Discount Rates for Australian Employee Benefit Liability Valuation

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Table of Contents

1 BACKGROUND

1.1 Objectives and Scope

The Group of 100 has commissioned Milliman to undertake research on developing a standardised set of discount rates to be made publicly available for the purpose of discounting employee benefit liabilities under Australian Accounting Standard 119 (AASB 119). The scope of the work is limited to Australian employee benefit schemes, and excludes any schemes of foreign subsidiaries of domestic entities which are denominated in foreign currency.

This paper reflects the first phase of our work relating to market analysis and the development of a suitable methodology as per our engagement letter dated 23 September 2014. The goal is to assess whether the Australian corporate bond market meets the requirements as outlined in AASB 119, and to determine a methodology to derive a full discount rate curve allowing for possible limitations in available market data. This discount rate curve will then be available as a transparent central reference point for the industry.

1.2 Structure of the Report

This report is structured in various sections. The overall findings of the report are outlined in the executive summary in Section 2. Section 3 details the appropriate sections of the relevant accounting standards, which set the requirements for both the definition of the asset calibration set and discount rate methodology. Section 4 presents analysis of the Australian bond markets in order to determine whether the accounting requirements are best able to be met, as well as a high level discussion on how other comparable international markets have addressed the issues.

Section 5 discusses various alternative methodologies that can be used to both interpolate and extrapolate a yield curve for a defined calibration set of assets. Finally, Section 6 provides some example yield curve calibrations based upon the methods discussed. Conclusions and recommendations are outlined at the end of each section and sub-section and tied together in the Executive Summary.

1.3 Reliances and Limitations

In producing this report, we have relied upon the following information:

- Capital market data as sourced from various providers such as Bloomberg, AFMA, AOFM, RBA, ABS amongst others as listed throughout this report. Should this data be incorrect, it could materially affect the analysis and conclusions drawn from it.
- Various research reports and papers publicly available in both the academic and industry literature. We have attempted to constrain these to reliable sources and authors, although should there be material errors in them that affect their conclusions, it could impact our work.
- Input from PricewaterhouseCoopers (PwC) experts relating to interpretations of accounting standards, and the approaches used in other geographic regions.

Users of this report should also be aware that it is subject to the following limitations:

- Current debt market conditions. Issuance of government and corporate bonds is subject to change over time, which may impact upon whether the accounting standard requirements of a deep market are met.
- Current capital market conditions, in particular the liquidity and credit ratings of corporate bond markets, which can change rapidly. The asset calibration set could change very rapidly under stressed market conditions.

- Reassessments of the suitability of the asset calibration set would be needed if the AAA and/or AA corporate bond market thins, which would require a prospective change to the assets selected for AASB 119 calibration purposes.

This report is subject to the terms and conditions of our engagement letter dated 23 September 2014. In particular, users should note that this report was prepared solely to provide assistance to the Group of 100 and the relevant Actuaries Institute of Australia sub-committee. Milliman does not intend to benefit and assumes no duty or liability to other parties who receive this report. Milliman recommends that any recipient of this report be aided by its own actuary or other qualified professional when reviewing the report. Milliman does not certify the information in this report, nor does it guarantee the accuracy, completeness, efficacy or timeliness of such information. Use of such information is voluntary and should not be relied upon unless an independent review of its accuracy, completeness, efficacy and timeliness has been performed. Materials may not be reproduced without the express consent of Milliman.

2 EXECUTIVE SUMMARY

The Group of 100 has commissioned Milliman to undertake research on developing a standardised set of discount rates to be made publicly available for the purpose of discounting employee benefit liabilities under Australian Accounting Standard 119, Employee Benefits (AASB 119). This paper reflects the first phase of our work relating to market analysis and the development of a suitable methodology as per our engagement letter dated 23 September 2014. The goal is to assess whether the Australian corporate bond market meets the requirements as outlined in AASB 119, and to determine a methodology to derive a full discount rate curve allowing for possible limitations in available market data. This discount rate curve will then be made available as a transparent central reference point for the industry to use on an ongoing basis.

AASB 119 provides the guidance for the discount rate to be used for discounting employee benefit liabilities, whilst International Accounting Standard 19 (IAS 19) is the international equivalent. Section 3 outlines the details of this and the related IAS 19 accounting standards and discusses the requirements of the asset calibration set. The following conclusion is drawn from this analysis:

Conclusion 1: The asset calibration set must include bonds that are of high quality where a deep market exists.

This is interpreted as corporate bonds with a credit rating of either AAA or AA. Furthermore, the bonds must be of nominal fixed coupon type with no embedded derivatives, issued by either domestic or foreign entities with coupon and principal payments denominated in AUD. Securitised bonds are also included in this definition.

Section 4.1 outlines in detail the characteristics of the Australian fixed income markets, and the detailed characteristics of bonds that meet the above requirements. The following conclusions are drawn from this analysis:

Conclusion 2: There is a sufficiently observable, deep and liquid market in a number of corporate bond market segments to meet the requirements.

Market pricing data at a security level is readily available via market data providers such as Bloomberg, which we have used as the primary data source for our analysis. The market for either pure AAA-rated or AA-rated bonds (including both domestic and foreign issuers) is sufficiently deep, with total amounts outstanding of AUD 12 billion and AUD 28 billion respectively. Combined, they represent AUD 40 billion, representing around 2.5% of the entire Australian fixed income market. The liquidity ratio (turnover/outstanding) appears to be around 55%, which is comparable with international market equivalents at around 50%. Analysis of bid-ask spreads also suggests the market is liquid out to around 10-year tenors.

Note that this will not apply to not-for-profit public sector entities, which are required to use the government bond rate in all circumstances under AASB 119, paragraph Aus83.1.

Conclusion 3: Pricing analysis clearly shows that whilst domestic and foreign issuers of equivalent credit ratings are priced consistently, AAA and AA corporate bonds are priced differentially. Despite this, in order to ensure as deep a market as possible, the recommended calibration set should include both AAA- and AA-rated bonds from both domestic and foreign issuers, resulting in an asset set market size of AUD 40 billion.

This calibration set has AUD 40 billion of outstanding notional (= 28 billion of AA-rated plus 12 billion of AAA-rated bonds). This is consistent with the current approach that combines Commonwealth and semi-government bonds into a single asset calibration set.

Conclusion 4: Australia is comparable with other international markets using corporate bonds, having similar liquidity ratios, and a deeper market compared with the comparable markets of Sweden and Norway, although market depth appears to be lower than Canada.

The four major markets that use corporate bonds as the reference assets for IAS 19 discount rate purposes include the US, Japan, the UK and the Eurozone. Each of these countries or regions supports a deep and liquid corporate bond market, with liquidity ratios of circa 50% to 70%. At the other end of the spectrum, there are several relatively poor quality, small or illiquid corporate bond markets, including China, Hong Kong, South America/Brazil, Malaysia, and Singapore, all of which use government bonds for IAS 19 discount rate purposes. In between these extremes lie Canada, Sweden and Norway, all of whom use corporate bonds for IAS 19 discount rate purposes.

Having recently moved to the use of corporate bonds, the Canadian market is the most comparable with Australia. The equivalent AAA+AA corporate bond market in Canada has a market capitalisation of AUD 120 billion, which is around 2.5 times that of Australia. Other markets that have recently moved to the use of corporate bonds are Sweden and Norway, both of which are smaller than Australia, at AUD 20 billion and 60 billion respectively (but significantly smaller when considering only fixed coupon bonds). All three of these markets have corporate bond market liquidity ratios of around 50%, which are below the equivalent ratio for Australia of 55%. Thus, there are multiple existing international precedents for the use of corporate bonds, all of which appear to have comparably deep and liquid markets compared to Australia.

Conclusion 5: Now appears to be a good time to move to a corporate bond basis as the markets have exhibited stability for a number of years since the Global Financial Crisis and are supported by a growing government bond market and a move towards central clearing houses for market transparency.

Australia's corporate bond market grew very strongly in the 1990s / early 2000s. However, significant uncertainty followed the GFC in 2008 as market issuance stopped and the overall size of the market declined. Since then it has stabilised, and over the last year or two has started to increase in size again. Growth in the Commonwealth Government bond market has supported issuance and pricing in the corporate market, particularly at longer durations. The introduction and continued focus on shifting to central clearing houses for corporate bonds (away from over-the-counter trading) is expected to aid market transparency and, ultimately, liquidity as it opens up the market to other sources of investors.

Conclusion 6: The Merrill Lynch Exponential Spline (MLES) model is recommended for the interpolation process to derive the best fit for the yield curve out to durations of 10 years.

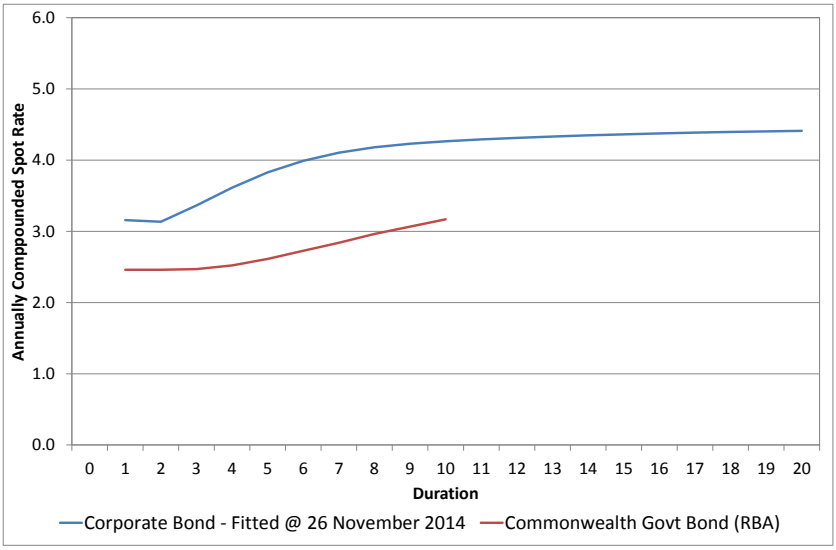
A range of parametric and non-parametric methods were considered for the yield curve interpolation process. Given the heterogeneity of the calibration set, non-parametric approaches are not a viable option, and there appears little benefit to using spread approaches. Given the findings from academic authors who have assessed the various parametric approaches, the MLES method appears to be a favourable solution. It also has the benefit of being similar to the preferred approach used by the RBA to derive the yield curve on Commonwealth Government bonds, hence providing consistency with published risk-free rates. The suggested weighting scheme will be based upon weighted (inverse) duration, and the optimisation process focused on replicating market prices rather than yields. This is also the methodology used by Fiera Capital to derive the corporate bond curve in Canada (see Fiera Capital, 2012). It should be noted that technically the Svensson model also appears to be a strong candidate, both being relatively popular and providing accurate results on a par with the MLES model.

Conclusion 7: The Constant Forward Rate method from the last market data point is recommended for the extrapolation process.

The Constant Forward Rate and parametric Ultimate Forward Rate methods are the primary extrapolation methods that could be justified. The choice between these is dependent largely upon whether consistency with observed rates at a point in time or liability stability across time is more important. Given the focus on market consistency of the accounting standards, and the entire lack of subjective assumptions required, the Constant Forward Rate methodology is recommended for extrapolation purposes.

Conclusion 8: The MLES and Constant Forward Rate methods result in suitable yield curves for AASB 119 discounting rate purposes, with sufficiently accurate calibration results for current market conditions

The MLES model achieved goodness of fit results of 95% for the calibration as at 26 November 2014. This means that the model is able to 'explain' 95% of the variability exhibited in market prices. Although the method is expected to be robust under a wide range of market environments, there is no guarantee that it will perform under all possible market environments. The figure below shows the resulting yield curve as at 26 November 2014 based upon the recommended methodology. For comparison, the RBA's published Commonwealth Government spot rate curve on the same date is also shown (to maturity of 10 years only).



Duration	Spot Rate	Duration	Spot Rate
1	3.16	11	4.29
2	3.13	12	4.31
3	3.36	13	4.33
4	3.61	14	4.35
5	3.83	15	4.36
6	3.99	16	4.37
7	4.10	17	4.39
8	4.18	18	4.40
9	4.23	19	4.40
10	4.26	20	4.41

Figure 1: Spot and forward yield curves for AAA+AA corporate bonds (domestic + foreign issuers) as at 26 November 2014, using MLES interpolation and Constant Forward Rate extrapolation methodologies. Note that yields are quoted on an annually compounded basis. Source: Milliman, Reserve Bank of Australia Statistical Table f17.

