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Benchmark tipping in the global bond market

Lawrence Kreicher, Robert N McCauley and Philip Wooldridge[1]

Abstract

We analyse the turnover of fixed income derivatives in seven currencies to test the hypothesis that market participants increasingly use contracts based on private rather than government rates to hedge and to take positions. In the US dollar money market, private benchmarks long ago displaced government benchmarks. In the bond markets, evidence from organised exchanges and the Triennial Central Bank survey on over-the-counter (OTC) markets suggests that the benchmark is tipping from government bond futures to private interest rate swaps. The global financial crisis seems only to have interrupted this process in the US dollar bond market, the European sovereign bond strains may have accelerated it in the euro bond market; and the policy to clear centrally OTC trades does not seem to be impeding it. Cross-sectional analysis of 35 bond markets identifies bond market size and GDP per capita as key determinants of the existence of government bond futures. Based on these results, one may expect successful introduction of government bond futures in China and Brazil even as such contracts continue to lose ground in today's major markets.

Keywords: Benchmark, safe assets, government bond futures, interest rate swaps, US Treasury bonds, German bunds, Japanese government bonds, UK gilts

JEL classification: E44, G12, O16

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Contents

1. Introduction

This is a study of global bond market participants' choice between using derivative contracts linked to government or private yields. We take this turnover choice to indicate the relative strength of government or private yields as benchmarks. We do not pursue an alternative definition of benchmarks based on yields and leads and lags (Dunne et al (2002), Poskitt (2007)).

Following Schelling (1978), we use "tipping" to refer to a process in which market participants find it advantageous to use first one, and then another, instrument in line with the preponderant choice of other market participants. McCauley (2001) found that eurodollar futures had supplanted Treasury bill futures at the short end of the yield curve and presented evidence suggesting that the same process might be at work at the long end of the US dollar yield curve.

In this paper, after updating observations in the dollar money market, we revisit the hypothesis that market participants have shifted from derivatives linked to government bonds to those linked to private instruments. We analyse not only the US dollar bond markets but also those in six other currencies. We use the Triennial Central Bank Surveys for 1995 through 2013 in combination with *Futures and Options World* data to produce a panel of seven currencies observed seven times over 18 years.

There are three reasons to analyse government versus private benchmarks in the fixed income markets. First, developments in the US dollar money market make it useful to understand better the history of how the US Treasury bill contract died, which Stigum and Crescenzi (2007) leave unfinished. In particular, the Libor scandal has raised questions about the possible replacement for the incumbent short-term benchmark and about the role of the authorities in easing any transition to a new benchmark (overcoming inertia from network externalities). Also, the US Treasury has introduced a floating-rate note based on its bill (US Treasury (2013)).

Second, at the longer end of the yield curve, the global financial crisis and the euro area sovereign debt strains have exerted contrary effects on the usefulness as hedges of government bonds versus interest rate swaps. On the one hand, dispersion of bank credit and revelations about self-dealing in the setting of the floating leg both make swaps more problematic. On the other hand, flight-to-quality and, in the euro area, idiosyncratic movements of German bond prices, have made government bond futures problematic hedges (introducing basis risk) for private paper.

Third, the global effort to centralise market structures for interest-rate swaps has the potential to make heretofore over-the-counter swaps more competitive with government bond futures. An alternative interpretation is that without the benefits of OTC trading, private benchmarks could lose out to government ones.

This paper is structured as follows. Section 2 reviews developments in the US dollar money market, the only currency in which a government money-market benchmark attained a predominant position. Section 3 shows how government bond derivatives have tended to lose ground to private rate derivatives in seven currencies over the past 18 years. Section 4 reports a statistical analysis of the existence of futures markets. Section 5 discusses money-market benchmarks and swap regulation. Section 6 concludes.

2. Benchmark tipping in the money market

To frame the analysis of benchmark tipping in the bond market, this section provides an updated analysis of how the eurodollar supplanted the Treasury bill as a US dollar money-market benchmark. The drying up of all trading in the Treasury bill contract makes a come-back very unlikely even given the US Treasury's introduction of floating-rate notes based on Treasury bills.[2]

At the same time, discussion of practical substitutes for Libor make it of interest to consider the role of private parties in shifting to Libor from the Treasury bill and the current competition between incumbent Eurodollar and its challengers, federal funds futures, overnight interest-rate swaps (OIS) and repo futures. In sum, we find that private market participants predominated in the shift of benchmarks, at least in the US market for adjustable-rate mortgages, and discover that Libor still dominates its rivals in the futures markets even though OIS has taken on some important benchmark roles in the over-the-counter market.

2.1 The US Treasury bill future loses out to Libor futures

The story of the short end of the US dollar yield curve is easily told. The Treasury bill contract was introduced in January 1976, the second exchange-traded interest rate derivative.[3] As such, it was well established before its private sector rivals even appeared. In particular, first the US certificate of deposit (CD) contract, was introduced in 1980 and then the eurodollar contract in 1982. The Treasury bill contract was also well established before the over-the-counter money market derivatives like forward-rate agreements appeared (Eurocurrency Standing Committee (1986)).

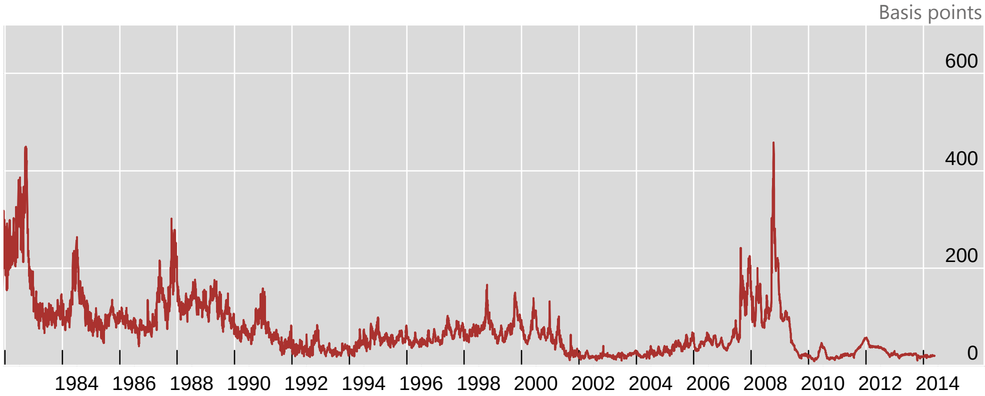
Despite a long head-start, the Treasury bill lost out as a benchmark to the Eurodollar future. What tilted the balance was basis risk that materialised in particular during crises. In Graph 1, peaks occurred with the start of Latin American debt crisis in August 1982, the Continental Illinois crisis in May 1984, the stock market break in October 1987, corporate defaults in late 1990, and the Asian financial crisis, LTCM/Russian default and the Brazilian crisis in the late 1990s.

On these occasions, hedges of Libor-based assets or liabilities with the Treasury bill future proved to be ineffective. In the extreme, price movements associated with a flight to quality could inflict losses on both sides of the intended hedge, as Libor-based long positions lost value and short positions in US Treasury futures also lost value. Such basis risk encouraged market participants to abandon the Treasury bill futures for the Eurodollar futures. The more who shifted, the more who were encouraged to do likewise in response to ebb of liquidity in the bill futures and the flow of liquidity into the eurodollar futures.

2 After extended discussions, the US Treasury (2013) has decided to use the 13-week Treasury bill auction rate to reset the interest rate every week on a one- to 10-year note. Were the Treasury bill future to stage a comeback, it would defy what might be called the F Scott Fitzgerald law of derivatives: there are no second acts in derivative lives.

3 On what is now the Chicago Mercantile Exchange. In October 1975, the Chicago Board of Trade opened trading in contracts for Ginnie Mae pass-through certificates, and before that what is now the CME opened trading in the Deutsche mark and other major foreign currencies. See Stigum (1990, p 726).

The spread between Treasury bill and eurodollar rates [1] Graph 1



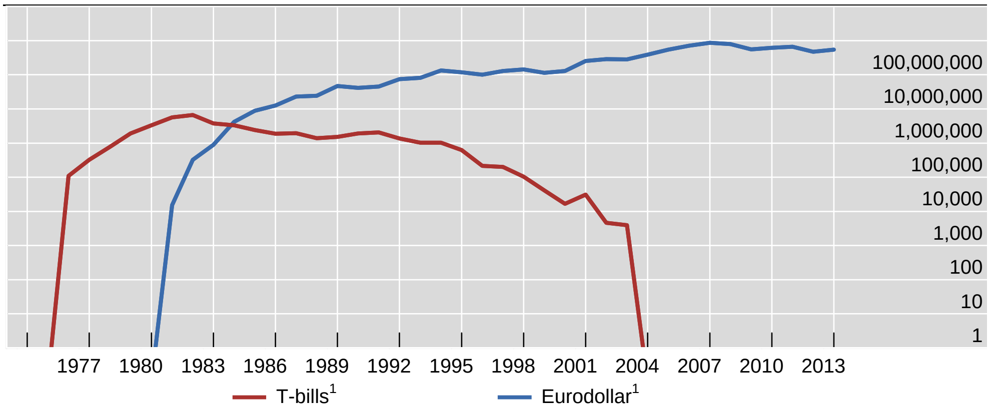
[1] Calculated as the difference between the daily three month US dollar Libor (Libid + 12.5 basis points before 6 December 1984) and the daily yield of the three month US Treasury bill.

Sources: Bloomberg; Federal Reserve Bank of St. Louis; BIS.

