we had a good case in law as well as in equity. It would be very embarrassing if the Tribunal found that while the Free State were morally bound, they were not in law formally bound by the Agreements...We should be subjected to every kind of misrepresentation, and unfortunately it was not generally known that at the time when the financial settlement was negotiated we had made such tremendous concessions to secure agreement that there was now nothing more left for us to concede.’ ISC (32) 28, 7th meeting, 5 July 1932. For its part, the Irish Free State was unwilling to accept arbitration that did not have non-Commonwealth members(B.P.P. 1931-32).

<sup>23</sup>“The cabinet considered yesterday the position created by the refusal of the Irish Free State to pay the half-yearly land annuities, amounting to £1,500,000 which are now due. Unless the money is in the hands of the National Debt Commissioners by midnight tonight the Free State will be in default, and as it is taken for granted that Mr. de Valera has no intention of handing the money over the Cabinet had to consider the next steps that must be taken. The Irish land stock is guaranteed by the British Treasury, and the holders will therefore receive their dividends as usual tomorrow. The Treasury will provide the money which will enable the Bank of England to make the payment but the Cabinet are determined that the burden shall not be borne by the British taxpayer. It was therefore agreed that steps should be taken to recover the money from the Irish Free State and when the business for next week is announced in the House of Commons today it will be found that time has been set apart for legislation on the subject which will be placed on the State Book before the summer recess. It is understood that the government will ask parliament to pass a measure giving the Treasury power to impose special duties on goods imported from Ireland, including livestock and dairy produce, notwithstanding the provision the import duties act that all goods imported from the Dominions shall enter this country free of duty until November 15. As the Bill will impose a tax, it is necessary for it to be preceded by a resolution in Committee of ways and means, and this resolution will be discussed on Monday.” *The Times*, 30 June 1932.

<sup>24</sup> According to the Press release, ‘The British Government duly fulfilled their guarantee in respect of interest payments to holders of land bonds whether in Ireland or in Great Britain, but the Government did not feel it fair to the taxpayers of this country to impose upon them this additional burden due to the failure of the Irish Free State to meet its just obligations. Moreover, other payments due by the Irish Free State, amounting in all to over £400,000, had not been made. In the circumstances the only course open to the British Government was to take steps to recoup themselves for the additional charge imposed on United Kingdom funds, and to this end they took action to pass the Irish Free State (Special Duties) Act and to issue an Order under it charging special duties on certain articles imported from the Irish Free State. ISC (Sub) (32) 6 (revise) - copy no 17-10 August 1932. 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).



### 3.3 Why did the UK not default on the land bonds?

A natural question arising from the default episode is why the UK did not lay 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 et al. 2010, Gennaioli et al. 2014). A default on the bonds would have hurt large UK government-owned institutional investors at a time when the government required their assistance to recover from the Great Depression.

As we describe in detail in Foley-Fisher and McLaughlin (2015), the UK government guaranteed land bonds were mostly held by UK government-owned institutional investors. At the time of the default, the single largest holder of UK guaranteed land bonds was the Post Office Savings Bank, which held about 50 percent of the nominal outstanding. A further 5-10 percent was held by the National Insurance Fund. Importantly, the land bond holdings accounted for a significant proportion of these institutions' assets.

In addition, primary evidence suggests the Irish government was aware that holdings in the UK would likely force the UK government not to 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.<sup>25</sup> During the same debate, the UK Prime Minister accused the Irish Prime Minister of strategically defaulting because he knew the UK government would not allow a default.<sup>26</sup> 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

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<sup>25</sup> 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)

<sup>26</sup> '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).

Table 4: Descriptive Statistics: UK and Irish Guaranteed Land Bonds

	Yield Spread		St. Dev. of Returns		Yearly Liquidity	
	UK	Irl.	UK	Irl.	UK	Irl.
N	5218	3378	5218	3378	20	13
Median	4.77	4.35	-.0001	-.0001	.84	.98
Mean	4.48	4.51	.0001	.0001	.84	.98
St Dev	.86	.45	.0036	.004	.03	.02

Note: The data sample is the post-War period (1919 onwards).

by a default.<sup>27</sup>

### 3.4 The long-term effect of structural breaks

Circulating rumours and the gradual development of major political events imply that the impact on bond spreads is diffused around significant events. Consistent with our empirical methodology, we assess the long-term effect of the structural breaks. To characterise the broader picture of the effect of the default on the bond market, we look at the statistical properties of yield spreads in the years prior to the structural breaks in comparison with the years after the events. 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 4 reports summary statistics for each of these variables separately for UK and Irish guaranteed land bonds.

The first two columns of Table 5 show the long-term change in the yield spread on land bonds over UK government bonds that occurred during the years 1921 and 1932. The

<sup>27</sup> 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 and Neary 1991, O'Rourke 1991).)