3 ACCOUNTING STANDARDS REQUIREMENTS

This section outlines the relevant accounting requirements for setting discount rates for employee benefit plans. Whilst the primary focus is on the Australian standard AASB 119, we feel it is useful to start with the equivalent international standard, IAS 19, which forms the basis of the Australian standard and also provides the relevant context when considering the experience of other markets. These standards provide the basis for determining appropriate definitions of the key concepts of high quality, security types, and a deep market.

3.1 International Accounting Standard 19, Employee Benefits

International Accounting Standard 19, Employee Benefits (IAS 19) provides the guidance for the discount rates to be used for discounting employee liabilities globally. Many local accounting standards are based upon it, such as Australia, and it provides the relevant context when considering the experience of other markets in addressing discount rate issues.

The following is the relevant extract on actuarial discount rate assumptions from IAS 19 (paragraphs 78–81):

78 ***The rate used to discount long-term employee benefit obligations (both funded and unfunded) shall be determined by reference to market yields at the end of the reporting period on high quality corporate bonds. In countries where there is no deep market in such bonds, the market yields (at the end of the reporting period) on government bonds shall be used. The currency and term of the corporate bonds or government bonds shall be consistent with the currency and estimated term of the long-term employee benefit obligations.***

79 *One actuarial assumption which has a material effect is the discount rate. The discount rate reflects the time value of money but not the actuarial or investment risk. Furthermore, the discount rate does not reflect the entity-specific credit risk borne by the entity's creditors, nor does it reflect the risk that future experience may differ from actuarial assumptions.*

80 *The discount rate reflects the estimated timing of benefit payments. In practice, an entity often achieves this by applying a single weighted average discount rate that reflects the estimated timing and amount of benefit payments and the currency in which the benefits are to be paid.*

81 *In some cases, there may be no deep market in bonds with a sufficiently long maturity to match the estimated maturity of all the benefit payments. In such cases, an entity uses current market rates of the appropriate term to discount shorter-term payments, and estimates the discount rate for longer maturities by extrapolating current market rates along the yield curve. The total present value of a defined benefit obligation is unlikely to be particularly sensitive to the discount rate applied to the portion of benefits that is payable beyond the final maturity of the available corporate or government bonds.*

3.2 Australian Accounting Standard 119, Employee Benefits

Australian Accounting Standard 119, Employee Benefits (AASB 119) provides the guidance for the discount rate to be used for discounting employee liabilities.

The following is the relevant extract on actuarial discount rate assumptions from AASB 119 (paragraphs 83–86):

83 ***The rate used to discount post-employment benefit obligations (both funded and unfunded) shall be determined by reference to market yields at the end of the reporting period on high quality corporate bonds. In countries where there is no deep market in such bonds, the market yields (at the end of the reporting period) on government bonds shall be used. The currency and term of the corporate bonds or government bonds shall be consistent with the currency and estimated term of the post-employment benefit obligations***

83.1 Notwithstanding paragraph 83, in respect of not-for-profit public sector entities, post-employment benefit obligations denominated in Australian currency shall be discounted using market yields on government bonds.

84 One actuarial assumption that has a material effect is the discount rate. The discount rate reflects the time value of money but not the actuarial or investment risk. Furthermore, the discount rate does not reflect the entity-specific credit risk borne by the entity's creditors, nor does it reflect the risk that future experience may differ from actuarial assumptions.

85 The discount rate reflects the estimated timing of benefit payments. In practice, an entity often achieves this by applying a single weighted average discount rate that reflects the estimated timing and amount of benefit payments and the currency in which the benefits are to be paid.

86 In some cases, there may be no deep market in bonds with a sufficiently long maturity to match the estimated maturity of all the benefit payments. In such cases, an entity uses current market rates of the appropriate term to discount shorter-term payments, and estimates the discount rate for longer maturities by extrapolating current market rates along the yield curve. The total present value of a defined benefit obligation is unlikely to be particularly sensitive to the discount rate applied to the portion of benefits that is payable beyond the final maturity of the available corporate or government bonds.

Based upon the above extract, we can summarise the key statements in a simple conclusion as follows:

Conclusion 1: The asset calibration set must include bonds that are of high quality where a deep market exists.

3.3 Interpretations and Definition of the Asset Calibration Set

3.3.1 What Is Meant by High Quality?

Global practice and rating agency definitions would indicate that AAA- and AA-rated bonds (or the two highest ratings of a particular rating agency) are deemed to be high quality for purposes of assessing whether there is a deep market in high-quality bonds. It is worth noting that the Securities Exchange Commission has provided an interpretation under US accounting standards that *high quality* means the two highest credit ratings given by a recognized ratings agency.[1] This is also the case in Canada[2] and the UK.[3]

The Interpretations Committee of the IASB has further indicated in July 2013 that high quality is an absolute and not relative notion. As such, a reduction in the number of high quality corporate bonds overall does not justify a change in interpretation of what is high quality.

[1] See the 23 September 1993 US FASB Emerging Issues Task Force meeting minutes on Administrative and Technical Matters, which states '*The staff suggests that fixed-income debt securities that receive one of the two highest ratings given by a recognized ratings agency be considered high quality (for example, a fixed-income security that receives a rating of AA or higher from Moody's Investors Service, Inc.).*'

[2] See the Canadian Institute of Actuaries educational note on 'Accounting Discount Rate Assumptions for Pension and Post-Employment Benefit Plans,' September 2011.

[3] Financial Reporting Council (November 2000), FRS 17 Retirement Benefits, paragraphs 32 and 33. Retrieved 28 April 2015 from https://frc.org.uk/Our-Work/Codes-Standards/Accounting-and-Reporting-Policy/Standards-in-Issue/FRS-17-Retirement-Benefits.aspx.

The following figure defines the credit ratings by each agency that map to each of these broad categories, which is the basis for the analysis in this report.

Category	AAA	AA
S&P	AAA	AA+, AA, AA-
Fitch	AAA	AA+, AA, AA-
Moodys	Aaa	Aa1, Aa2, Aa3

Figure 2: Definition of AAA and AA credit ratings by agency

Where there is disagreement between credit rating agencies on particular securities, we suggest using the following conditions:

- If a security has at least two AAA ratings, then it is classified as a AAA security.
- If a security has at least two AA ratings, then it is classified as a AA security.
- If a security has only been rated by two agencies with different ratings, then the lower rating is used.
- If a security has only been rated by one agency, then that rating becomes the sole reference.

Hereafter, all references to credit ratings refer to those that meet the above conditions. For the purposes of this paper, we refer to this as the combined credit rating.

3.3.2 What Type of Fixed Income Securities May Be Considered in the Calibration Set?

The next consideration is what type of fixed-income securities may be considered in the calibration set.

3.3.2.1 Physical vs. Derivatives

The accounting standard clearly refers to bonds, which are physical securities. There is no mention of derivatives, which would thus exclude the use of interest rate swaps. In Section 4, we do provide some information on the swap market, as it may be useful as a point of comparison for some methodologies in the absence of a sufficiently deep corporate bond market.

3.3.2.2 Issuer

The entity could be either a government or corporate entity. There are two main types of government entities that issue debt: the Commonwealth Government (Treasury) and state governments (semi-government). Both of these meet the definition of government. There are also a small number of councils (regional government) that issue debt which are also included in the definition of government. As specified in the standards, government bonds might be required in the asset calibration set if corporate bonds do not meet all the conditions.

Bonds issued by government agencies that run on a commercial for-profit basis (e.g., Australia Post) are considered to be corporates, rather than government bonds. Such issues currently account for a small proportion of the total Australian corporate bond market (around 3% of the outstanding AAA+AA corporate bond set).

Bonds issued by Australian corporates clearly meet the requirements of the standard.

Note that there is no explicit condition that the issuer itself needs to be an Australian entity, just that the denomination of its debt is in AUD. Thus, kangaroo bonds (AUD debt issued by foreign entities onshore in Australia), and Australian dollar Eurobonds (AUD debt issued by foreign entities offshore) issued by non-government organisations also meet the accounting requirements (subject to all other requirements as well).

3.3.2.3 Currency

The currency of the bonds must be consistent with that of the liability, which means that only AUD-denominated bonds can be used.

3.3.2.4 Term

The term of the securities needs to be consistent with the term of the liabilities. As employment benefit obligations are very long-term liabilities, a yield curve that extends out all the way to 50+ years will be required. Thus there are no specific term restrictions.

3.3.2.5 Coupon and Maturity Type

Given the fixed contingent cash flow nature of the liability, fixed rather than floating coupon bonds are required in the calibration set. There appears to be no reason why perpetuities would be excluded from the calibration set, and they might have a minor beneficial impact as they help add extra duration to the existing fixed term market.

Typically, employee benefit cash flows are projected on a nominal basis, taking into account expected wage and consumer inflation as relevant. Typically, nominal discount rates are used to value these cash flows, although real rates could also be used if cash flows are projected in real terms. In this case, bonds with coupons and/or maturity payments that are indexed to inflation are the relevant measure. Construction of a real interest rate curve, based on inflation-linked securities, is outside the scope of this report.

3.3.2.6 Embedded Derivatives

Some bonds have embedded derivative features, such as being callable, putable, convertible and extendible. These features have value and thus impact the price/yield on the security. Incorporating them in the asset calibration set complicates the calculations somewhat as the impact of these features would need to be stripped out in order to be comparable with other vanilla bonds as well as defined benefit pension liabilities. The most material is a callable feature, which is predominantly found in lower-rated debt of single A and below. Overall, such features are not a material part of the AAA or AA corporate bond market, accounting for less than 1% of issuance. Hence there is limited value in including them relative to the additional cost and complication, and it is thus suggested that all bonds with embedded derivatives be excluded from the asset calibration set.

3.3.2.7 Securitised Assets

Securitisation involves creating debt securities directly from cashflows from specific assets such as home loans or corporate loans. There are a significant number of bonds backed by specific pools of assets, including covered bonds and asset-backed securities (ABS). Covered bonds are debt securities backed by cash flows from mortgages which remain on the issuer's consolidated balance sheet. ABS securities include:

- Residential mortgage-backed securities (RMBS). Australian RMBS are securitised prime and non-prime residential mortgages.
- Commercial mortgage-backed securities (CMBS). CMBS reference a commercial mortgage loan pool.
- Securities collateralised by assets other than mortgage loans, for example, receivables derived from motor vehicle loans, credit cards, personal loans and royalties.

RMBS and CMBS are issued predominantly by banks, and have credit ratings attached to them similar to other debt securities. These credit ratings reflect the ability of the pool of assets to meet the debt repayment schedule of the security. This is different from a standard unsecuritised corporate bond where the credit rating reflects the ability of the entire entity to meet the debt repayment schedule of the security.

A simple thought experiment illustrates the equivalence between two corporate entities that are identical apart from the debt structure of its balance sheet. One entity issues a single standard corporate bond, whilst the other issues two securitised bonds backed by the two separate assets that entirely make up its asset base. The single corporate bond for the first entity must have a credit rating that is a weighted average of that of the two securitised assets, otherwise arbitrage opportunities would become available. Thus, the two approaches are economically equivalent (ignoring residual operational and transaction costs).

As a result of this equivalence, securitised assets should also be considered for inclusion in the asset calibration set, subject to meeting all the other criteria as per normal.

3.3.2.8 Liquidity

In order to be consistent with readily observable market yields, any securities included in the calibration set should only include issues where traded prices or yields can be reasonably determined from actual market activity on or near the reporting date.

This suggests two additional criteria should be met by any securities included within the calibration set.

Firstly, valuations should use sources of market price/yields which are determined from actual market activity, rather than using a model extrapolation. This excludes certain model-based sources of price, such as Bloomberg's 'BVAL' source.

Secondly, evidence of recent transaction activity on a security should be available before that security can be considered to represent current market yields. For example, the security should have been traded in sufficient volume over the prior business day in order to conclude that the observed price reflects recent market activity.

3.3.3 What Is a Deep Market?

A *deep market* is not defined in the accounting standards. It is thus subject to judgement.

Factors to consider in evaluating whether a particular bond market is deep or not may include:

- The size of outstanding notional amount on issue and the number of issuers of these bonds—as compared with the total bond market. Small bond issues are unlikely to be liquid securities.
- Access to observable market yields.
- Turnover volumes and bid-ask pricing spreads.
- Macro-economic factors such as the status of initiatives by the government to create or support a deep and liquid bond market.
- Trends in volumes of bonds traded over time.