Graph 2 shows how turnover in US dollar money market futures shifted from government to private instruments in the 1980s. As noted, Treasury bill futures had no competition until the CD contract appeared in the spring of 1982 (Stigum (1990, p 55)). It fell victim to a variant of Gresham's Law as the bad credit of Manufacturers' Hanover drove out the good credit of JP Morgan.[4] Introduced in 1982, the Libor contract, based on a trimmed average of self-reported rates of top global banks, proved a better mousetrap. Trading in the eurodollar contract took off in 1984, the year of the Continental Illinois crisis, and that year it surpassed trading volume in the Treasury bill contract. The Treasury bill contract died in the mid-2000s.

Turnover of Treasury bill and eurodollar futures and options

In millions of US dollars, logarithmic scale Graph 2



[1] Traded on the Chicago Mercantile Exchange.

Source: FOW trade data; Futures Industry Association.

[4] At maturity, any of the top 10 banks' CDs (the "run") could be delivered into the contract. Owing to heavy but uneven exposures to Mexico, Brazil and Argentina, the CD contract began to reflect variations in the creditworthiness of these sovereigns, and Manufacturers' Hanover was usually cheapest to deliver owing to its having staked a multiple of its equity in these countries.

2.2 Benchmark tipping on US adjustable rate mortgages

Recent discussion of how a transition from the manifold uses of Libor might work raises the question of the role of private and public initiative in shifting from Treasury bills to Libor in the first place. McCauley (2001) suggested that the triumph of Libor at times drew on legal change, citing how in the late 1990s, bankers lobbied Congress to change the basis of student floating-rate loan pricing towards Libor. In the event, however, the Congress opted for fixed rates for student loans.

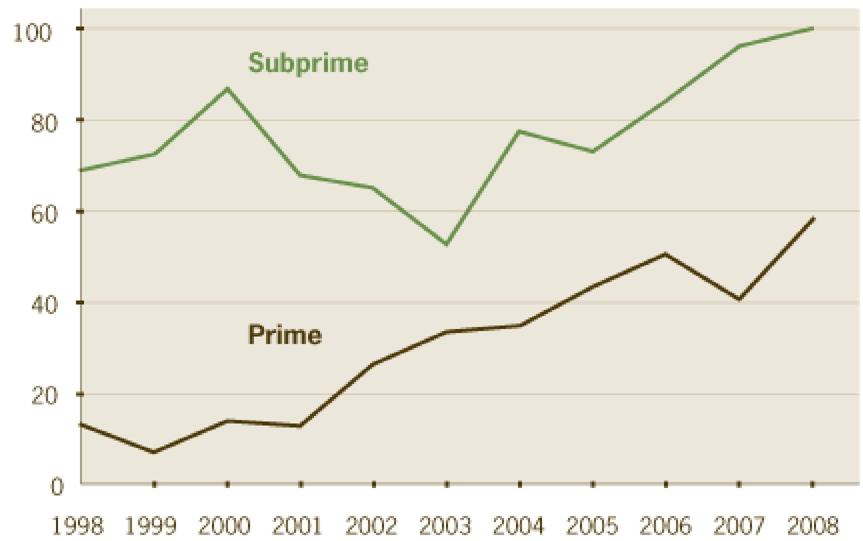
Morgenson (2012) tells the story of how mortgage bankers looking to ease securitisation sought to shift the benchmark for adjustable rate mortgages to Libor, but this is a case of change in market practice rather than a change in the law. Previously, the constant-maturity one-year Treasury rate published by the Federal Reserve or the 11th District Cost of Funds Index (a slow-moving average cost of debt for the thrifts in the district) was used (Roll (1987)). Particularly to market securitised mortgages to European banks whose dollar funding was generally priced in terms of Libor, US securities firms found Libor an easier sell.

Graph 3 shows how the pricing of adjustable rate mortgages (ARMs) in Ohio tipped towards Libor between 1998 and 2008. From the early days of the subprime market, borrowers were easily persuaded to take on the risk of Libor, but it is striking how Libor gained among prime mortgages as well.

Table 1 shows how the *stock* of outstanding ARMs was priced in May 2012. Fully 78% of sub-prime ARMs were Libor-based, and 43% of prime ARMs, both substantially lower than the peak *flow* share in originations Ohio in 2008. The stock numbers count outstanding mortgages, unweighted by amounts, and they probably overstate the role of Treasury-indexed and other indexed ARMs by including old mortgages with balances approaching zero.

Proportion of Libor-based adjustable rate mortgages in Ohio, 1998–2008 — Graph 3

Proportion



Year of origin

Sources: McDash Analytics, as reported by Schweitzer and Venkatu (2009).

First-lien mortgages by type in May 2012

Table 1

Type	Number
Prime	35,505,295
Fixed	31,602,412
Adjustable-rate mortgages	3,772,655
Libor-indexed	1,629,599
Treasury-indexed	1,222,130
Other index	920,926
Other	130,228
Subprime	1,172,296
Fixed	700,263
Adjustable-rate mortgages	470,746
Libor-indexed	368,991
Treasury-indexed	66,642
Other index	35,113
Other	1,287
Total	36,677,591

Note: "Libor-indexed" in the table refers to loans indexed to the 6-month US dollar Libor, while "Treasury-indexed" refers to loans indexed to the 1-year US Treasury bill.

Source: Lender Processing Services, Inc, as reported in Venkatu (2012).

The message from the US market for adjustable rate mortgages is that tipping from entrenched public to private benchmarks was a decentralised market process. It followed the futures market tipping and remains to this day incomplete. While the process evidently started with sub-prime mortgages, where the customers with weaker histories and taking on higher leverage accepted higher fees as well as an unfamiliar benchmark, it diffused to prime mortgages as well. The benchmark may have been "Changed by Wall Street, for Wall Street", as Morgenson (2012) suggests, but the government played little role.

2.3 Competing private benchmarks in US money market futures today

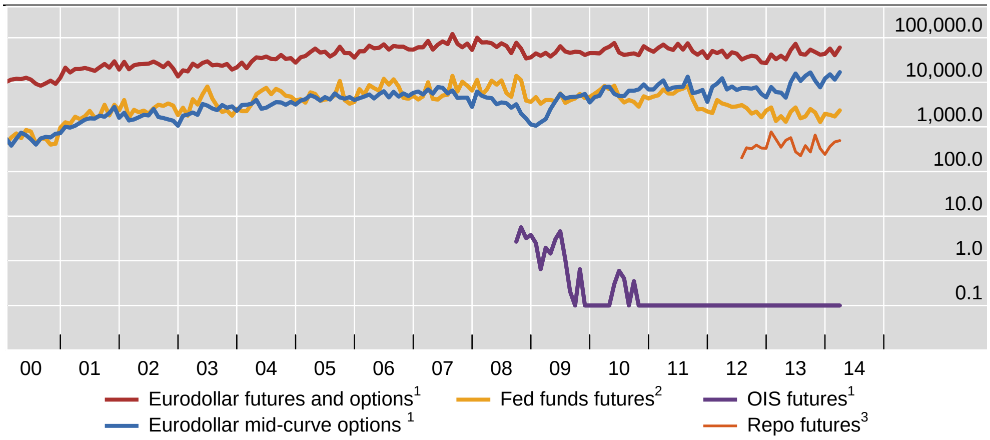
Given the revelations concerning Libor, both before and during the global financial crisis,[5] it is worthwhile consulting the futures markets regarding the progress of its three rivals in the dollar money market, discussed by the UK Treasury (2012) [the Wheatley Report]. In order of appearance, the three alternative futures contracts are the federal funds futures, overnight interest rate swaps (OIS) futures and the Depository Trust and Clearing Corporation (DTCC) government collateral repurchase (GC repo) futures.

5 IOSCO (2013, p 1); US Commodity Futures Trading Commission (2012, 2013). See also Gyntelberg and Wooldridge (2008).

US dollar money market futures and options

Monthly turnover in billions of US dollars, logarithmic scale

Graph 4



[1] Traded on the Chicago Mercantile Exchange. [2] Traded on the Chicago Board of Trade. [3] Traded on the NYSE Liffe.

Source: FOW trade data.

Federal funds futures began trading on the Chicago Board of Trade (now CME) in October 1998. Their turnover peaked in the crisis months of August 2007 and September 2008. Upper (2006) showed its utility in forecasting Federal Reservepolicy and that of the associated options in capturing the dispersion of market expectations. However, either its open interest or its turnover "pales" (Stigum and Crescenzi (2007, p 738)) in comparison to the Eurodollar futures (Graph 4).

A futures contract on OIS started trading in the fateful month of September 2008. Its turnover collapsed about a year later (Graph 4). That said, OIS has found uses: "major financial institutions active in derivatives markets were shifting towards the use of (near) risk free reference rates (eg fixed OIS rates) when calibrating the net present values of their derivatives portfolios" (Working Group (2013, p 27)). With the OIS contract widely used in pricing models, dealers use an active OTC market in OIS/Libor basis swaps to bridge to the futures market. As a result, the liquidity and ease of trading of eurodollar futures is imparted to OIS. Thus, OIS serves some benchmark functions even though its futures contract failed.

Great hopes accompanied the introduction of the GC repo futures in July 2012, at least partly in response to the strong wish by many to find a transactions-based alternative to Libor. Competitors suggested that the correlation of repo and federal funds would prevent the new contract from attracting liquidity (Sturm and Labuszewski (2012)). Kreicher et al (2013) found that large excess reserves and a change in the FDIC insurance base loosened this link, potentially creating space for the repo futures. Nevertheless, turnover has fallen from the January 2013 peak.

All in all, while the federal funds future is well established, the eurodollar's dominance of the US dollar money market futures is hardly challenged. Indeed, the response of these futures contracts to the prospect of a turn in Federal Reserve policy in April 2013 through June 2013 is telling. The turnover in the federal funds futures contract rose (Graph 4). However, eurodollar futures and options turnover more than doubled in that period, from \$30 trillion to \$69 trillion. The latter figure fell short of the turnover only in August 2007 and January 2008. The eurodollar midcurve options, where market participants make short-term bets on eurodollar rates in 2015-17, almost tripled in that period from $5.7 trillion to $15.8 trillion.