Table 5: 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.	0.689*** (105.30)	0.502*** (138.14)	0.005*** (170.86)	0.004*** (204.90)	0.828*** (96.95)	0.964*** (125.05)
Indep.	-0.286*** (-41.81)		-0.002*** (-57.97)		0.012 (0.81)	
Def.	-0.495*** (-149.62)	0.163*** (37.97)	0.000*** (13.94)	-0.001*** (-32.07)	0.006 (0.34)	0.021*** (2.58)
Obs.	4697	3117	4607	3114	18	12
Adj. $R^2$	0.86	0.32	0.35	0.24	-0.10	0.34

Note: Robust t-statistics are reported in parentheses. The variables ‘Independence’ and ‘Default’ equal zero before, and one after, the independence and default events, respectively. The data sample is the post-War period (1919 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.

constant term is the average spread in percentage points in the benchmark period. In the case of UK-backed land bonds the benchmark years are 1918-1921 while for Irish-backed land bonds the benchmark years are 1923-1932. Thus, during the benchmark years, both UK- and Irish-backed land bonds had a spread of about 70 basis points over long-term UK government bonds.<sup>28</sup>

The coefficient on the dummy variable for the years following independence shows the long-term change in land bond spreads after 1921. The first column shows that UK-backed land bond spreads fell about 30 basis points (Irish-backed land bonds were not traded prior to 1923). Similarly, the coefficient on the dummy variable for the years following default indicate that the spread on UK-backed land bonds fell about 50 basis points during 1932 while the spread on Irish-backed land bonds rose by about 16 basis points.<sup>29</sup> Thus, by the end of our sample period, the spread on UK-backed land bonds had dropped to about zero, with most of the decline occurring as a consequence of the default event.

<sup>28</sup> 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 and Flores 2009). In part, this may have been due to its inheritance of institutions that were well-known to British investors.

<sup>29</sup> For some context, Eichengreen (1989)’s study of yield spreads in the 1930s had a mean of 46 basis points and a standard deviation of 120 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 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 5 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 5 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)

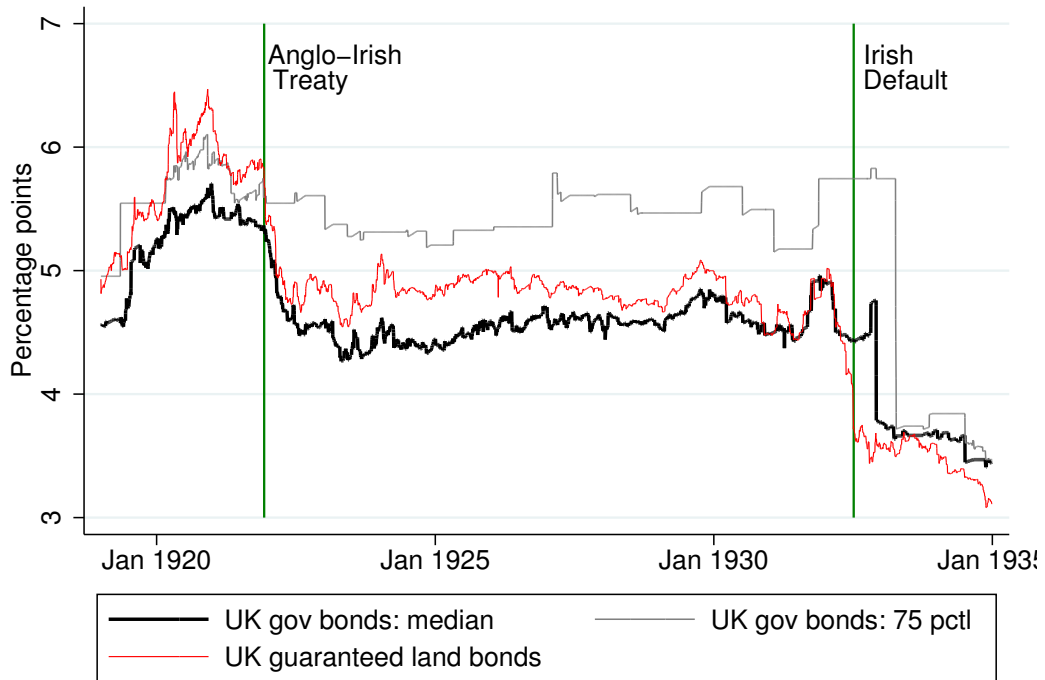
it is possible that the land bonds were reacting to the removal of an elevated risk of restructuring, perhaps related to a widely-anticipated conversion of the gigantic 5 percent War Loan.<sup>30</sup> However, Figure 4 shows that the movement in the spread is more likely due to the default and subsequent guarantee. In the figure, the medium red line represents the weighted average yield to maturity on UK-backed land bonds while percentiles from the distribution of long-term UK government bonds are represented by the thick black line for the median and by the thin grey line for the 75th percentile. The chart shows that the yield to maturity on the UK-backed land bonds was above the range of UK government yields before the Anglo-Irish Treaty. Although the yield on the UK-backed land bonds fell somewhat after the treaty was signed, it remained at the upper end of the range of UK government yields, consistent with continued uncertainty about the value of the UK guarantee. Once it became clear that the UK government would take responsibility for the payment of the UK-backed land bonds, the spread dropped below the median long-term UK government bond spread. This suggests that the decline in the yield on the UK guaranteed land bonds was a reaction to the default episode.