The quantifiable factors are the amounts on issue (relative to total market), number of issuers, turnover volumes and bid-ask spreads. While these figures might not be conclusive at all observation dates, a history of significance or an upward trend would support the notion of depth. Readily available data on yields is critical.

As noted in AASB 119, a deep market in high-quality bonds does not need to exist at all durations. Techniques to extrapolate a yield curve are acceptable provided a deep market in high-quality bonds exists at some duration.

3.4 Summary of Requirements

The set of assets to be used to calibrate a discount rate curve is defined by those securities that meet the following conditions:

1. Individual bonds must have the following characteristics:
    a. Physical bonds, with no embedded derivatives (e.g., callable, putable, convertible, extendible, variable/floating coupon, index-linked).
    b. Government issuers can be both Commonwealth and state governments.
    c. Corporate issuers can be both Australian and foreign entities.
    d. Pay fixed (or zero) coupons.
    e. Payments denominated in Australian dollars (AUD).
    f. All maturity terms.
    g. Minimum amount outstanding on an individual security of $100 million.
    h. Securitised bonds are included.

2. They must be high quality, as defined by having a credit rating of AAA or AA by at least two credit rating agencies.
3. A deep market for these bonds must exist, as characterised by the following key quantities (plus the ready availability of observable yields):
    a. Readily observable market yields
    b. Size, in absolute terms and compared to the total bond market
    c. Liquidity by reference to turnover
    d. Number of issuers

Where a deep market is not present in high-quality corporate bonds, then the current status of using a mixture of Commonwealth and semi-government debt will be used.

3.5 Description of the Australian Defined Benefit Pension Market

When choosing a discount rate for the valuation of post-employment pension liabilities, AASB 119 states that the rate 'shall be determined by reference to market yields at the end of the reporting period on high quality corporate bonds...the currency and term of the Corporate bonds or Government bonds shall be consistent with the currency and estimated term of the post-employment benefit obligations' The exception to this is not-for-profit public sector entities that shall continue to be discounted using market yields on government bonds.

Australia's remaining defined benefit liabilities can be split into those in respect of public sector employees and those in the private sector. Public sector liabilities, backed by state and Commonwealth governments, make up the majority of defined benefit pension obligations in Australia and can have durations of liabilities up to 15 years. In the private sector, defined benefit obligations are a combination of lump sum benefits and pension liabilities. Since the majority of private sector defined benefit funds are now closed, the durations of the majority of the liabilities are typically only up to 10 years.

When considering the materiality of estimating spot rates from market observed data, or from choosing a rate from within a range, a rule of thumb for a fund with duration of liabilities around 10 years is that a 0.5% change in the discount rate has an impact on liabilities of approximately 5%. Whilst it is outside the scope of this paper to discuss the approach and implications of choosing a specific spot rate for use in AASB 119 valuations, it is worth acknowledging the potential materiality impact here particularly when discussing interpolation and extrapolation techniques.

4 MARKET ANALYSIS

4.1 Australian Bond Markets

4.1.1 Overview

The following diagram shows an overview of the physical Australian bond market. It breaks down the amount outstanding by sector, issuer and currency of denomination.

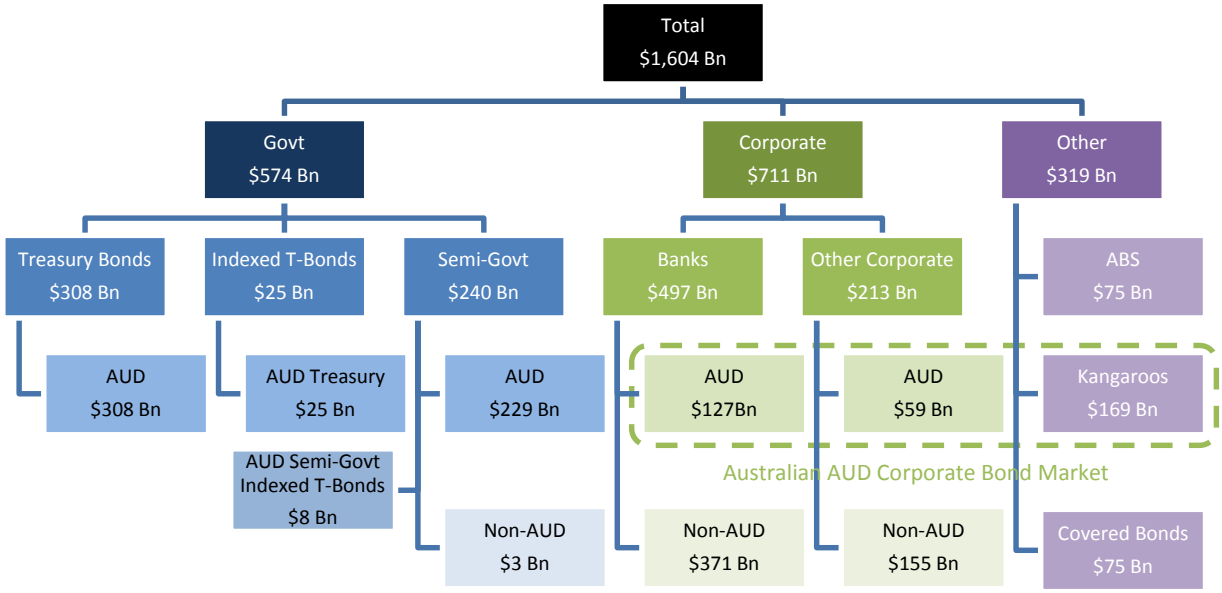


Figure 3: Breakdown of the Australian physical bond market by sector, issuer type and amount outstanding ($ billions). Source: Milliman analysis based upon Bloomberg data as at 24 October 2014 and supplemented with RBA data.

The Australian bond market has around $1.6 trillion dollars of notional debt outstanding. The market value of this debt is broadly equivalent to the notional outstanding value, as most of the debt has coupon payments that are broadly equivalent to current interest rate levels.

Government, corporate and other debt account for 34%, 47% and 19% of the market, respectively. Commonwealth Government debt is dominated by (nominal) treasury bonds at $308 billion, with a relatively small issuance of indexed treasury bonds at $25 billion. The remainder of government debt is issued by the states ($240 billion) as represented by the semi-government bond market, with a trivially small amount of debt issued by government agencies. Almost all government debt is denominated in Australian dollars (AUD), with only a trivially small amount of overseas-denominated debt issued by state governments.

Corporate debt issued by Australian entities, sometimes referred to as non-government debt, accounts for 47% of the market. This market is dominated by the banks, which account for $497 billion, or around 70% of the market. The banks have a heavy appetite for non-AUD debt, having raised 75% of their debt, or $371 billion, in foreign currencies. The Australian corporate bond market, as defined by the total amount of AUD denominated and Australian entity issued corporate debt, is around $185 billion, representing 12% of the total Australian bond market.

Other debt is a mixture of asset-backed securities (ABS), covered bonds, and kangaroo bonds (AUD denominated debt issued by foreign entities). The ABS market is dominated by residential mortgage-backed securities (RMBS). These markets are large enough to warrant analysis as to whether they meet the requirements for inclusion in the asset calibration set.

4.1.2 Commonwealth Government Bond Market

As of late October 2014, there were 20 (nominal) treasury bonds on issue. The characteristics of these bonds are outlined in the following table.

Maturity	Term (Years)	Modified Duration	Coupon	Face Value ($m AUD)	Market Value ($m AUD)	Cumulative % of Market Value
15-Apr-15	0.5	0.46	6.25	14,797	15,054	4.6%
21-Oct-15	1.0	0.95	4.75	13,899	14,204	8.9%
15-Jun-16	1.6	1.54	4.75	21,900	22,697	15.7%
15-Feb-17	2.3	2.13	6	21,096	22,728	22.6%
21-Jul-17	2.7	2.55	4.25	18,900	19,741	28.6%
21-Jan-18	3.2	2.94	5.5	20,500	22,328	35.4%
21-Oct-18	4.0	3.71	3.25	10,300	10,514	38.5%
15-Mar-19	4.4	3.92	5.25	20,847	23,003	45.5%
21-Oct-19	5.0	4.62	2.75	6,000	5,982	47.3%
15-Apr-15	0.5	4.85	4.5	20,397	22,062	54.0%
15-May-21	6.6	5.43	5.75	21,599	25,125	61.6%
15-Jul-22	7.7	6.28	5.75	17,500	20,653	67.9%
21-Apr-23	8.5	6.91	5.5	21,300	24,947	75.4%
21-Apr-24	9.5	8.24	2.75	18,000	17,241	80.6%
21-Apr-25	10.5	8.8	3.25	13,100	13,005	84.6%
21-Apr-26	11.5	9.14	4.25	12,200	13,199	88.6%
21-Apr-27	12.5	9.58	4.75	13,000	14,721	93.0%
21-Apr-29	14.5	11.37	3.25	7,800	7,503	95.3%
21-Apr-33	18.5	12.77	4.5	7,900	8,701	97.9%
21-Apr-37	22.5	14.96	3.75	7,000	6,847	100.0%
Total		**5.3**		**308,035**	**330,267**	

Figure 4: Characteristics of Commonwealth treasury bonds outstanding as at October 2014. Source: Australian Office of Financial Management.

As can be seen, the treasury market extends out to terms of 22 years, although 93% of the market value has a modified duration of less than 10 years. The long-duration bonds on issue from 15 to 22 years are relatively small. All of these bonds carry a AAA credit rating, as rated by Fitch and Moody.

The Commonwealth Government also issues treasury-indexed bonds. As of late October 2014, there were seven treasury-indexed bonds on issue. The characteristics of these bonds are outlined in the following table.

Maturity	Term (Years)	Modified Duration	Coupon	Face Value ($m AUD)	Market Value ($m AUD)	Cumulative % of Market Value
20-Aug-15	0.8	0.8	4	1,152	2,044	6.0%
21-Nov-18	4.1	3.98	1	3,539	3,648	16.7%
20-Aug-20	5.8	5.23	4	4,964	9,384	44.2%
21-Feb-22	7.3	6.98	1.25	3,890	4,234	56.7%
20-Sep-25	10.9	9.46	3	5,543	7,606	79.0%
20-Sep-30	15.9	13.36	2.5	3,293	4,311	91.7%
21-Aug-35	20.8	17.18	2	2,500	2,844	100.0%
Total		**8.3**		**24,881**	**34,071**	

Figure 5: Characteristics of Commonwealth treasury-indexed bonds outstanding as at October 2014. Source: Australian Office of Financial Management.

Although much smaller when compared with the nominal treasury market, it is almost as long, extending out to around 20 years.

4.1.3 State Government Bond Market

Debt issued by Australian state governments constitutes the Australian semi-government bond market. It is comprised of debt from the following issuers.

State Issuer	AUD	NZD	GBP	JPY	CHF	Total
Queensland Treasury Corp	81,576	1,487	0	209	121	83,393
New South Wales Treasury Corp	63,327	0	549	27	137	64,041
Treasury Corp of Victoria	34,353	0	0	109	0	34,462
Western Australian Treasury Corp	30,951	0	0	0	0	30,951
South Australian Government Financing Authority	16,139	0	0	0	0	16,139
Northern Territory Treasury Corp	4,095	0	0	0	0	4,095
Tasmanian Public Finance	3,924	0	0	0	0	3,924
Australian Capital Territory	2,997	0	0	0	0	2,997
Total	237,361	1,487	549	346	259	240,001

Figure 6: Australian semi-government bond market outstanding debt by issuer and currency amount ($ millions). Note this includes indexed linked bonds as well. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

This market is dominated by Queensland and New South Wales, which account for 61% of outstanding debt. Almost all of the debt is denominated in AUD.

In 2009, the Australian Commonwealth Government announced that it would provide a time limited, voluntary guarantee over Australian state and territory government debt. This was available for both existing and new issuances of debt over a range of maturities, but did not extend to issuances denominated in foreign currencies. As a result, where state and territory governments have taken up this offer, the credit rating on the debt is effectively that of the Australian Commonwealth Government, which is AAA. For debt where this guarantee doesn't apply, the credit rating of the state or territory is applicable. This guarantee offer was withdrawn by the Commonwealth Government for all issuance after 31 December 2010.

The following table shows a breakdown in outstanding debt by credit rating.