This section concludes that, despite the incumbent's advantage, the Treasury bill future lost out to a private-bank futures contract a generation ago. Despite the success of the federal funds future, hopes for the repo contract, and the possibilities raised by the new floating-rate note based on Treasury bill yields, the eurodollar contract continues to turn over an order of magnitude more than its challengers. The next section tests whether a parallel process is at work at the long end of the yield curve, not only for the US dollar but for other major currencies as well.

3. Government bond and interest rate swaps turnover

This section analyses how the relationship between turnover in government bond futures and swaps evolved over seven triennial surveys in as many as seven currencies with active government bond futures markets. The hypothesis is that market participants have been switching to interest rate swaps for much the same reason as they switched to Libor from Treasury bills in the US dollar money market.

The burden of our argument is that episodes of flight to quality induce a trend towards more turnover in bond derivatives linked to private instruments relative to those linked to government bonds. At such times of tensions in bond markets, the safety of government bond markets may attract investors, but those hedging private instruments with government bond futures experience basis risk.[6] In the limit, a seemingly hedged position can produce losses on both the long position in private instruments and the short position in government bonds.

In addition, we consider whether the tipping has continued notwithstanding two credit shocks and one structural shock. The global financial crisis and the European sovereign crisis were shocks to credit, while the ongoing push to get swaps onto centralised platforms is a structural shock. In general, credit shocks should accelerate the tipping, but 2008-09 saw an unprecedented decline in the creditworthiness of the major swap dealers and their related consolidation. As for the shift of swaps to centralised trading and clearing, this could make swaps more or less competitive with government bond futures.

Subsection 3.1 displays the spread between benchmark government bonds and interest rate swaps, which indicates the basis risk. Subsection 3.2 presents seven triennial observations on the exchange and OTC data separately. Subsection 3.3 shows how the ratio of government to total long-term bond derivatives turnover has tended to decline over the years 1995-2013.

3.1 Government bond and swap performance in crises

The shorter history of swaps has seen how credit and other strains in financial markets can occasion a widening of the gap between government bond yields and the fixed rate leg of interest rate swaps (Graph 5). Episodes that appear in a range of bond market from the late 1980s to date include the corporate and bank debt

6 See Covitz and Sharpe (2005) and Chernenko and Faulkender (2011) on hedging with swaps.

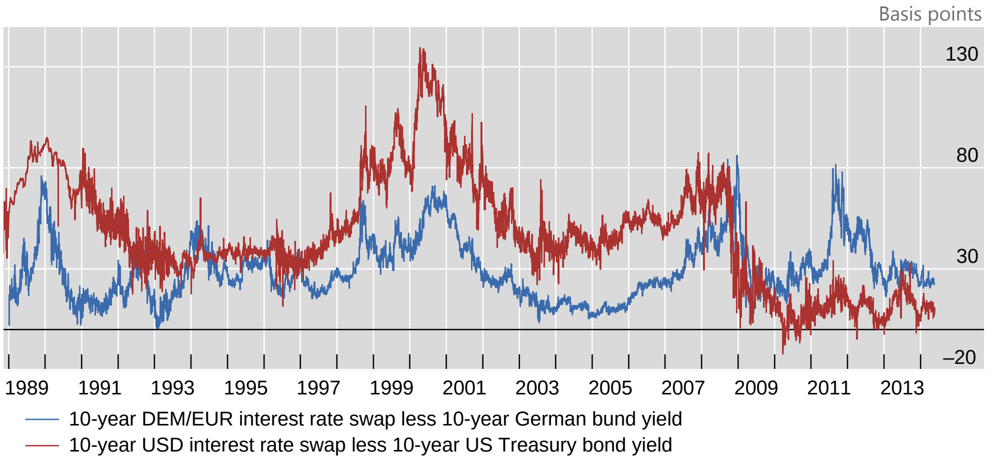
strains around the turn of the year 1990, which featured the bankruptcy of a swap dealer, Drexel Burnham Lambert. The bond market sell-off of 1994, the Asian financial crisis of 1997, the LTCM collapse and Russian default August-September 1998 are evident (Kobor et al (2005)), as are the corporate credit strains associated with the bursting of the tech bubble in 2000. The global financial crisis of 2008, which saw an unprecedented loss of creditworthiness of major swap dealers, widened swap spreads out to the widest level ever in the euro but not the dollar.

Reinhart and Sack (2002, p 47) describe the events of 1998 as a watershed:[7]

> *there has been considerable discussion about a possible transition to interest rate swaps as a "benchmark" for the pricing and hedging of other fixed income assets. Our results indicate that the swap rate is not a precise proxy for the risk-free rate but, rather, does include some compensation for credit risk, albeit less than most corporate bonds. Indeed, the swap rate has deviated from the risk-free rate by more than the Treasury rate in recent years ..., reflecting the impact of the credit risk and liquidity factors. Of course, the fact that swaps have some credit risk may be an important advantage in becoming a benchmark for the pricing and hedging of private instruments. Much of the discontent with intermediate- and longer-term Treasuries as hedging instruments began in autumn 1998, when the flight to quality ... pushed down Treasury yields and pushed up lower rated corporate yields. Unlike Treasuries, swaps have exposure to both the credit risk and the liquidity preference factors, the two factors influenced by the flight to quality, which makes them more comparable to corporate bonds. Thus, swaps may well have provided a better hedge for corporate bonds during that period.*

Some strains are more evident in the DM/euro or the US dollar bond market. The 1992 ERM crisis and the sovereign debt and associated bank strains in Europe in 2011-12 are both much more evident in the DM/euro market. The US Treasury's announcement of its buyback around the turn of the century and then hedging of mortgage convexity in 2003 both roiled the US bond market.

The spread between government bonds and private yields — Graph 5



Sources: Bloomberg; BIS calculations.

7 See also Fleming (2000). Kobor et al (2005) discuss how swap spreads are more volatile after 1998. See Krishnamurthy and Vissing-Jorgensen (2012) on corporate spreads.

3.2 Turnover of government bond futures and swaps, 1995-2013

The central bank Triennial Survey provides us with seven observations of turnover in OTC swap markets over the years 1995-2013 for as many as seven currencies with active government bond futures market.[8] We select observations from the financial futures exchanges to match these OTC observations.

Table 2 shows daily turnover levels by currency for countries with active government futures (and possibly options on futures) contracts over the period 1995-2013. In most currencies turnover of exchange-traded government bond futures tended to grow over 1995-2013 and to reach record levels in 2013.

Two exceptions stand out. Even with all the excitement generated by an easing of monetary policy in the Japanese government bond market in April 2013, turnover remained below the 1995 level. But the more important and recent exception is the euro area. Activity in the German bund futures market not only fell following the global financial crisis (ie between April 2007 and April 2010), but declined again in the aftermath of sovereign debt strains in Europe (ie between April 2010 and April 2013). As a result, turnover of futures and options on US Treasury bonds in 2013 exceeded that on German bunds for the first time since the inception of the euro. This decline affecting bund derivatives caused total turnover of government bond futures across countries to shrink in April 2013 relative to April 2010, something that had not happened since at least the inception of the euro.

As in the international bond market, the German government and the US Treasury have a near duopoly in government futures turnover. Even with the decline in bund derivative trading in 2010-13, Treasuries and bunds account for 82% of turnover in April 2013 (and a like percentage of OTC swaps, below). Their joint share reached a high of 90% in 2004 and stood at 87% in April 2007.

Daily turnover of exchanged-traded government bond futures and options contracts

In millions of US dollars

Table 2

Currency	1995	1998	2001	2004	2007	2010	2013	*Memo: 2013 share %*
Australian $	3,278	3,705	4,631	9,044	11,569	13,046	27,652	*4.2*
British pound	3,412	6,183	3,104	7,428	15,377	13,922	20,670	*3.2*
Canadian $	187	452	401	757	2,236	2,063	4,613	*0.7*
Euro*	31,120	89,638**	154,229	269,446	332,316	309,756	234,527	*35.9*
Japanese yen	80,208	35,073	32,284	31,990	45,048	38,359	50,469	*7.7*
Korean won	No data	No data	2,260	2,706	6,480	9,223	16,408	*2.5*
US dollar	52,776	84,018	73,066	206,467	220,707	290,518	299,322	*45.8*
Total	194,856	233,072	269,975	527,838	633,733	676,887	653,661	

* DEM only for 1995 and 1998. ** DEM/FRF/ITL/ESP total = $108,580 million for 1998.

Source: FOW Trade data; authors' calculations.

8 We define active as a bond futures market in which average daily turnover in all contracts exceeded $2 billion in the month of September 2013. The market closest to this cut-off is that of the South African government bond futures, which on average traded $1.7 billion per day. The Canadian government bond futures traded $4.6 billion per day.

Daily turnover of OTC swaps and options

In millions of US dollars

Table 3

Currency	1995	1998	2001	2004	2007	2010	2013	*Memo: 2013 share*
Australian $	na	1,387	4,031	7,364	15,540	28,588	64,885	*4.4%*
Excluding OIS	na	na	*2,500*	*4,830*	*9,642*	*17,762*	*30,744*	
British pound	na	9,034	24,899	65,150	130,367	160,289	99,015	*6.7%*
Canadian $	na	4,139	4,615	5,943	14,462	39,155	27,745	*1.9%*
Euro*	8,315	53,716**	184,032	344,943	589,316	631,783	747,296	*50.4%*
Excluding OIS	*na*	*na*	*49,820*	*143,579*	*215,409*	*340,725*	*501,393*	
Japanese yen	25,360	23,835	18,579	45,719	132,803	121,774	69,315	*4.7%*
Korean won	na	na	36	336	4,543	16,039	12,022	*0.8%*
US dollar	23,847	48,054	112,700	288,255	434,536	371,946	463,176	*31.2%*
Total			348,892	757,710	1,321,567	1,369,574	1,483,454	*100.0%*

Notes: *DEM only for 1995 and 1998 **DEM/FRF/ITL/ESP total = $79,784 million for 1998 na = not available

Source: Australian Financial Markets Association (2013); European Central Bank (2013); BIS Triennial Bank Survey (1996-2013).