UK government policies may also affect the results through the weighted average UK bond yield. On one hand, uncertainty about the conversion of the War Loan may have 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 benchmark weighted average yield 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.

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<sup>30</sup> 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 3 $\frac{1}{2}$  percent, (ii) with three months' notice, the bonds could optionally be redeemed at 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 3 $\frac{1}{2}$  per cent War Loan (Wormell 2000).

Figure 4: UK government bonds and UK guaranteed land bonds yields to maturity



Source: Dublin Stock Exchange, authors' calculations

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.

## 4 Concluding remarks

In this paper, we study events that had long-lasting effects on the credibility of government debt guarantees around the time that Ireland seceded from the United Kingdom. We use 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 the Anglo-Irish Treaty of 1921 and

Ireland's decision to default on the land bonds in 1932 had significant and long-lasting effects.

In particular, 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. This risk spread on UK-guaranteed land bonds disappeared when the Irish government defaulted on its intergovernmental agreement (land bond annuity transfers) and the UK government upheld its guarantee.

The environment we study is useful when thinking about sovereign debt that is jointly guaranteed by multiple governments. Several policy proposals have suggested joint-guarantees for European debt issuance as part of efforts to avoid a repeat of the European sovereign debt crisis (Delpla and von Weizsacker 2011, Stiglitz and Basu 2013). These proposals suggest that all guarantors would take joint and several responsibility for the obligations issued under the guarantee, allowing countries with high spreads to take advantage of the creditworthiness of other countries. These proposals may be taken to suggest that jointly guaranteed sovereign debt would have almost-zero spreads (Hatchondo et al. 2014).

Our findings imply that sovereign debt mutualization may not be enough to eliminate risk spreads whenever there is doubt about the guarantee. Our results show that a significant uncertainty premium of about 50 basis points existed for a long time after Irish independence and until the UK government guarantee was tested. For comparison, a debt-weighted average of European peripheral 10-year sovereign spreads over the benchmark German bond indicates that spreads were about 12 basis points in 2007 and 103 basis points in 2014.<sup>31</sup> Thus, our study suggests that the issuance of jointly-guaranteed European debt might reduce spreads from their current levels, but it is unlikely to return spreads to their pre-crisis levels so long as there is uncertainty about the credibility of the joint guarantee.<sup>32</sup>

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<sup>31</sup> Following the debt policy proposal of Delpla and von Weizsacker (2011), the weight for each country is the minimum of debt and 60 percent of GDP. If the debt to GDP ratios are used as alternative weights, the weighted average peripheral spreads were about 23 basis points in 2007 and 287 basis points in 2014. We include spreads for Greece, Ireland, Italy, Portugal and Spain in the calculation.

<sup>32</sup> Our comparison applies only to proposals for jointly-guaranteed sovereign debt and not to proposals for mechanisms that would securitize and tranch European sovereign debt (Brunnermeier et al. 2011).

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## A Computing land bond yields to maturity

In this appendix, we derive the formula equating the price of a land bond to its present discounted value to find the yield to maturity. 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 land bond, we assume that the principal ( $M$ ) 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.

Table 6: Notation for algebra

Description	
Price of bond	$p$
Coupon on bond	$c$
Probability of repayment	$q$
Principal amount	$M$
Yield to maturity	$r$
Periods to maturity	$T$

The general formula for the price of an infinitely-lived bond that has a lottery provision can be expressed as the present discounted value of (probabalistic) cash flows:

$$\begin{aligned}
 p &= q \left( \frac{c+M}{1+r} \right) + (1-q) \left[ \frac{c}{1+r} + q \left( \frac{c+M}{(1+r)^2} \right) + (1-q) \left[ \frac{c}{(1+r)^2} + q \left( \frac{c+M}{(1+r)^3} \right) + \dots \right] \right] \\
 &= q \left( \frac{c+M}{1+r} \right) \left[ 1 + \frac{1+q}{1+r} + \left( \frac{1+q}{1+r} \right)^2 + \dots \right] + \frac{(1-q)c}{1+r} \left[ 1 + \frac{1+q}{1+r} + \left( \frac{1+q}{1+r} \right)^2 + \dots \right] \\
 &= \frac{c+qM}{1+r} \left[ 1 + \frac{1+q}{1+r} + \left( \frac{1+q}{1+r} \right)^2 + \dots \right]
 \end{aligned}$$

Converting to finite time, with  $T$  periods to maturity, we can re-write the formula as a function  $f(r) = 0$  where:

$$f(r) \equiv p - \frac{c+qM}{1+r} \left[ 1 - \left( \frac{1+q}{1+r} \right)^T \right]$$

We 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  $\epsilon$  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 second and third derivatives of the function are simply:

$$\begin{aligned} f'(r) &= \frac{c + qM}{r + q} \left[ \frac{1}{r + q} - \left( \frac{1 - q^T}{1 + r} \right) \left( \frac{1}{r + q} + \frac{T}{1 + r} \right) \right] \\ f''(r) &= \frac{c + qM}{r + q} \left( \frac{1 - q}{1 + r} \right)^T \left( \frac{T}{(1 + r)^2} \right) (T + 1) \end{aligned}$$

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 lottery repayment.