Issuer	AAA	AA	Other	Total
Queensland Treasury Corp	8,762	72,814	0	81,576
New South Wales Treasury Corp	62,479	0	848	63,327
Treasury Corp of Victoria	34,187	0	166	34,353
Western Australian Treasury Corp	0	29,321	1,630	30,951
South Australian Government Financing Authority	0	16,139	0	16,139
Northern Territory Treasury Corp	0	0	4,095	4,095
Tasmanian Public Finance	0	3,924	0	3,924
Australian Capital Territory	2,997	0	0	2,997
Total	108,425	122,198	6,739	237,361
% of Total	**46%**	**51%**	**3%**	**100%**

Figure 7: Australian semi-government bond market outstanding debt (in $ millions) by credit rating (based upon S&P major groups). Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

Roughly half of the market is AAA-rated, whilst the other half is AA-rated.

The following table shows the breakdown of the market (outstanding notional) by term and credit rating.

Term	AAA Per Year	AAA Cumulative	AA Per Year	AA Cumulative
1	4.2%	4%	12.2%	12%
2	7.6%	12%	12.0%	24%
3	11.4%	23%	14.3%	38%
4	9.7%	33%	9.8%	48%
5	12.2%	45%	9.9%	58%
6	11.8%	57%	10.1%	68%
7	5.9%	63%	9.6%	78%
8	12.8%	76%	6.2%	84%
9	4.9%	80%	5.8%	90%
10	5.9%	86%	6.3%	96%
11	4.3%	91%	2.2%	98%
12	3.6%	94%	0.5%	99%
13	2.9%	97%	0.0%	99%
14	0.0%	97%	0.0%	99%
15+	2.8%	100%	1.1%	100%

Figure 8: Marginal and cumulative distributions of Australian semi-government bond market outstanding debt by term and credit rating. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

The AAA market extends out to around 15 years, with a scattering of issuance out to 30 years, although the AA market is mostly complete by the 10-year point.

4.1.4 Corporate Bonds

As noted earlier, the Australian corporate bond market, as defined by the total amount of AUD-denominated Australian entity issued corporate debt, is around $185 billion and represents around 12% of the total Australian bond market. Around $3 billion of this relates to inflation-indexed bonds, a further $113 billion are bonds with floating rate or variable coupons, and a further $7 billion have prices which are sourced from a valuation model rather than using actual trade or quote information for that security, largely less illiquid privately placed bond issues. This leaves $61 billion of nominal bonds for consideration.

The following figure provides a breakdown of this market by the industry of issuer.

Industry	Outstanding ($ Million)	% Total	% Cumulative
Banks	29,701	49.0%	49.0%
Real Estate	7,209	11.9%	60.9%
Utilities	4,175	6.9%	67.7%
Transportation & Logistics	3,425	5.6%	73.4%
Wireline Telecom Services	2,650	4.4%	77.8%
All Other	13,491	22.2%	100.0%
Total	60,651	100%	

Figure 9: Australian fixed- and zero-coupon corporate bond market outstanding debt by issuer industry ($ millions). Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

The market is dominated by the banks, which account for 50% of fixed coupon bond issuance.

The following table shows the decomposition of the market by the combined credit rating.

Combined Credit Rating	Number of Securities	Outstanding ($Millions)	% of Total
AAA	14	9,883	16.3%
AA	76	22,091	36.4%
A	59	16,422	27.1%
BBB	49	10,655	17.6%
BB	3	950	1.6%
Other (not rated)	9	651	1.1%
Total	210	60,651	100.0%

Figure 10: Australian corporate bond market outstanding debt by combined credit rating ($ millions). Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

The largest credit rating category is AA, with AUD 22 billion of outstanding, followed by A and BBB. The following table looks at the breadth and consistency of the AAA and AA combined credit ratings groups. For example, there were 20 securities with a combined credit rating of AAA that were only rated AAA by two rating agencies, with the other rating agency not rating them.

Credit Rating Group	Number of Securities	Outstanding ($Millions)	% of Total
Combined Credit Rating of AAA			
2 AAA, 1 Not Rated	11	9,158	92.7%
1 AAA, 2 Not Rated	3	725	7.3%
Total AAA	14	9,883	100.0%
Combined Credit Rating of AA			
2 AA, 1 Not Rated	35	10,445	47.3%
3 AA	27	9,038	40.9%
1 AA, 2 Not Rated	14	2,608	11.8%
Total AA	76	22,091	100.0%

Figure 11: Credit rating breakdown of the AAA and AA Australian corporate bond market. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

The above figure shows that the AAA market is very well covered with consistent ratings: 93% of the market is rated by two rating agencies. Interestingly, there isn't a single security in this group that was rated AAA by all three agencies. The AA market is also very well covered with consistent ratings, with around 86% of the market having at least two AA ratings. Both of these markets thus appear quite robust to potential reductions in the number of ratings provided, as the classification rules would still enable them to be classified as either AAA or AA bonds if the issuer decided to remove one of their ratings.

The following table decomposes the AA market further by industry and issuers.

Industry / Issuer	Number of Securities	Outstanding ($Millions)	% of Total
Banks	66	19,874	90.0%
Westpac	17	7,065	32.0%
NAB	21	5,675	25.7%
CBA	11	3,763	17.0%
ANZ	17	3,371	15.3%
Educational Services	3	700	3.2%
Government Agencies	3	705	3.2%
Railroad	4	812	3.7%
Grand Total	76	22,091	100.0%

Figure 12: Australian corporate bond market outstanding debt ($ millions) by industry and issuer for issuers with a combined credit rating of AA. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

It is evident from the above that the AA corporate bond market has an extreme amount of concentration in not just one sector, banks, but also only four issuers, the four dominant banks. There is a relatively large number of individual securities on issue, again dominated by the main four banks.

This industry concentration is even higher in the AAA market, as evidenced in the following table.

Industry / Issuer	Number of Securities	Outstanding ($Millions)	% of Total
Banks	12	9,408	95.2%
Westpac	2	2,825	28.6%
CBA	2	2,125	21.5%
ANZ	2	1,700	17.2%
Suncorp	3	1,950	19.7%
NAB	1	750	7.6%
Bank of Queensland	2	58	0.6%
Government Agencies	2	475	4.8%
Total	14	9,883	100.0%

Figure 13: Australian corporate bond market outstanding debt ($ millions) by industry and issuer for issuers with a combined credit rating of AAA. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

The primary difference between the AAA and AA markets is the presence of one additional material issuer: Suncorp, which is a diversified financial services firm whose primary business activities are insurance rather than banking. It could thus be argued that there is a slight increase in industry diversification in the AAA market compared with the AA market, given the relative materiality of Suncorp debt. Industry diversification increases significantly as credit ratings decline, with the banks making up only 37% and 25% of the A and BBB markets.

The following table shows the breakdown of the market (outstanding notional) by term and credit rating.

	AAA			AA		
Term	**# Securities**	**Per Year**	**Cumulative**	**# Securities**	**Per Year**	**Cumulative**
1	2	0.6%	0.6%	18	19.1%	19.1%
2	2	12.1%	12.7%	6	15.7%	34.8%
3	4	54.6%	67.4%	8	14.3%	49.1%
4	0	0.0%	67.4%	11	14.6%	63.7%
5	1	2.5%	69.9%	14	21.0%	84.7%
6	1	2.8%	72.7%	10	9.1%	93.8%
7	0	0.0%	72.7%	7	4.6%	98.5%
8	0	0.0%	72.7%	0	0.0%	94.2%
9	2	18.5%	91.1%	1	0.8%	99.3%
10	2	8.9%	100.0%	0	0.0%	99.3%
11+	0	0.0%	100.0%	1	0.7%	100.0%
Total	14	100.0%		76	100.0%	

Figure 14: Marginal and cumulative distributions of Australian corporate bond market outstanding debt by term and credit rating. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

The AAA corporate bond market is extremely lumpy with almost half the issuance at a three-year term, and another sizable issuance at 10 years. By contrast, the AA market is dominated by issuance up to six years (94%), with a relatively larger number of smaller sized bonds at longer terms out to 30 years.

The above analysis highlights the risk that both the AAA and AA corporate bond market are highly exposed to changes in the credit rating of a very small number of issuers all from the one industry: banking. If there was an event that caused a significant stress on the Australian banking industry, then they could all, *en masse*, be

downgraded below AA, the market would largely evaporate, and it would be highly likely to no longer meet the definition of a deep market. Thus, the asset calibration set should ideally include a contingency plan for this scenario, such that an alternative calibration set is already defined and agreed. Under such a scenario the high-quality corporate bond market would be unlikely to be considered deep, and perhaps reversion to the use of Commonwealth Government bonds will be required.

The case for the alternative scenario where banks are upgraded, resulting in an increase in outstanding AAA bonds at the expense of the AA bond market, is also worth noting. Given the accounting standard requirement to use high-quality corporate bonds, such a shift in the overall rating quality of the AAA and AA would not render the calibration set invalid, although it may result in a step-change over time in the average credit quality of bonds used, and hence the level of the resulting yield curve.

There are also some individual securities that have are relatively small amounts of notional outstanding (e.g., <$100 million). Pricing on these securities is likely to reflect significantly lower liquidity and wider bid-ask spreads compared with those with higher issuance levels. The criterion for a minimum amount of issuance should exclude the impact that these smaller issues have on building the yield curve.

For both AAA and AA corporate bonds, bonds with embedded derivatives account of for less than 1% of the market. Excluding these will not materially affect the size of the observable market.

4.1.5 Market Liquidity

In addition to the size of the market as measured by outstanding notional, the liquidity of a market is also a relevant metric to consider when determining whether a market is sufficiently deep.

The most common method for assessing liquidity is turnover, as measured by the volume and size of transactions that are traded.

The following figure shows the amount of turnover for the total government bond and non-government bond markets.

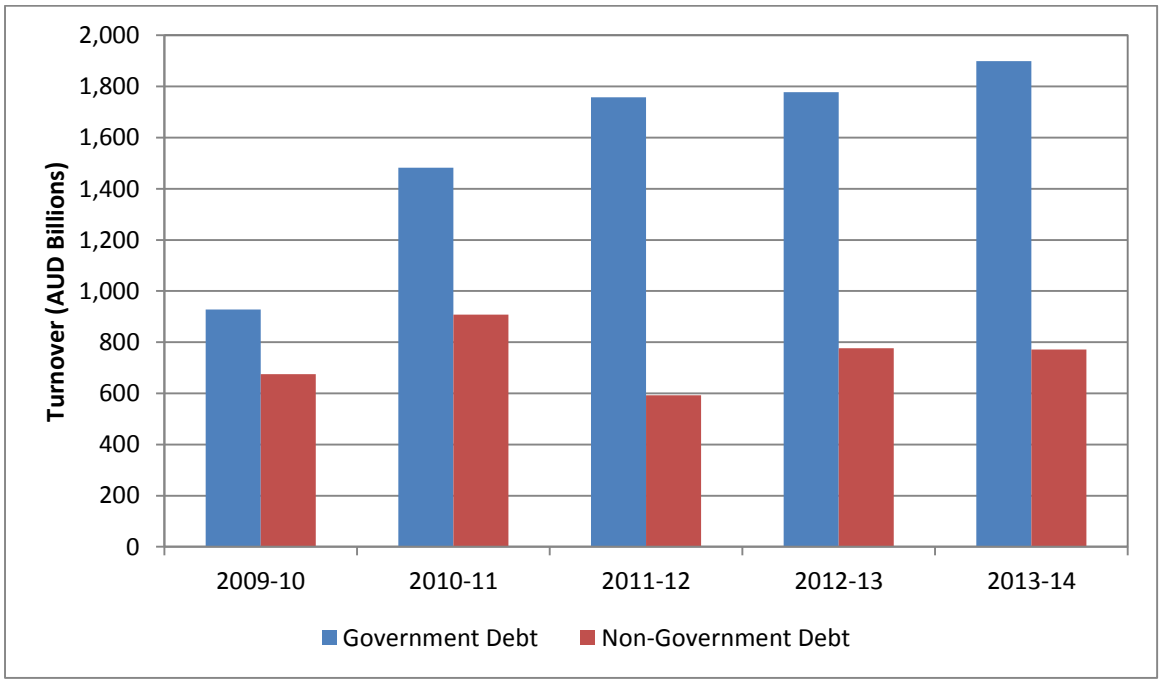


Figure 15: Annual turnover of Australian debt markets. Source: Australian Financial Markets Association.