The successful introduction of a futures contract on the three-year Korean Treasury bond in the 2000s highlights the prospect that emerging markets can join the very short list of bond markets with active government bond futures. Indeed, the Korean contract already trades more than the Canadian government bond future and may be closing in on the UK gilt future. We discuss in Section 4 below how other emerging countries are trying to follow Korea in introducing futures as their local bond markets increase in size and their financial markets develop and mature.

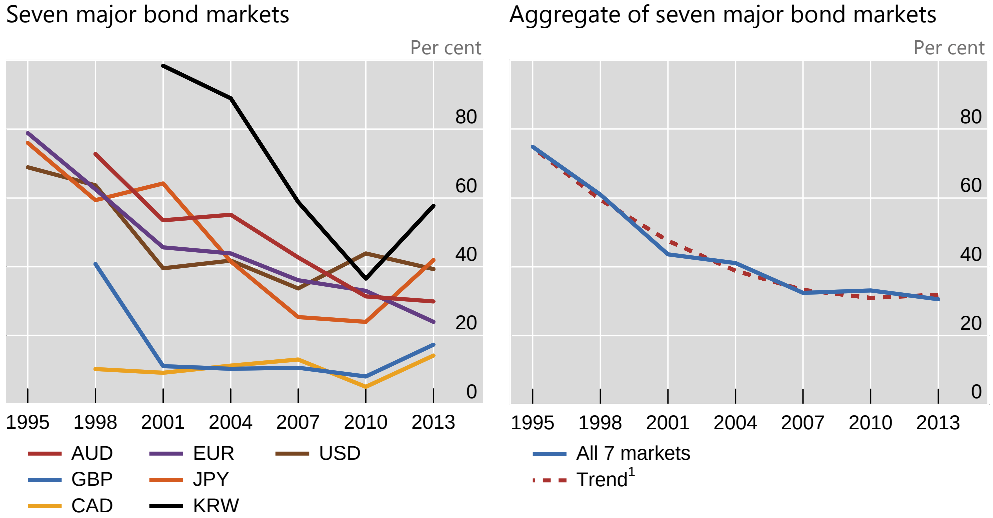
OTC trading of interest-rate swaps and options also grew on balance over the period 1998-2013 (Table 3). Swap turnover in our seven selected currencies in aggregate, and in the euro and the dollar in particular, reached all-time highs in 2013. US dollar swap turnover retreated temporarily in 2010, in part owing to the consolidation among dealers. Turnover in euro swaps has exceeded turnover in dollar swaps from the inception of the euro, owing to the lack of euro area government bond (Remolona and Wooldridge (2003)). In addition, the European sovereign strains in 2010-13 raised turnover in euro swaps relative to that of US dollar swaps, consistent with the German bunds' idiosyncratic pricing as a safe haven.

3.3 Government bond derivatives as a share of bond derivatives

This section finds that the evidence supports our hypothesis of a trend favouring trading in bond derivatives linked to private instruments at the expense of derivatives linked to government bonds. Graph 6, left-hand panel, uses the data in Tables 2 and 3 to plot the turnover of exchange-traded government bond futures and options as fractions of total turnover of all long-dated interest-rate derivatives, both exchange-traded and OTC derivatives (swaps and options linked to private benchmarks).

Government futures and options as proportion of bond derivatives

Graph 6



[1] Ratio = 0.75 - 0.17 time + 0.016 $time^2$. T-ratios = -9.1 and 5.4, respectively. Adjusted R Square = 0.97.

Sources: FOW trade data and Central Bank Triennial Survey.

Before analysing trend in each bond market, an aggregate view conveys our major finding. Graph 6, right-hand panel, aggregates the seven major bond markets with substantial government futures. The evidence is compelling: the ratio of government bond futures to total bond derivatives has fallen significantly, albeit at a decreasing rate, over the past 20 years.

The evidence suggests that government bond futures and options will not completely tip towards private-label derivatives. Government bond-linked derivatives may well maintain their utility both as hedges for government bond portfolios and as tools for pure interest-rate risk positioning, as witnessed by the persistence of government bond futures at a low turnover ratio in both the UK and Canadian markets. Instead, we look for the global turnover ratio to find a floor below, but not necessarily far from, its current level, 30%.

While a paucity of data precludes strong statistical inferences, Graph 6 shows a quadratic trend line. The coefficients on both the time variable and its squared value have the correct signs: negative and positive, respectively, consistent with a declining trend at a decreasing rate. Both are statistically significant.

Returning to Graph 6, left-hand panel, there are differences across markets. In the *US dollar bond market*, the ratio starts in 1995 at 68.9% and reaches its minimum twelve years later on the eve of the global financial crisis in April 2007 at about half that, at 35%. This powerful trend was interrupted by the financial crisis. As shown in Tables 2 and 3, turnover in US government bond futures and options contracts jumped by nearly 32% between 2007 and 2010, while trading in OTC dollar swaps and options slumped by 14%. However, the situation in this market has become more normal in the most recent three-year period: trading in government futures and options grew by only 3% between 2010 and 2013 (down from 7% over 2004-2007), while OTC turnover in private swaps and options grew at a double-digit rate of 24% (versus 51% between 2004 and 2007). As a result, the most recent observation shows a renewed, albeit small, decline in the ratio to less than 40%.

Several features of the global financial crisis as it emanated from the US housing market affected the balance between government bond futures and interest-rate swaps. The widening of the Treasury-swap spread is our long-term story, but more immediate may have been the effects of counterparty risk (Borio (2004, pp 10-11)), the increase in dealer concentration with mergers and general deleveraging among banks and securities firms (Adrian and Shin (2014)). Beyond the interdealer market, subdued mortgage origination implied subdued hedging among originators. Moreover, the acquisition of low-coupon mortgage securities by the Federal Reserve, which does not hedge its duration exposure, also led to less use of swaps. Given these considerations, the renewed decline of the ratio in 2013 might be ascribed in part to the recovery of the US housing market.

In the *euro bond market*, the decline is steeper and more consistent. For a 1995 observation, it is necessary to consult the Deutsche mark market. Back then, turnover in the bund contract represented 78.9% of German bond derivatives. In 1998, this fell to 62.5%. That year, just before the inception of the euro, we can compute the comparable ratio for the sum of Deutsche mark, French franc, Italian lira and Spanish peseta at only a slightly lower proportion: 57.6%. The first observation for the euro proper, in 2001, shows a decline to 45.6%. And between then and April 2013, the ratio fell by half to 22%.

European sovereign bond strains have reduced use of government bond futures. Trading in euro-based government bond futures and options (practically all German bunds) declined by nearly 7% between 2007 and 2010, and then declined dramatically after the onset of sovereign debt strains. Between 2010 and 2013, turnover in exchange-traded euro-government bond futures and options fell by 24%. Meanwhile, trading in euro-denominated OTC swaps and options grew by 7% between 2007 and 2010, and by 18% between 2010 and 2013. These shifts suggest that the European sovereign debt strains accelerated the shift away from government bond benchmarking towards private benchmarks in euro.

Given the duopoly highlighted above, the results for these two markets suffice to establish the result that turnover in exchange-traded government contracts has globally shifted from well exceeding trading in comparable OTC private bond derivatives to falling short of such trading. Moreover, Annex 2 shows that the result holds even if short-term swaps are excluded in the euro market.

On balance the other bond markets, including the yen, sterling, Australian dollar and the Korean won, show declining ratios. Only the Canadian dollar shows a very low initial level and not much of a trend.

Most of the other currencies showed a rise in the government bond futures share in 2013. We analyse below whether there is a link to the centralisation of swap clearing, although the evidence is meagre.

In conclusion, the aggregate of all seven bond markets shows the ratio of government bond futures to total long-term interest-rate derivatives generally declined, albeit it at a decreasing rate, during the period 1995-2013. A crisis-related retreat into US dollar government futures during 2007-10 interrupted the aggregate ratio's decline. However, the decline resumed during the latest triennial period and derivatives trading linked to government bonds touched a new ratio low of 30% in 2013, down 3% from 2010. Finally, we do not expect that government-linked derivatives to be completely displaced by the private derivatives and individual countries will find their own balance between the two. As for our current aggregate, the evidence points to a turnover ratio floor between 25-30%.

4. Regression, contingency and logistic analyses of cross-section data

We have seen that the successful introduction of Korean Treasury bond futures widened the narrow circle of currencies with active government bond futures. This raises the question of whether other bond markets might be able to support government bond futures. Could new government bond futures markets challenge the duopoly of the euro and the dollar? And could the arrival of other government bond futures markets slow or even possibly reverse the trend towards private hedging instruments?

On the face of it, the case of Korea suggests that new entrants will not alter the trend in the global bond market. Not only does the Korean bond market represent a small share of the global market, it has broadly participated in the trend away from government bonds. Still, bigger bond markets than Korea's might be in the queue, so it makes sense to ask the data what factors make for a successful government bond futures market.