The above figure shows that turnover of government debt has grown over recent years, although not quite as fast as issuance itself (which has increased four-fold). The liquidity ratio (turnover as a % of outstanding) is around 370% for Commonwealth Government bonds.

The following figure shows the 2013–2014 annual turnover and estimated amounts outstanding for non-government AUD bonds, along with the liquidity ratio (annual turnover/outstanding)

Grouping	Annual Turnover ($Millions)	Amount Outstanding ($Millions)	Liquidity Ratio
Corporate Securities	116,105	213,000	55%
Bank Securities	319,647	572,000	56%
Mortgage and Asset-backed Securities	216,187	75,000	288%
Foreign Non-government and Offshore AUD Issues	119,688	40,000	299%
Total	771,626	900,000	86%

Figure 16: Liquidity ratio of Australian corporate bond markets. Source: Milliman analysis of Australian Financial Markets Association, Bloomberg and RBA data.

Turnover for non-government debt has broadly remained unchanged over the last five years, which reflects the relatively flat level of outstanding notional. The liquidity ratio for total non-government debt is around 86%, reducing to around 55% when considering only corporate and bank securities only. Note that the non-government debt figures relate to all corporate bonds, including those denominated in foreign currency, all types of credit ratings and mortgage and asset-backed securities. Unfortunately, a split into AUD-denominated AAA and AA corporate bonds is not readily available. As this market segment only represents around 12% of the total non-government debt market, there is a large degree of uncertainty when extrapolating these broad market results down to the AUD-denominated AA corporate bond market.

An indirect measure of liquidity at the security level is the bid-ask spread. Securities that are highly liquid will tend to trade with lower bid-ask spreads than securities that are illiquid. Bid-ask spreads are a useful indicator of liquidity because they are readily observable at any point in time at the security level. They can thus be used to analyse liquidity at a point in time broken down by bond characteristic (term, issuer, credit rating, etc.)

We have undertaken an analysis of the liquidity of the corporate bond market using the following measure:

Bid-ask spread = (Ask Price – Bid Price) / average (Ask Price, Bid Price)

This calculation is performed at the security level. A weighted average is then calculated for each term, using the amount outstanding as the weight. The results of this are shown in the following figure for AAA and AA corporate bonds, with the equivalent AAA and AA government bonds used by way of comparison.

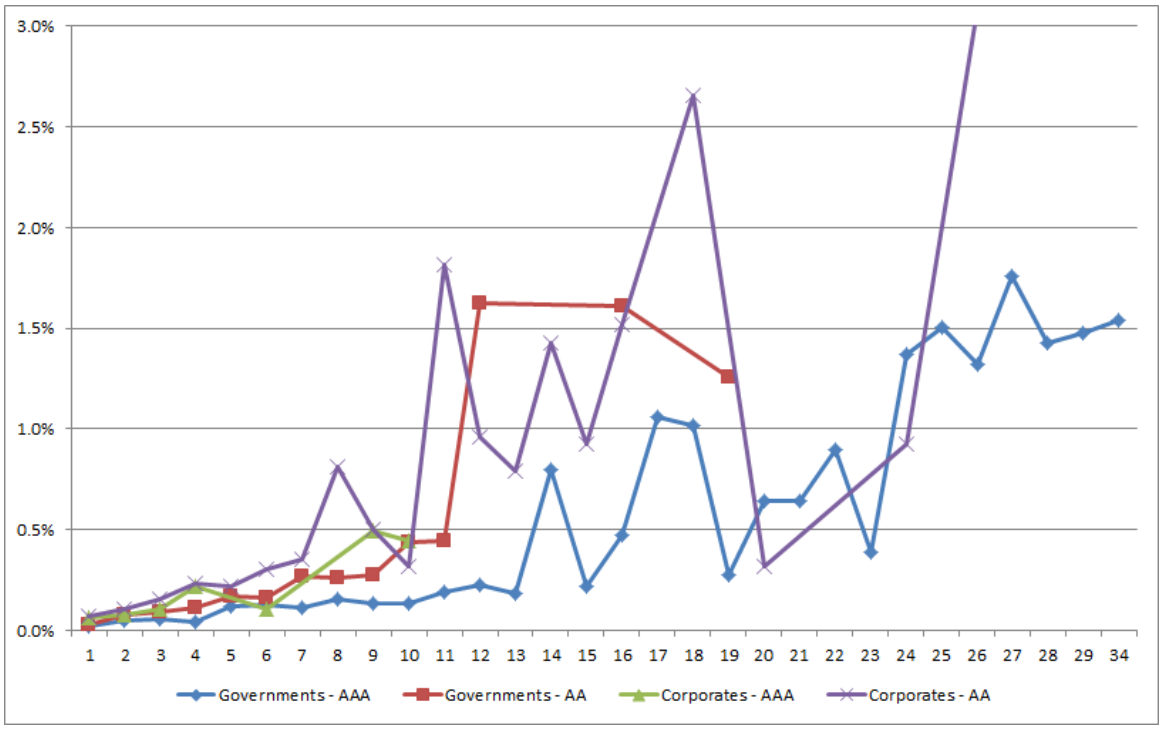


Figure 17: Bid-ask spreads (% of mid) for AAA- and AA-rated government and corporate bonds by term to maturity. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

A few characteristics are notable from this analysis:

- As expected, AAA-rated government bonds have the lowest bid-ask spreads, which increase until the 13-year term which covers approximately 90% of the market. Beyond this, bid-ask spreads increase significantly both in magnitude and volatility as the market thins out. This provides a baseline against which other markets can be compared.
- AA-rated government bonds (mainly semi-government bonds) have bid-ask spreads around double that of AAA-rated government bonds, out to terms of around 11 years. Beyond this, the market is very thin and bid-ask spreads expand considerably.
- AAA-rated corporate bonds have very similar bid-ask spreads to AA-rated government bonds out to 10 years. As previously noted, there is no AAA-rated corporate bond market beyond 10 years.
- AA-rated corporate bonds have bid-ask spreads that are only marginally higher than AAA-rated corporate bonds out to five years (which is where the vast majority of issuance lies). Bid-ask spreads from five to 10 years do increase somewhat, although 10-year terms look particularly reasonable. Beyond this, the market is very thin and bid-ask spreads expand considerably in both magnitude and volatility.

The above analysis indicates that the AAA corporate bond market is liquid out to 10 years, the AA corporate bond market is sufficiently liquid out to five years, and a relatively strong case can be made on bid-ask spread grounds that it is reasonably liquid out to 10 years (at least at the date of analysis). It would be worth considering implementing a bid-ask spread liquidity rule that looks at the ratio of AA corporate bond spreads to those of both AAA corporate bonds and AA semi-government bonds, in order to assess whether securities meet the deep market criteria or not.

4.1.6 Securitised, Covered and Kangaroo Bonds

4.1.6.1 Asset-backed Securities

Australia also has a sizable securitised bond market. The following figure shows the development over time in the issuance of the mortgage and asset-backed component of the market, broken down by security type.

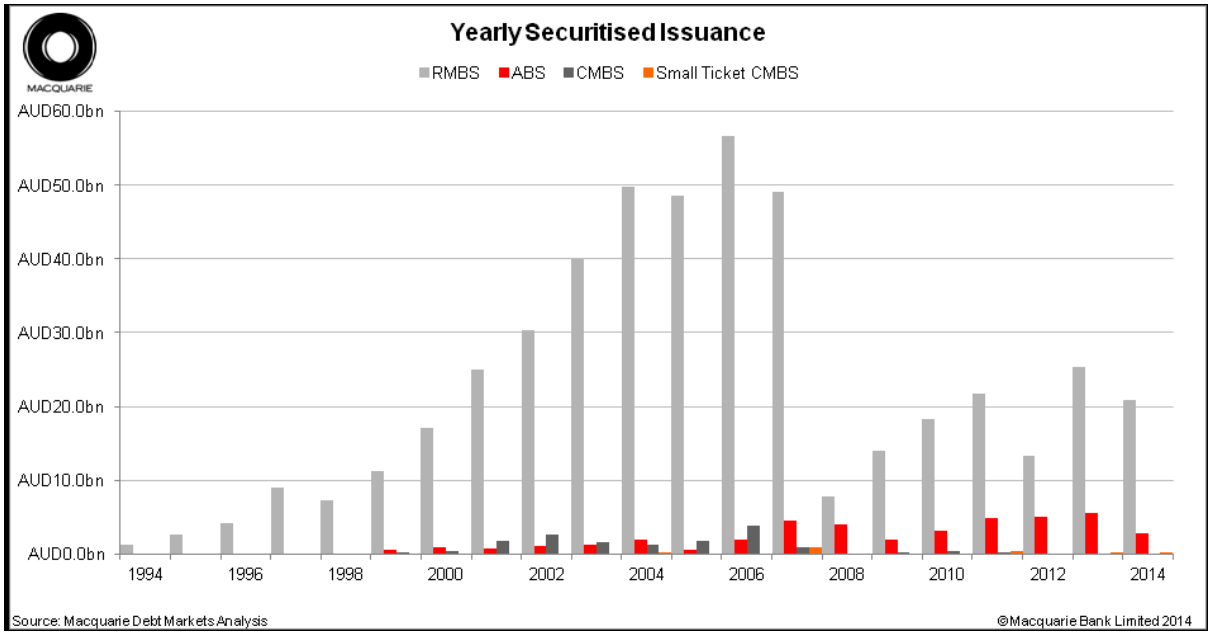


Figure 18: Historic issuance of asset-backed securities. Source: Macquarie Bank Debt Markets.

As can be seen above, the ABS market is dominated by RMBS. Other ABS market is a relatively small component of the market, whilst the CMBS market is tiny. Issuance of ABS securities fell dramatically in the wake of the global financial crisis, due to the loss of investor confidence in this asset class globally.

The following figure shows the development over time in the issuance and size of the RMBS market, broken down by currency.

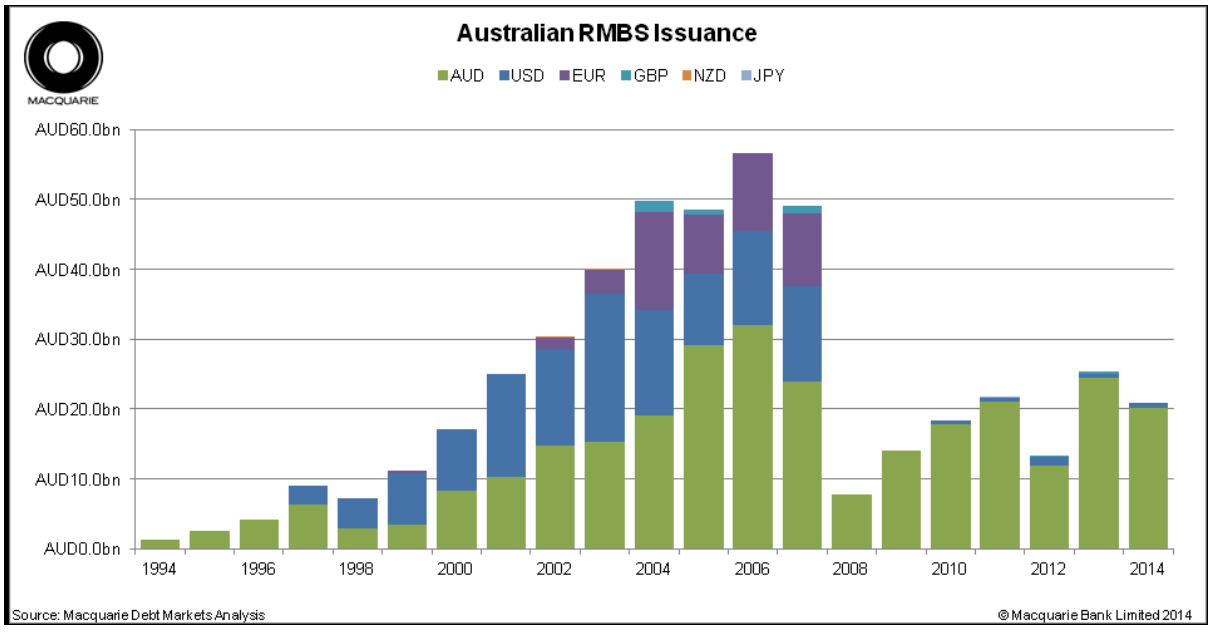


Figure 19: Issuance of residential mortgage-backed securities. Source: Macquarie Bank Debt Markets.

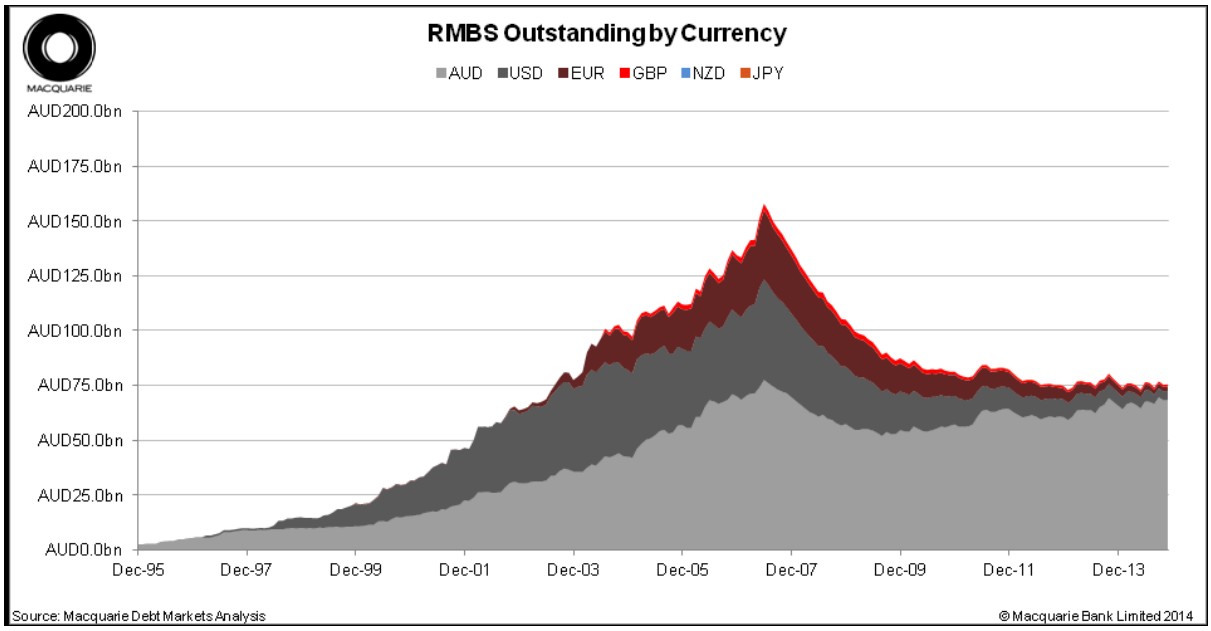


Figure 20: Size of the residential mortgage-backed securities market. Source: Macquarie Bank Debt Markets.

The above figures show that there is around AUD 75 billion in outstanding RMBS, which at the current time is dominated by AUD issuance. The ABS market is relatively small, as shown by the issuance profile in the following figure.

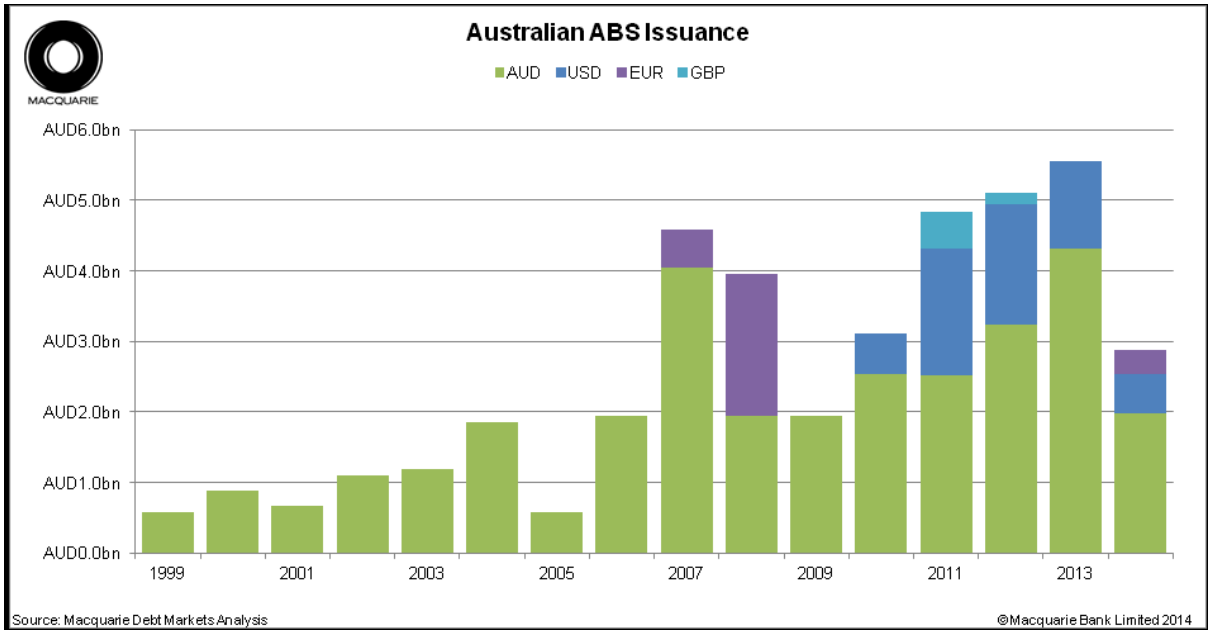


Figure 21: Issuance of asset-backed securities. Source: Macquarie Bank Debt Markets.

The main problem with securitised bonds is that they pay predominantly floating rather than fixed coupons, so their yields are not useful to derive a long-term yield curve. This is evidenced directly via primary issuer published information,[4] directly via a breakdown of outstanding by coupon type, and indirectly via a turnover figures as outlined in the two figures below.

Credit	RMBS			Other ABS		
Rating	Fixed	Floating	Total	Fixed	Floating	Total
AAA	2.1%	85.7%	87.8%	0.0%	73.4%	73.4%
AA	0.0%	2.6%	2.6%	0.0%	7.1%	7.1%
A	0.0%	2.2%	2.2%	0.0%	5.9%	5.9%
BBB	0.0%	1.1%	1.1%	0.0%	3.8%	3.8%
BB	0.0%	0.5%	0.5%	0.0%	2.7%	2.7%
B	0.0%	0.3%	0.3%	0.0%	0.0%	0.0%
Not Rated	0.4%	5.2%	5.6%	1.1%	6.1%	7.2%
Total	2.3%	97.5%	100.0%	1.1%	98.9%	100.0%

Figure 22: Breakdown of RMBS and ABS outstanding by coupon type and credit rating. Source: Milliman analysis of Bloomberg data.

	MBS (RMBS + CMBS)			Other ABS		
Year	Fixed	Floating	Fixed % Total	Fixed	Floating	Fixed % Total
2009-10	143	142,943	0.1%	90	3,393	2.5%
2010-11	2,518	176,985	1.4%	41	479	7.6%
2011-12	2,797	93,521	2.8%	117	3,990	2.8%
2012-13	519	201,988	0.3%	139	862	13.9%
2013-14	1,359	213,360	0.6%	131	1,336	8.9%

Figure 23: Annual turnover of ABS (AUD Millions). Source: Australian Financial Markets Association.

The turnover of fixed MBS is currently very small both in absolute terms and relative terms, being less than 1% of the total MBS market. Turnover of other fixed ABS is even lower in absolute terms, despite it being higher in relative terms.

The main issue is that there are no outstanding issues of either RMBS or other ABS securities that have a credit rating of AA and that have fixed rate coupons.

Given the above findings, RMBS, CMBS and ABS securities do not currently meet the AASB 119 requirements.

[4] For example, NAB (http://capital.nab.com.au/popup-disclaimers/securitisation-deal-summaries.phps), CBA (www.commbank.com.au/about-us/Securitisation/mortgage-backed-securities.html), Westpac (http://www.westpac.com.au/about-westpac/investor-centre/fixed-income-investors/securitisation-user-agreement/outstanding-issuance-disclaimer/), ANZ (http://www.debtinvestors.anz.com/phoenix.zhtml?c=248688&p=debt-mbs) and Suncorp (http://www.suncorpbank.com.au/financial-services/treasury/wholesale-funding/securitisation-apollo).

4.1.6.2 Covered Bonds

The other component of the Australian securitised bond market relates to covered bonds. There is currently around $75 billion in outstanding notional in covered bonds, issued by the four main banks and Suncorp. The following figure shows the breakdown of this market by issuer and term to maturity.

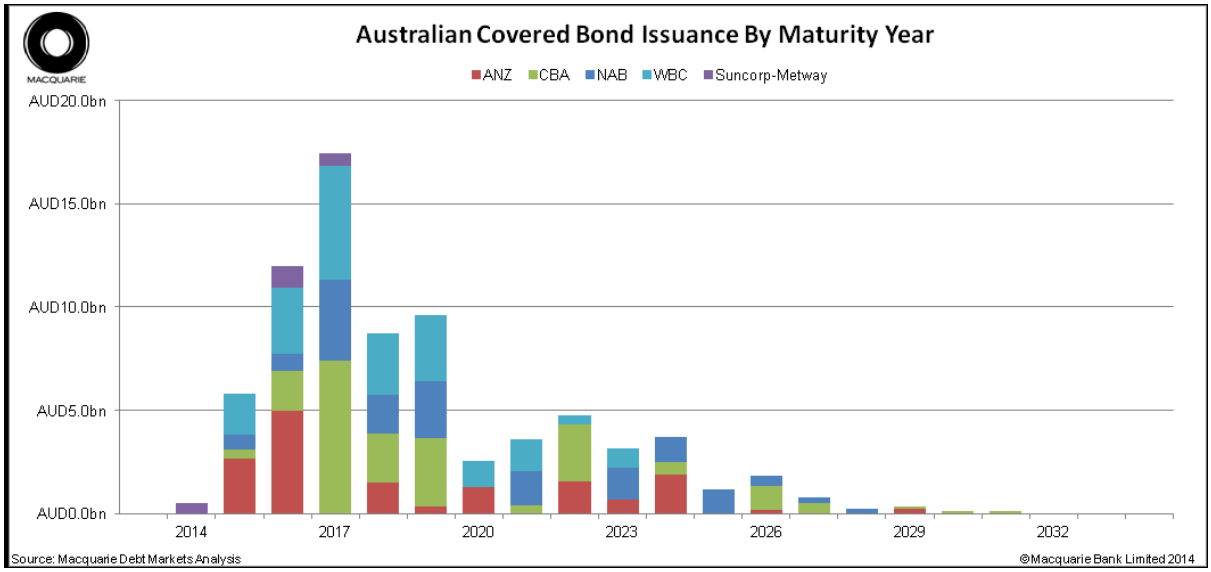


Figure 24: Issuance of covered bond securities by issuer and term. Source: Macquarie Bank Debt Markets.

The vast majority of the market is due to mature within the next five years, by 2019. The following figure shows that the majority of covered bonds are denominated in foreign currency, as opposed to AUD.

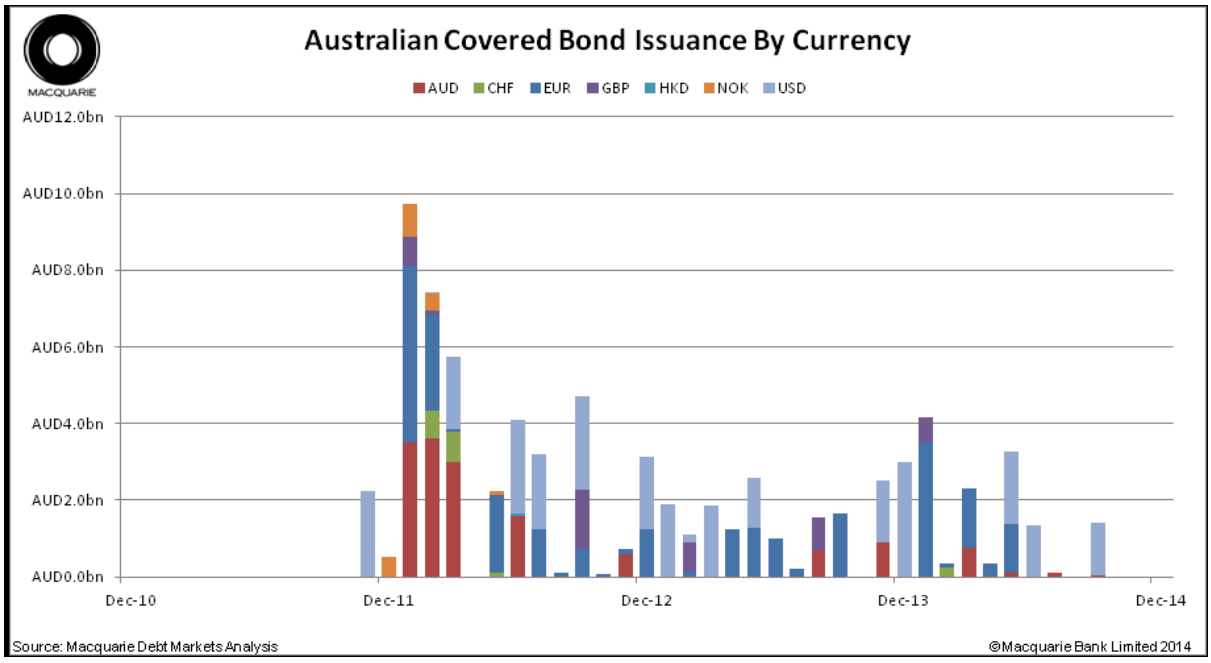


Figure 25: Issuance of covered bond securities by currency. Source: Macquarie Bank Debt Markets.