This section reports the results of three statistical analyses of the data. While the previous section reported ratios of government bond derivatives to all derivatives, most currencies feature more or less substantial OTC bond derivative markets *in the absence of robust government bond futures trading*. So we first analyse the determinants of derivatives trading, using ordinary least squares for the OTC turnover and the sum of OTC and bond futures. Then we use logistic analysis of the probability (between zero and one) of the observation of bond futures, given two key explanatory variables. We finish with a 2x2 contingency analysis, also focused on the existence of bond futures. In these analyses, we again use 35 currencies covered in the Triennial Central Bank Survey in 2013 in a cross-section.

4.1 Determinants of OTC bond and government bond futures

Based on the work of the Committee on the Global Financial System (1999), Inoue (1999) and McCauley and Remolona (2000), Chabchitrchaidol and Panyanukul (2008, p 207) suggest that "government debt markets require a minimum aggregate threshold size (roughly 100-200 billion USD in mature markets in industrial countries) in order to maintain liquidity". With hindsight, this conclusion was too pessimistic, at least in some circumstances. In particular, the Australian government bond market has retained quite respectable liquidity even though it shrank below and has stayed below the $100 billion threshold.

In this section, we report three regression analyses of the 2013 interest rate derivatives for 35 currencies as compiled by the Triennial Central Bank Survey. In order to answer the question why do some currencies have government bond futures, we proceed in three steps. First we seek a parsimonious account of OTC derivatives across currencies. The 2013 Survey did a better job of collecting data in international financial centres on trading in emerging market interest rate derivatives, so these data provide the best ever basis for identifying such an empirical model (Table 4). Second, we add the exchange-traded government bond futures to our dependent variable and rerun the model.

OTC interest rate derivative turnover in April 2013[1]

Net-net basis,[2] daily averages in April, in millions of US dollars — Table 4

Currency	Total	FRAs	Swaps	Options	Swaps plus Options (less OIS)	*Memo: Government bond*
Euro	1,145,802	398,505	693,465	53,831	747,296	*23.9%*
					(501,393)	*(31.9%)*
US dollar	656,935	193,759	373,716	89,459	463,176	*39.3%*
Pound sterling	186,761	87,745	92,287	6,728	99,015	*17.3%*
Japanese yen	69,607	292	59,618	9,698	69,315	*41.9%*
Australian dollar	76,109	11,224	62,854	2,031	64,885	*29.9%*
					(30,744)	*(47.4%)*
Canadian dollar	29,747	2,002	26,794	951	27,745	*14.1%*
Swedish krona	36,157	19,373	14,618	2,165	16,784	*0*
Brazilian real	16,303	31	16,111	162	16,273	*0*
Chinese renminbi	14,504	22	14,301	181	14,482	*0*
Korean won	12,116	94	10,880	1,142	12,022	*57.7%*
Mexican peso	9,597	30	9,285	281	9,566	*0*
Indian rupee	6,491	26	5,953	512	6,465	*0*
Swiss franc	14,393	8,871	5,335	187	5,523	*0*
South African rand	15,816	11,198	4,198	420	4,618	*0*
New Zealand dollar	4,946	1,362	3,498	86	3,584	*0*
Singapore dollar	3,694	126	3,349	219	3,568	*0*
Norwegian krone	9,320	6,694	2,560	66	2,626	*0*
Thai baht	2,622	29	2,536	57	2,593	*0*
Polish zloty	7,411	5,135	2,138	138	2,276	*0*
Hong Kong dollar	2,105	48	1,992	65	2,057	*0*
Danish krone	4,000	2,139	1,808	53	1,860	*0*
Malaysian ringgit	1,882	24	1,805	53	1,858	*0*
Chilean peso	1,238	27	1,158	53	1,211	*0*
Israeli new shekel	1,592	526	939	128	1,066	*0*
New Taiwan dollar	776	28	639	109	748	*0*
Hungarian forint	2,475	1,781	648	46	694	*0*
Czech koruna	748	278	416	55	471	*0*
Saudi riyal	406	56	273	77	350	*0*
Colombian peso	393	50	288	55	343	*0*
Russian rouble	384	91	242	51	293	*0*
Turkish lira	256	26	91	140	231	*0*
Argentine peso	130	26	48	56	104	*0*
Philippine peso	112	23	35	53	89	*0*
Indonesian rupiah	111	28	26	57	83	*0*
Peruvian new sol	103	25	30	48	79	*0*

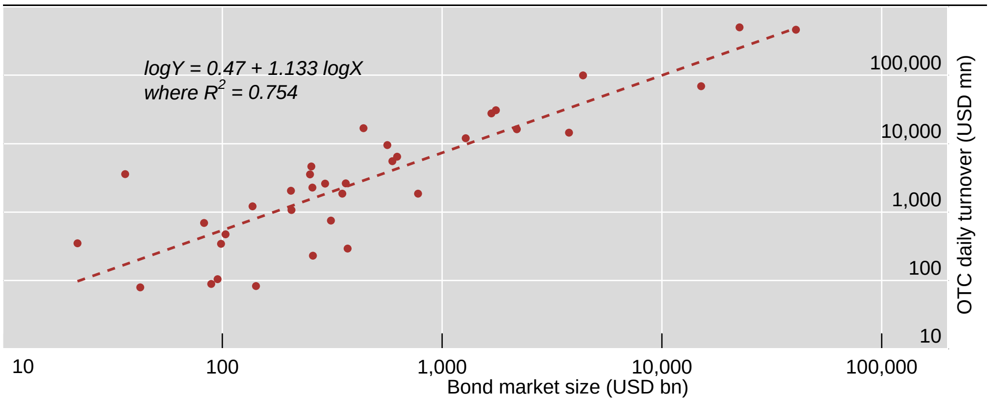
[1] Single currency interest rate contracts only. [2] Adjusted for local and cross-border inter-dealer double-counting (ie "net-net" basis).

Source: FOW trade data; BIS; authors' calculations.

The size of the underlying bond market is the best single predictor of OTC interest rate derivatives turnover. Graph 7 plots the log of the turnover from the penultimate column of Table 4 against the log of the bond market size for the 35 currencies surveyed. The bivariate relationship between bond market size at end-2012 and the

OTC bond derivatives and bond market size

Logarithmic scales Graph 7



Sources: Central Bank Triennial Survey; BIS.

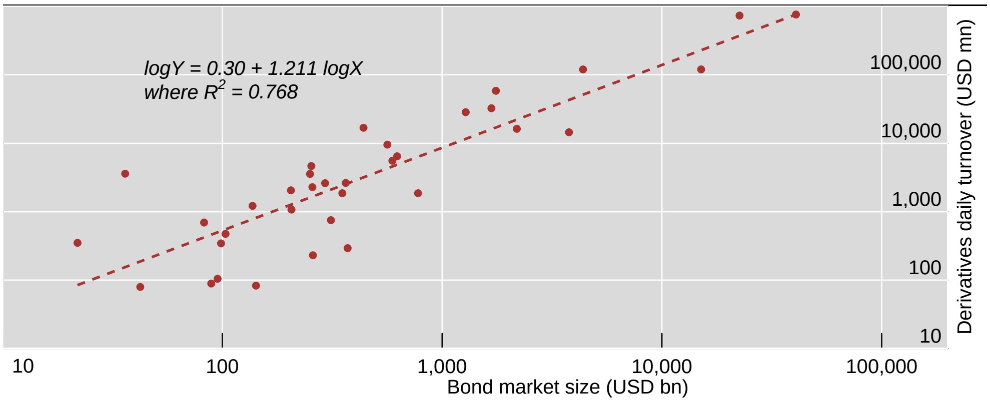
turnover of bond derivatives in April 2013 is very strong and fairly elastic. In particular, three-quarters of the cross-sectional variance is explained by market size. A doubling of bond market size leads to a 113% rise in derivative turnover.

When we add the bond futures transactions, the bivariate relationship is every bit as strong and the elasticity is higher (Graph 8). It stands to reason that adding turnover to the largest markets leads to a steeper least squares line. Indeed, the elasticity rises from 1.1 to 1.2, suggesting a stronger relationship between size and liquidity.

Despite the strength of the bilateral relationship, it is of interest to add explanatory variables. From analysis of foreign exchange trading in relation to underlying trade transactions (McCauley and Scatigna (2013)), we know that financial trading rises with income, so by analogy we add GDP/capita. This variable is itself known to be positively related to the government's bond rating (Cantor and Packer (1996)). Indeed, GDP/capita stands out as a key proxy for the both the levels of economic and financial development. When added to our regressions, this variable was significant at the 1.5% level, implying that 10% increase in economic and financial

OTC and exchange traded bond derivatives and bond market size

Logarithmic scales Graph 8



Sources: FOW trade data; Central Bank Triennial Survey; BIS.