It appears that only around $12 billion of this is denominated in AUD, representing around 17% of the market currently.

As noted by the RBA (see Debelle 2014), issuance of covered bonds has slowed now that the banks' programs are maturing, as shown in the following graph.

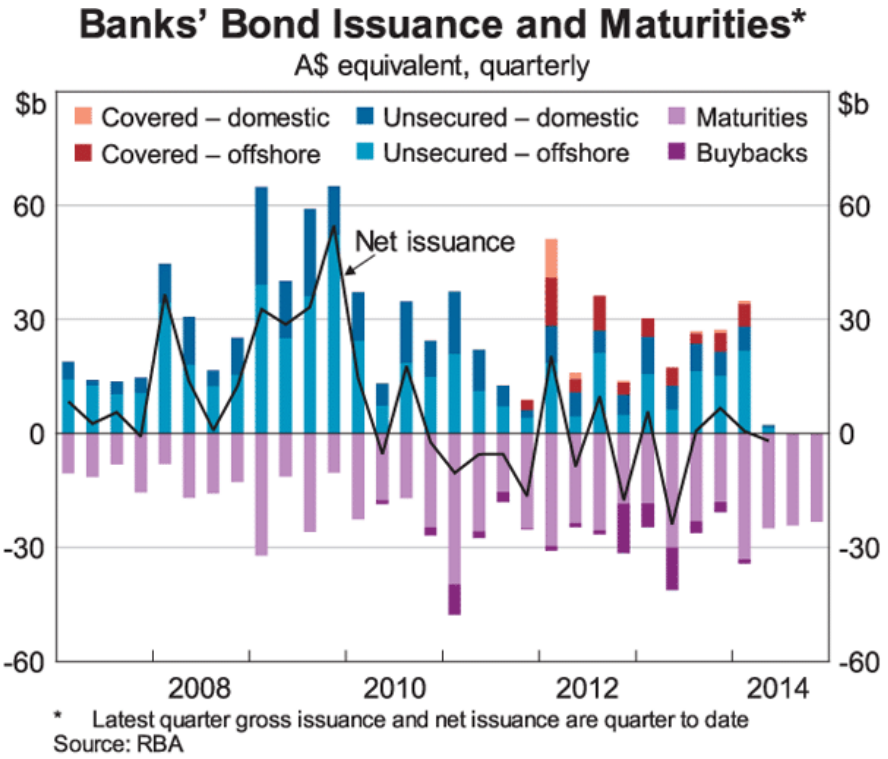


Figure 26: Quarterly issuance of covered and unsecured bonds by banks and maturities/buybacks. Source: RBA (Debelle Speech, April 2014).

The following figure shows the turnover of the covered bond market in recent years.

Year	AUD	Non-AUD	Total
2011-12	11,503	726	12,228
2012-13	3,366	380	3,746
2013-14	2,771	1,350	4,120

Figure 27: Annual turnover of covered bonds by denomination currency (AUD millions). Source: Australian Financial Markets Association.

Turnover has declined significantly for AUD covered bonds over recent years and is currently at relatively low levels in absolute dollar terms. Overall turnover is also very low when compared with total outstanding notional, at around 5%.[5] Hence, this market is significantly illiquid when compared with the government and non-government bond markets.

Taking all the above into consideration, there appear to be relatively few covered bonds that meet the requirements of the accounting standard. Covered bonds which meet all of the inclusion criteria (e.g., fixed coupons, market observable prices, etc.) will be included within the calibration set.

4.1.6.3 Kangaroo Bonds

Kangaroo bonds are bonds issued in the Australian bond market denominated in AUD by foreign entities.

[5] $4.1 billion turnover compared with $75 billion outstanding.

The following figure shows the size of the market, broken down by coupon type and credit rating.

Credit Rating	FIXED	FLOATING	STEP CPN	VARIABLE	Total
			Outstanding ($ Million)		
Government	123,720	6,100	0	0	129,820
AAA	2,600	1,750	0	0	4,350
AA	5,625	500	0	0	6,125
A	12,962	8,354	22	311	21,649
BBB	625	625	0	867	2,117
BB	0	63	0	1,027	1,091
B	0	251	0	0	251
NR	1,054	2,910	12	0	3,976
Total Non Govt	22,866	14,453	34	2,204	39,557
			% of Total		
Government	84.4%	29.7%	0.0%	0.0%	76.6%
AAA	1.8%	8.5%	0.0%	0.0%	2.6%
AA	3.8%	2.4%	0.0%	0.0%	3.6%
A	8.8%	40.6%	64.7%	14.1%	12.8%
BBB	0.4%	3.0%	0.0%	39.3%	1.2%
BB	0.0%	0.3%	0.0%	46.6%	0.6%
B	0.0%	1.2%	0.0%	0.0%	0.1%
NR	0.7%	14.2%	35.3%	0.0%	2.3%
Total	86.5%	12.1%	0.0%	1.3%	100.0%

Figure 28: Size of the Kangaroo market in both outstanding amounts ($ millions) and %, by credit rating and coupon type. Source: Milliman analysis of Bloomberg data.

The majority of the market is fixed rather than floating coupon. The high-quality market is dominated by government entities and supranational organisations which receive government or explicit support with AAA- and AA-rated corporate fixed coupon bonds accounting for 5.6% of the market, or $8.2 billion in outstanding notional. This subset of the market has 49 individual securities.

The next figure shows the turnover of the market.

Year	Fixed	Floating	Fixed % Total
2009-10	9,779	783	10,674
2010-11	122,553	19,542	142,094
2011-12	96,948	10,570	107,519
2012-13	130,832	17,261	148,093
2013-14	106,760	12,682	119,442
Avg 2010-14	114,273	15,014	129,287

Figure 29: Annual turnover of the Kangaroo market ($ millions) by coupon type. Source: Milliman analysis of Bloomberg data.

Turnover is dominated by fixed rate paper and has been relatively stable over recent years. For the fixed coupon market, the liquidity ratio is around 80%, which is relatively liquid and only slightly less than that for the total corporate bond market. Note that as this ratio includes government and corporate issuers, it is likely to be notably higher than the equivalent corporate-only segment. The following table shows the breakdown of corporate fixed coupon AAA and AA rated bonds by term.

Term	% by Year	% Cumulative
1	28.6%	28.6%
2	35.3%	63.8%
3	9.1%	73.0%
4	8.2%	81.2%
5	10.3%	91.5%
6	10.3%	91.5%
7	4.9%	96.4%
8	0.0	96.4%
9	3.6%	100.0%
Total	100.0%	

Figure 30: AA-rated fixed coupon kangaroo bonds by term. Source: Milliman analysis of Bloomberg data.

As can be seen, the market extends out to eight years, broadly in line with AA corporate bonds.

In summary, the fixed-coupon, AA-rated, kangaroo bond market appears to be of sufficient size, breadth, depth and liquidity to be included in the asset calibration set, although government-related entities (the majority of issues) should be excluded. This leaves a small but non-trivial addition to the observable set.

4.1.7 Market Yields

Market yields provide objective information on the homogeneity of the credit risk within a particular asset calibration set. Pricing or spread differences between asset calibration sets provide information on the degree of heterogeneity of risk between them. This subsection considers whether the various market segments justify full detailed analysis using a proper interpolation approach. Rough measures of estimating yield curves based upon yield to maturity data are calculated. Note that these are indicative only as they do not account for variations in coupon levels, and thus are a precursor to the full detailed interpolation analysis presented later in Section 5.2. Nonetheless, it is a useful way to get an initial feel for the homogeneity or heterogeneity of market pricing of the various market segments.

By way of example, the following figure shows the yield to maturities on Commonwealth and semi-government yield curves.

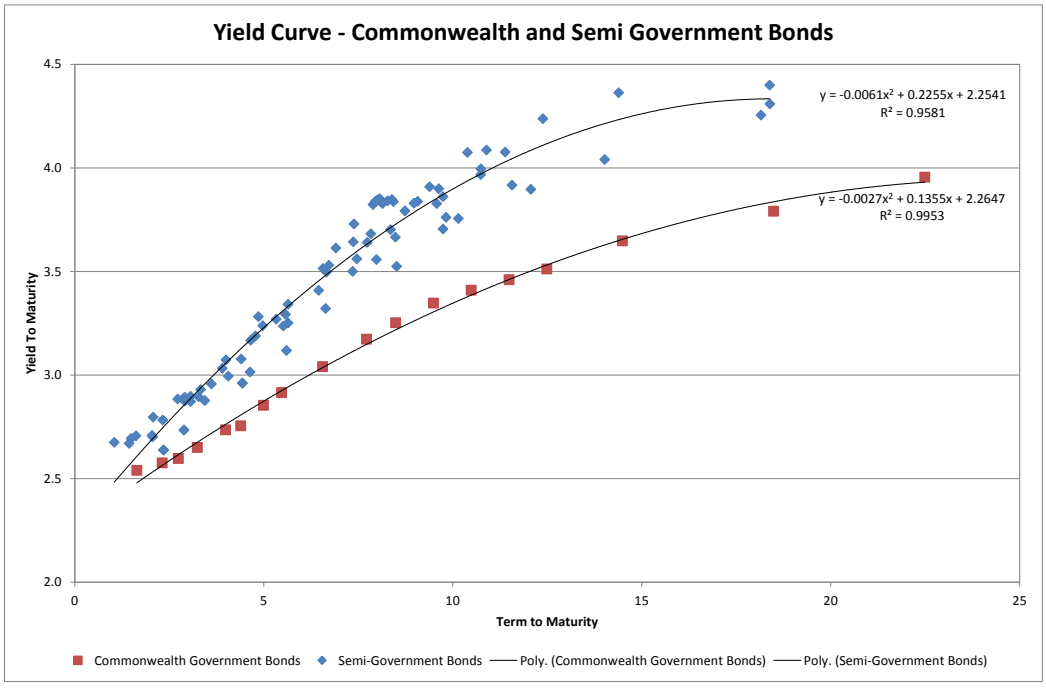


Figure 31: Commonwealth and semi-government bond yield to maturities as at 24 October 2014, with quadratic function curve fits, by term to maturity. Source: Milliman analysis of Bloomberg data.

This figure illustrates that the Commonwealth bond market is extremely homogenous, with almost no uncertainty in pricing as reflected by the extremely high goodness of fit statistic R-Squared, which shows that a simple quadratic function can explain 99.5% of pricing variability. The semi-government bond market exhibits less homogeneity, as shown by a greater degree of scattering around the fitted curve, which explains 95.8% of variability. Note some variability is expected naturally given variations in coupon rates by bonds. It is also notable that these two markets have clearly different prices for risk, with a clear spread between them with no degree of overlap. Although not shown, when these two asset sets are combined, the goodness of fit measures decline materially, explaining only 82% of variability. This illustrates the trade-off between increasing the depth of the market by widening the assets included in the calibration set, and the accuracy in measuring the price of risk as evidenced by worsening goodness of fit measures.

The following figure shows the equivalent analysis for the corporate bond market (domestic issuers only) split by credit rating.