Regression analysis of the log of turnover of bond derivatives

For a cross-section of 35 countries (p-values in parentheses) Table 5

	OTC				OTC + Futures			
	Log size	Log (GDP/cap)	Domestic credit/GDP	Adjusted R^2	Log size	Log (GDP/cap)	Domestic credit GDP	Adjusted R^2
1.	1.13	-	-	0.746	1.21	-	-	0.761
	(0.000)				(0.000)			
2.	1.04	0.49	-	0.784	1.11	0.52	-	0.800
	(0.000)	(0.014)			(0.000)	(0.010)		
3.	1.02	0.46	0.141	0.778	1.10	0.51	0.077	0.793
	(0.000)	(0.039)	(0.717)		(0.000)	(0.026)	(0.846)	

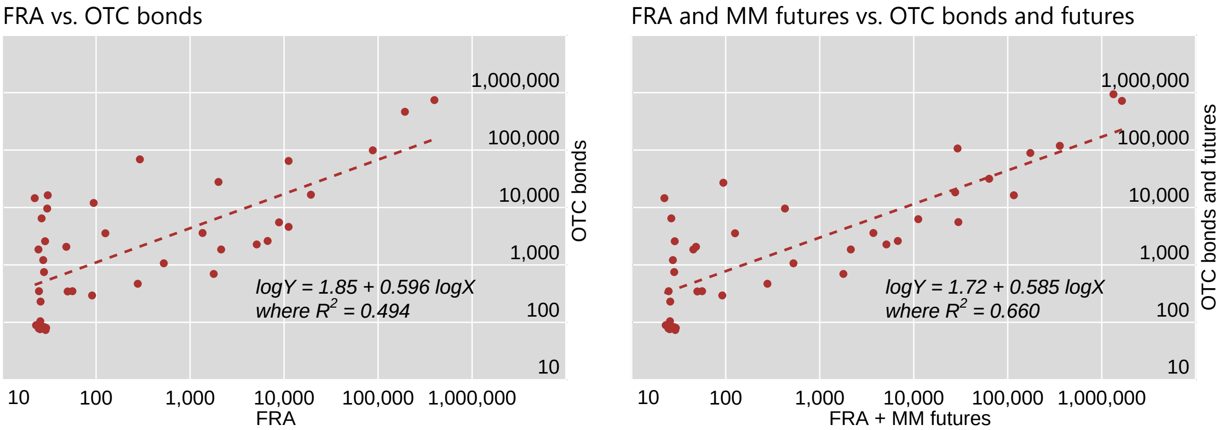
Sources: FOW data; IMF, *International Financial Statistics;* Triennial Survey.

"depth" leads to a 5% increase in bond derivative turnover (Table 5). The addition of another financial depth proxy, namely the bank credit to GDP ratio, did not improve the results of our regressions and was not statistically significant.

The relationships between bond derivative turnover, on the one hand, and turnover in money and foreign exchange markets, on the other, are worth a look. Both are strongly and positively related. Graph 9, left-hand panel, shows the relationship between turnover of forward-rate agreements (FRAs) and OTC bond derivatives.[9] Graph 9, right-hand panel, shows the relationship between the sum of FRAs and money-market futures, on the one hand, and the sum of OTC and exchange-traded bond derivatives, on the other. These more inclusive measures are even more strongly related. *Foreign exchange* turnover and bond derivative turnover are also closely related (Graph 10).

Money market and bond market derivative daily turnover

In millions of dollars in April 2013, logarithmic scale Graph 9

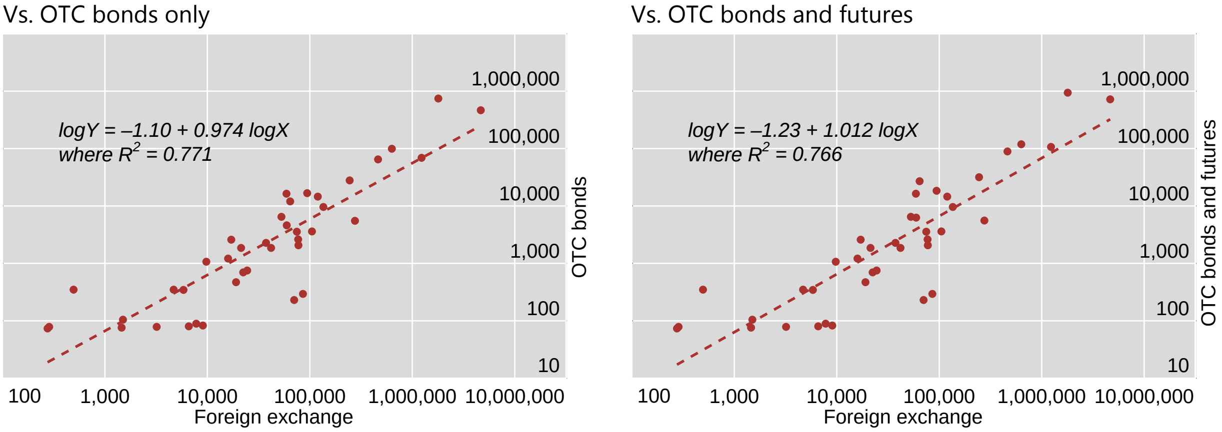


Sources: FOW trade data; Central Bank Triennial Survey; BIS.

[9] The big outlier on reported FRAs is Japan (Table 4), about which Stigum and Crescenzi (2007, p 838) say "no one knows why". Historically, the turnover of FRA in Japan has been very small. Until 1994, market participants thought that FRAs violated gambling laws. Then, the government made clear that they did not, but FRAs still remained inactive. Instead, market participants have used single period swap (SPS), which shares FRS's economics.

Foreign exchange and bond derivative daily turnover

In millions of dollars in April 2013, logarithmic scale | Graph 10



Sources: FOW trade data; Central Bank Triennial Survey; BIS.

These relationships are suggestive, but we do not attach any cause and effect interpretation to them. Instead, the levels of money market, foreign exchange, and bond derivatives trading are of one piece in tapping into a broader, overarching notion of financial market development.

4.2 Contingency and logistic analyses of government bond futures

We now turn to the challenge of explaining the existence of a government bond futures market. Given our relatively small sample size with only 35 countries and the even smaller number of countries with substantial bond futures (7 as of mid-2013), we must proceed with caution.

A natural starting point is to ask which countries have already developed domestic money markets and, in particular, money futures. Such development might naturally precede the creation of longer-dated debt instruments and their derivatives, leading to the question, "Are countries with money market futures more or less likely to have bond futures?" Such a pair of yes-no questions is best handled in a 2x2 contingency framework, and our analysis, presented below in Table 6, yields a strong conclusion: we strongly reject the null hypothesis that there is no relationship between the existence of money market futures and government bond futures. Forty percent of the currencies with money market futures have bond futures. The Korean won is the only currency that has a bond futures without a money-market futures (Park (2011)).

This result is suggestive, even encouraging. We turn next to a logistic regression.

Logistic regression is used to model binary outcome variables in which the "log odds" of the outcome is modelled as a linear combination of the predictor variables.

Regular logistic regression employs maximum-likelihood estimation, and while the asymptotic properties of maximum likelihood estimators are well known, little is known about their small sample properties. In fact, efficiency and unbiasedness cannot be taken for granted in small samples.

Relationship between government bond futures and money futures				Table 6
		Bond futures		**Total**
		Yes	No	
Money market futures	Yes	US dollar, euro, yen, Australian dollar, British pound, Canadian dollar	9	**15**
	No	Korea	19	**20**
	Total	**7**	**28**	**35**

Source: FOW data.

Note: X^2 = 4.6 permits rejection of the null hypothesis of no relationship between the existence of money market futures and the existence of government bond futures at the .0328 level.

The logistic regression model is specified as follows:

$$log\left[\frac{p}{1-p}\right] = \alpha + \sum \beta_i X_i + \varepsilon_i$$

Following McCauley and Remolona (2000), bond market size plays a key role in bond market liquidity, including whether a country has a government bond futures market. Therefore our baseline empirical model includes this one predictor, and given our focus on elasticities we will continue to use the natural log of bond market size in our logistic regression.

Because of the small-sample estimation issues mentioned above, we have no choice but to limit the number of our predictor variables to at most two. While several variables bearing on a country's creditworthiness or financial openness present themselves, we settle on GDP/capita as the best choice for a second predictor, our proxy for financial depth.

Focusing on our baseline regression (Table 7, equation 1), we observe an estimated coefficient on our log of bond market size variable of 2.12. Given our specification, this means that a 1% increase in domestic bond market size implies a bit more than a 2% increase in the odds that a bond market will have a companion futures market. The p-value of 0.014 indicates that we are on reasonably solid ground statistically.

An interesting question concerns what size bond market has a 50-50 chance of developing a companion futures market? Based on equation #1 above (and our unreported constant estimate α = -16.00), we can calculate that key market size as approximately $1.9 trillion: if a country's bond market is at least $1.9 trillion in size, the odds favour the existence of a government bond futures market.

Reviewing our data, we find that the size of six markets out of 35 exceeds this threshold, while in 29 markets it falls short of this threshold. Of the six, four (67%) do have futures markets; the two exceptions are China ($3.8 trillion) and Brazil ($2.2 trillion). Twenty-six out of the 29 markets (90%) below our $1.9 trillion threshold are correctly classified as not having a government bond futures market, but there are three misses that do have futures markets: Australia (bond market size equals $1.8 trillion), Canada ($1.7 trillion), and Korea ($1.3 trillion). A respectable sorting for our one predictor variable, with 30 correct cases out of 35… but can we do better?

Logistic analysis of bond futures: bond market size and GDP/capita			Table 7
Equation	Log bond market size	Log (GDP/cap), 2012	Pseudo R^2
1.	2.12		0.649
	(0.014)		
2.	5.13	3.57	0.818
	(0.159)	(0.177)	

Sources: FOW data; BIS.

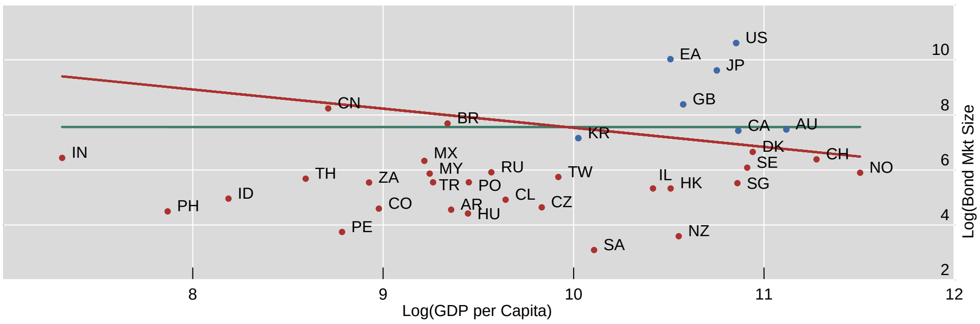
Adding GDP/capita to our model (Table 7, equation #2) definitely improved our overall fit (for example, the pseudo-R^2 rises to 82% from equation #1's 65%). In addition, both coefficients have the right sign and, given the likelihood of small-sample inefficiency, the reported significance of the estimated coefficients (both significant at the 20% level) is not so bad. Based on equation #2, the effect of a 1% increase in bond market size increases the odds of a country having a futures market by 5.13%, nearly 2½ times the effect estimated for this variable in equation #1. Our estimated elasticity for GDP/capita is a big 3.57, so that a 1% increase in GDP/capita raises the odds in favour of a futures market by more than 3½%.

The results of Table 7 are illustrated in a compelling way in Graph 11. The various points represent a scatter of bond market size and GDP/capita. The green horizontal line, drawn at a height of $1.9 trillion, shows the result of our single-variable logistic regression (Table 7, equation 1). A slightly lower threshold would indeed bring Australia, Canada and Korea into the "should have a futures market" category, but that notion is not scientific: China and Brazil would become even bigger outliers, and our single-variable model's inadequacy even more apparent.

The red line using both bond market size and our proxy for financial depth (equation #2) provides a nearly perfect sorting. To the northeast of this red line are bond markets with active trading of bond futures; to its southwest are bond markets without active trading of bond futures. The sole exception is Korea. The "hit" ratio for our two-predictor model is excellent: one market (Korea) out of 35 is

Bond futures - yes or no?

Graph 11



Blue dots identify countries having a bond futures market. AR = Argentina, AU = Australia, BR = Brazil, CA = Canada, CH = Switzerland, CL = Chile, CN = China, CO = Colombia, CZ = Czech Republic, DK = Denmark, EA = Euro Area, GB = United Kingdom, HK = Hong Kong SAR, HU = Hungary, ID = Indonesia, IL = Israel, IN = India, JP = Japan, KR = Korea, MX = Mexico, MY = Malaysia, NO = Norway, NZ = New Zealand, PE = Peru, PH = Philippines, PO = Poland, RU = Russia, SA = Saudi Arabia, SE = Sweden, SG = Singapore, TH = Thailand, TR = Turkey, TW = Chinese Taipei, US = United States, ZA = South Africa.

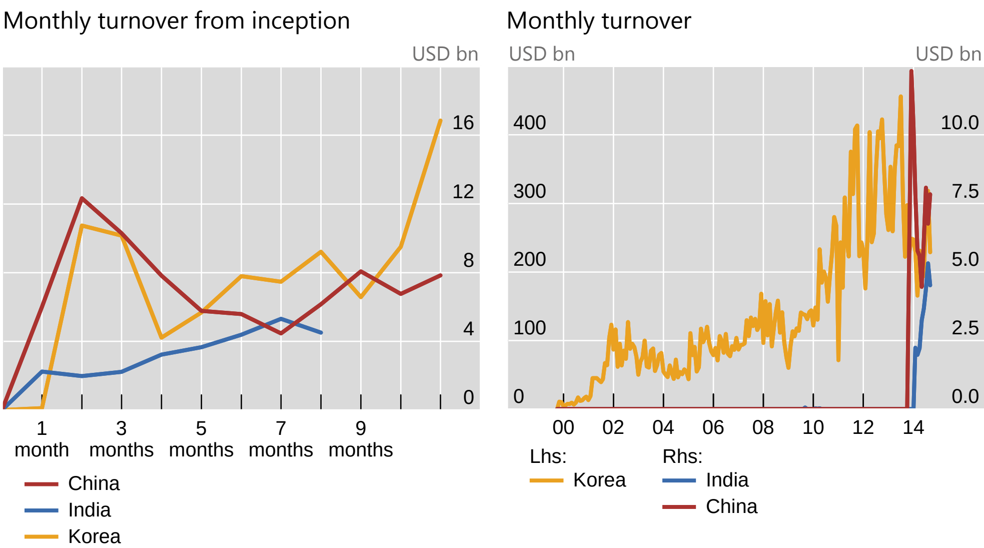
Sources: FOW data; BIS.

miscategorised. In addition, we are tempted to suggest that those emerging markets just below the line, China and Brazil, are the most likely candidates to develop futures markets.

In the event, government bond futures contracts have been introduced in October 2013 in China and in January 2014 in India. Not all contracts that are introduced succeed, however; the take-off of any particular contract is more like the first flight in the sands of Kitty Hawk than a routine take-off from the tarmac at Heathrow. Many years ago, China's government bond futures contract was banned after it was seen to have become a vehicle for destabilising speculation. After the Reserve Bank of India permitted over-the-counter interest rate derivatives in 1999, a cash-settled futures contract based on a notional zero-coupon curve was introduced on the National Stock Exchange in 2003. This failed to take off owing to "deficiency in product design" (Reserve Bank of India (2008, para 5, p 7)) in the form of settlement on an unobservable zero coupon curve, which was not only complicated but also introduced substantial basis risk. Similarly, a contract allowing delivery of a basket of bonds that was introduced in 2009 failed to get off the ground (Reserve Bank of India (2012, para 5.8). The third, and at writing promising, try is a contract that refers not to a basket of bonds but rather only the current benchmark bond, in which a large fraction of cash market trading takes place. Basis risk should be under control.

Trading in both new contracts can be compared to that in the early months of the Korean Treasury bond contract (Graph 12, left-hand panel). Subsequent trading of the Korean government bond trading sets a higher standard, however (Graph 12, right hand panel – note double scale at about 30X).

Government bond futures in Korea, China and India | Graph 12



Sources: FOW; BIS

5. Money market benchmarks and swap market regulation

Two ongoing developments could possibly alter the dynamics of competition between government bond futures and swaps as vehicles for hedging and positioning. First, alterations are under consideration to the money-market reference rates benchmarks against which long-term fixed rates are swapped. The still open question of how to make short-term rate fixings more robust and less manipulable creates uncertainties for any product, like interest rate swaps, based on such fixings. No such uncertainties dog government bond futures contracts.

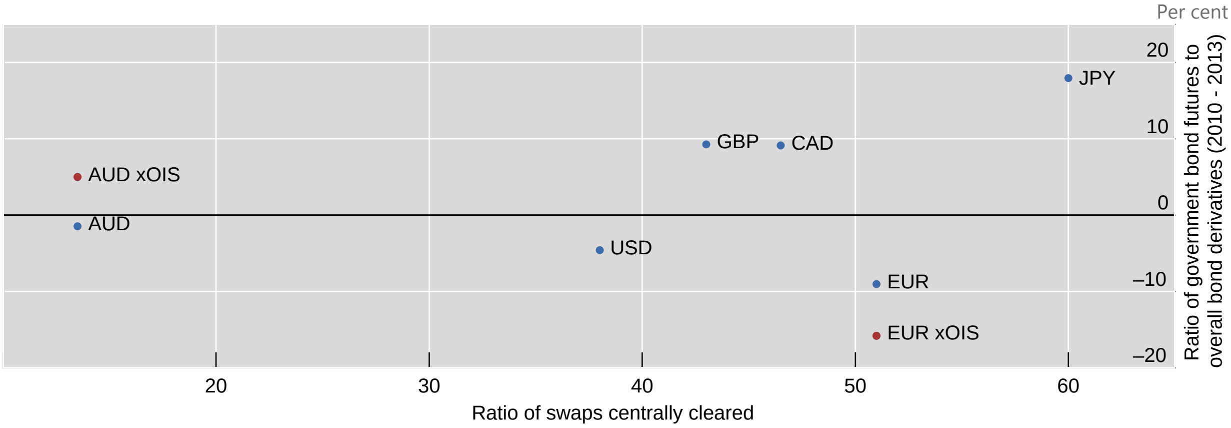
Second, there is the ongoing shift of OTC products, including swaps, to centralised clearing. The risks highlighted in the global financial crisis led regulators to introduce policies to reduce counterparty risks in OTC markets and to render their working more transparent. Among these policies is the requirement that OTC derivatives be centrally cleared where possible. This was backed up by hikes in capital charges and margin requirements for deals that were contracted bilaterally. In the United States, the Commodities and Futures Trading Commission is requiring that interest rates swaps be traded electronically on swap execution facilities (SEFs).

The second development, while ambiguous in its effect on the competition between swaps and government bond futures, is more likely to affect the choice between them substantially. This judgment is based on the cross-sectional observation that the floating leg of swaps is based on a wide variety of fixings around the world. Quite different from the construction of dollar or yen Libor, or euribor, the floating leg is constructed in Australia from bank bills, in India from OIS, and in Mexico idiosyncratically.

In principle centralised clearing of swaps could favour or hurt swaps relative to government futures. On the one hand, the current swap credit exposures and the operational complexity of keeping track of partially offsetting transactions with various counterparties could have been putting swaps at a competitive disadvantage. On the other hand, the new transactions costs for customers to collateralise swaps, and higher costs for bespoke contracts that cannot readily be cleared centrally, might put swaps at a competitive disadvantage.

Gyntelberg and Upper (2013) show that by April 2013, there is considerable cross-currency variation in central clearing of swaps. Yen swaps were centrally cleared to the extent of about 60%. About half of euro swaps were centrally cleared, and between a third and a half for US dollar, Canadian dollar and sterling swaps, but less than 15% for the Australian dollar. Is there any evidence of these divergent shares affecting the balance between swaps and government bond futures in April 2013? Graph 13 shows the relationship between the fraction of swaps centrally cleared as reported by Gyntelberg and Upper (2013) on the horizontal axis and the change in the ratio of government bond futures to overall bond derivatives between 2010 and 2013. These meagre data do not point to an effect.

Change in government share of bond derivatives and central clearing | Graph 13



Sources: LCH.Clearnet; FOW trade data, BIS Triennial Central Bank Survey; authors' calculations.

6. Conclusions

We observe that the Treasury bill futures enjoyed a head start as a hedge and a means of positioning in short-term interest rates but lost out to Libor. This private benchmark outlasted the underlying interbank market and the evidence of manipulation has attracted both top-down reform and competition on the ground from overnight index swaps (OIS). OIS, it must be recalled, is based on a federal funds market that is a small fraction of its pre-crisis self (Afonso et al (2013); Kreicher et al (2013)). For our purposes, however, whether a reformed Libor, OIS or repo prevails, there is no prospect for a government rate to reclaim benchmark status at the short end of the yield curve, in the dollar or any major currency.

Benchmark tipping in the global bond market has gone a long way. From a 2000 perspective, with beguiling surpluses in US fiscal accounts, it was important to suggest that modern fixed income markets could, if necessary, generate their own benchmarks without help from the US Treasury (McCauley (2002)). The problem is no longer the disappearance of the government benchmark, but rather such a superabundance of government debt that it threatens its "risk-free" status (BIS (2013b)).

But benchmark tipping does not look like it will go all the way. The evidence of Graph 6 is that government obligations' role in providing a benchmark in the derivatives market is not entirely disappearing. Thus, the thoroughgoing tipping at the short end does not seem to be happening at the long end. Government bond futures in the UK and Canada seem to hang on to a share of 10% (perhaps 20% if short-term OIS could be identified for these currencies, as they can be for the euro and the Australian dollar).

Moreover, the existing small cast of active government bond futures markets will be joined over time by new contracts on emerging market government bonds. In these markets, government bond futures will have to compete with established swap markets, unlike the first mover government bond futures (and apparently Korea's). These markets' jump into futures is not only a matter of the growing size (Eichengreen and Luengnaruemitchai (2006)), liquidity of these market and related general financial market development. In addition, as global bond market investors participate more actively in these markets, there is increased demand, particularly in times of market strains, for hedging instruments, both for foreign exchange exposures and for duration exposures.

Emerging market authorities can find themselves torn between the desirable goal of market development and an understandable caution. Should foreign institutional investors be given free rein in government bond futures, or should they be prohibited from short positions or limited to short positions no larger than long cash positions? Should long futures positions be summed with long cash positions in determining whether foreign institutional investor quota limits have been respected?

The effect of the centralisation of swaps on public versus private benchmarks remains to be seen. Have the advantages of over-the-counter trading, whether flexibility in the contracts or (for end-users) the operational ease of bilateral credit, helped swaps to displace government bond futures? Or have dealers' resistance to centralisation of swaps held back these private benchmarks? Only time will tell.

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Annex 1: Futures and options contracts used

Exchanged-traded contracts on government notes and bonds — Table A

Currency	1995	1998	2001	2004	2007	2010	2013
Australian dollar	Sydney FE: F&O, 3yr and 10yr	Sydney FE: F&O, 3yr and 10yr	Sydney FE: F&O, 3yr and 10yr	Sydney FE: F&O, 3yr and 10yr	Sydney FE: F&O, 3yr and 10yr	Sydney FE: F&O, 3yr and 10yr	Sydney FE: F&O, 3yr and 10yr
British pound	Liffe: Long gilt futures only	Liffe: Long gilt futures only	Liffe: Long gilt futures only	Liffe: Long gilt F&O	NYSE-Liffe: Long gilt F&O	NYSE-Liffe: Short, med & long gilt F&O (long only)	NYSE-Liffe: Short, med & long gilt F&O (long only)
Canadian dollar	Montreal Exchange: Fut – 5yr, 10yr	Montreal Exchange: Fut – 5yr, 10yr	Montreal Exchange: Fut – 10yr, 20yr	Montreal Exchange: Fut – 2yr, 10yr	Montreal Exchange: Fut – 2yr, 10yr	Montreal Exchange: Fut – 10yr	Montreal Exchange: Fut – 2yr, 5yr, 10yr
Euro	Futures Exchanges: Belgium, Germany, Spain, Finland, France, Ireland, Italy, Netherlands, Liffe	Futures Exchanges: Belgium, Germany, Spain, Finland, France, Italy, Netherlands, Liffe	Deutsche Term: F&O – Bund, Bobl, Schatz; Euronext France: 10yr notional	Deutsche Term: F&O – Buxl, Bund, Bobl, Schatz; CBOT, futures only	Deutsche Term: F&O – Buxl, Bund, Bobl, Schatz	Deutsche Term: F&O – Buxl, Bund, Bobl, Schatz EUREX: BTP	Deutsche Term: F&O – Buxl, Bund, Bobl, Schatz EUREX: Short, med & long BTP, med, long OAT
Japanese yen	Tokyo SE: 10, 20yr JGB F&O; also Liffe & Singapore	Tokyo SE: 5, 10yr JGB F&O; also Liffe & Singapore	Tokyo SE: 5, 10yr JGB F&O; also Liffe & Singapore	Tokyo SE: 10yr JGB F&O; also Liffe & Singapore	Tokyo SE: 10yr JGB F&O; also NYSE-Liffe & Singapore	Tokyo SE: 10yr JGB F&O; also NYSE-Liffe & Singapore	Tokyo SE: 10yr JGB F&O; also NYSE-Liffe & Singapore
Korean won	No data	No data	Korea FE: 3yr KTB	Korea FE: 3yr KTB, also MSB	Korea FE: 3yr, 10yr KTB	Korea FE: 3yr, 10yr KTB	Korea FE: 3yr, 10yr KTB
US dollar	CBOT F&O: 2, 5, 10, long UST, also muni; Mid-America & CottonExch, TSE	CBOT F&O: 2, 5, 10, long UST, also muni; also Mid-America & CottonExch	CBOT F&O: 2, 5, 10, long UST, also agency; also Cantor & Mid-America	CBOT/ EUREX: F&O – 2, 5, 10, long UST	CBOT: F&O – 2, 5, 10, long UST	CBOT/NYSE-Liffe US: F&O – 2, 3, 5, 10, long, ultralong UST	CBOT/ELX Futures/ NYSE-Liffe US: F&O – 2, 5, 10, long, ultralong UST

Source: FOW Trade data.

Annex 2: Excluding OIS from interest rate swaps

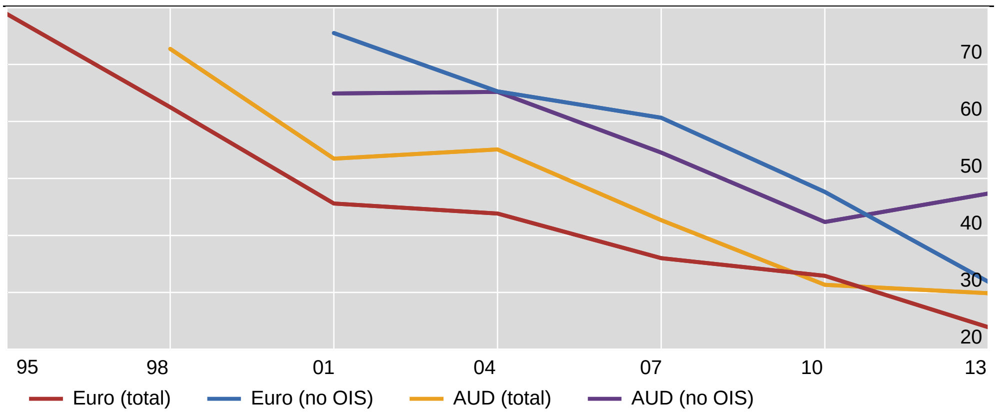
A problem with the evidence presented in the body of this paper is that the overall OTC swap data include overnight interest rate (OIS) swaps. These are essentially money-market, not bond-market instruments like other swaps. This is evident from the ECB's *Euro money market survey*. In particular, OIS swaps overwhelmingly mature within a year, while other swaps generally mature in more than one year. Having only arrived on the scene in the late 1990s, OIS swaps could have grown at such a rapid rate to account for the observation that swaps are growing faster than government bond futures. Thus in this Annex we use the breakdown from the ECB survey to improve our measure of the ratio and to confirm the decline in the government share. We also use data from the Australian Financial Markets Association to purge the Australian OTC data of OIS.

According to the ECB, OIS swaps dominated the euro money market in 2002-03, with other swaps amounting to only about a fifth of turnover. The fraction of other, longer-term swaps then rose to about a third before the crisis, approached one-half in 2008-11, only to surpass 60% in 2012-13.

When we take out the estimated OIS swaps from total swaps, the resulting ratio for the euro area starts out with a much higher fraction of government bond trading, but it falls faster (Graph A). In particular, the government share starts at 80% rather than below 50% (using the ECB's 2002 observation to calculate the 2001 non-OIS swaps). But then the government proportion falls to 34%, at a rate of 3.8%/year, faster than the 1¾% rate using all swaps. Similarly for the smaller Australian bond market, the effect of the removal of OIS deals is to raise the government share, although the share still declines except in 2013.

Government futures and options as proportion of bond derivatives

In per cent Graph A



Australian Financial Markets Association (2013); ECB (2013); FOW trade data; Triennial Central Bank Survey; authors' calculations.

For the euro, at least, excluding the OIS swaps on the grounds that they are of short maturity suggests that government bond derivatives started as more predominant but that they have lost ground faster. While our confidence in the benchmark tipping result is necessarily lower for the US dollar and yen, there is reason to suspect that OIS trades have fallen out of favour in the dollar and yen as much as in the euro, given the low for long policies of the Federal Reserve and the Bank of Japan.