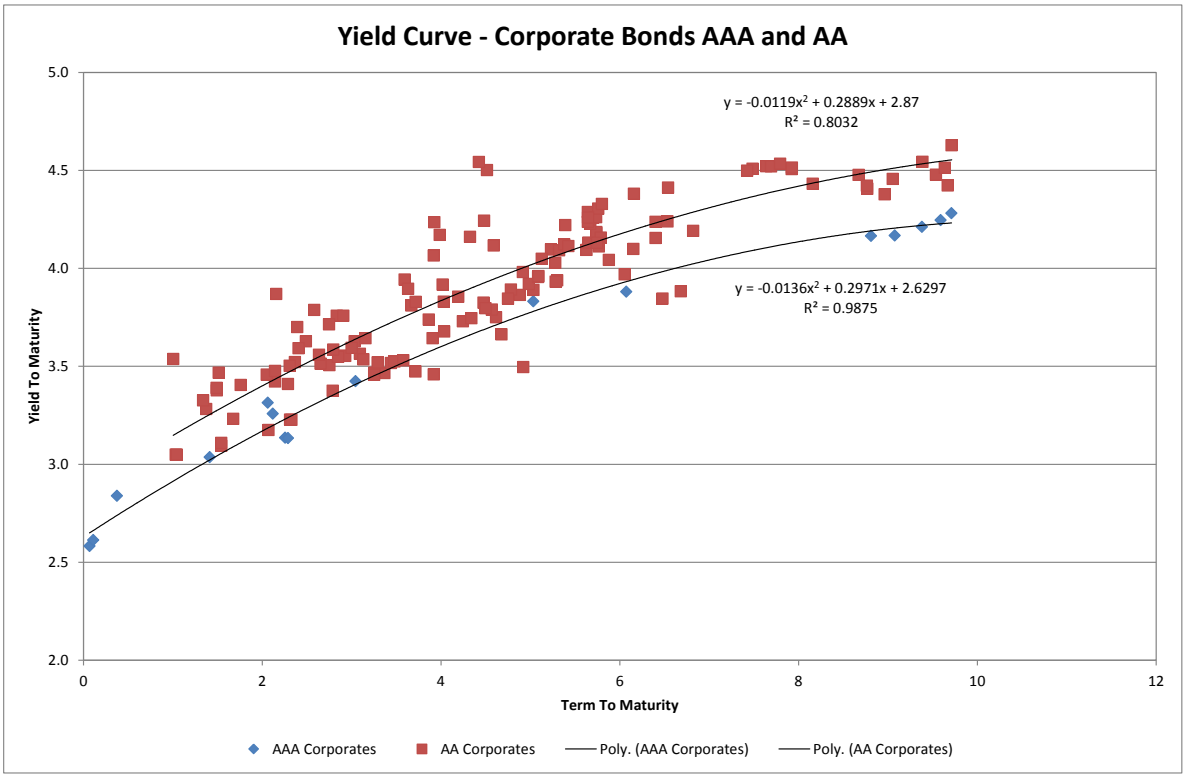


Figure 32: Domestic issuer corporate bond yield to maturities as at 24 October 2014, split by credit rating, with quadratic function curve fits, by term to maturity. Source: Milliman analysis of observable market trades as captured by and sourced from Bloomberg data.

The domestic issuer corporate bond market exhibits greater heterogeneity for the AA segment compared with the AAA segment and government market, as evidenced by goodness of fit measure of 80%, compared with the other around 99% range. Perhaps because of this heterogeneity, there is greater overlap between the two markets with a less clear-cut pricing spread evident (at least at this date). This could also be explained by natural coupon variability (which would be allowed for under a proper methodology) and credit ratings becoming out of date. When these two asset sets are combined, the goodness of fit measures decline only marginally to 77% (from 80%). Prima facie, this supports the use of a combined AAA and AA asset calibration set.

The following figure looks at the pricing consistency of the domestic against the foreign issuer market, split by credit rating.

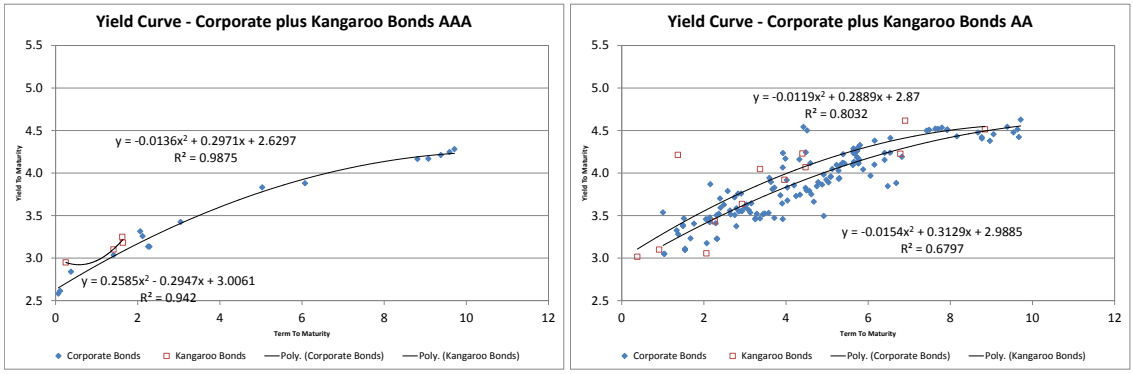


Figure 33: Domestic and foreign issuer (Kangaroo) corporate bond yield to maturities as at 24 October 2014, split by credit rating, with quadratic function curve fits, by term to maturity. Source: Milliman analysis of Bloomberg data.

AAA-rated domestic corporate bond yields appear to be broadly consistent with the very small number of corporate AAA foreign-issued bonds. When combined, goodness of fit measures remain very high at 97%. Overall, AAA assets look to be broadly priced consistently across both domestic and foreign issuers. AA-rated domestic corporate bond yields also appear to be consistent with their foreign counterparts, although the higher levels of dispersion indicate that any differences are unlikely to be significant. When combined, goodness of fit measures average out to be 78%.

Finally, the following graph shows the combined view of AAA and AA domestic and foreign bonds.

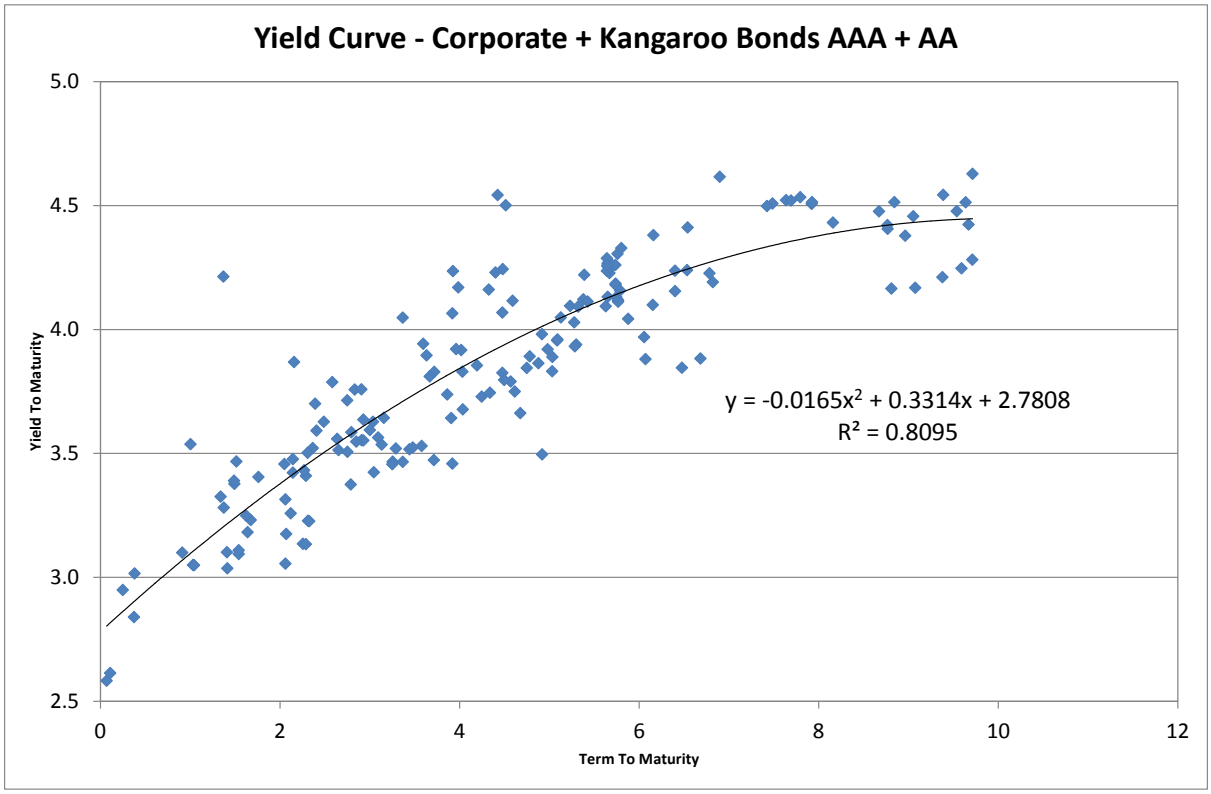


Figure 34: Domestic and foreign issuer (kangaroo) corporate bond yield to maturities for combined AAA and AA ratings as at 24 October 2014, with quadratic function curve fits, by term to maturity. Source: Milliman analysis of Bloomberg data.

Not surprisingly, the above shows that when both AAA- and AA-rated domestic and foreign issuers of corporate bonds are combined, the goodness of fit measure deteriorates somewhat to 81%, reflecting the relatively greater number of AA-rated securities. Note that these goodness of fit measures are only rough

estimates, as they do not take into account differences in coupon rates, which could explain the variability. Instead, a proper interpolation methodology is required, which is investigated in Section 5.3. Nonetheless, this analysis does lead to some conclusions:

- There does not appear to be any material difference between domestic and foreign issued bonds of the same rating (i.e., either AAA or AA).
- There appear to be significant pricing differences between AAA- and AA-rated corporate bonds, relating to both domestic and foreign issuers.
- There appears to be greater uncertainty in the pricing of AA bonds compared with AAA bonds.

The following figure summarises the key depth and pricing characteristics of the potential asset calibration sets.

Bonds	Depth (AUD Bn)	Pricing Goodness of Fit
Domestic AAA+AA	Fair – 32	Fair – 77%
Foreign AAA+AA	Poor – 8	Excellent – 97%
Domestic + Foreign AAA+AA	Fair – 40	Good – 81%

Figure 35: Summary of depth and pricing goodness of fit for various potential asset calibration sets.

If the sole focus was on AAA-rated bonds, then the combined domestic + foreign asset set is clearly the best choice, as it has depth and very good pricing fitness. It appears that the results for the pure AA-rated bonds are dominated by the combined AAA+AA results in all respects. Hence, if AA corporate bonds are to be included, then there appears to be a strong case for using the last asset calibration set of domestic and foreign bonds rated AAA and AA. This calibration set has AUD 40 billion of outstanding notional (= 28 billion of AA plus 12 billion of AAA bonds). This is consistent with the current approach that combines Commonwealth and semi-government bonds into a single asset calibration set.

Note that the above goodness of fit results are indicative only and should not be relied upon conclusively. Rather, the accurate goodness of fit results that can indeed be relied upon should be based upon a formal interpolation methodology, as outlined in Section 5.2.

Taking all the above analysis into account, it is possible to conclude the following:

Conclusion 2: There is a sufficiently observable, deep and liquid market in a number of corporate bond market segments to meet the requirements.

Conclusion 3: Pricing analysis clearly shows that whilst domestic and foreign issuers of equivalent credit ratings are priced consistently, AAA and AA corporate bonds are priced differentially. Despite this, in order to ensure as deep a market as possible, the recommended calibration set should include both AAA- and AA-rated bonds from both domestic and foreign issuers, resulting in an asset set market size of AUD 40 billion.

4.2 Australian Interest Rate Swap Market

Swap rates are commonly used as a benchmark in the construction, hedging and valuation of derivative contracts. They represent the fixed rate paid or received by a party in exchange for receiving or paying a floating (that is, variable) short-term interest rate.

Quoted swap rates typically incorporate an allowance for underlying credit risk, representing the credit risk associated with investing in the rate underlying the floating leg of a swap contract for the term of the swap. Additional counterparty risk also exists, but is typically small given the requirements to post collateral for mark-to-market movements in most swap contracts.

A variety of floating rate instruments are used as underlying securities on which swap rates are based. In Australia, the most common of these is the range of Bank Bill Swap Rates (BBSW), which reflect a trimmed average of surveyed mid-rates on reference bank bills of exchange for various short-term maturities. In

overseas currencies, LIBOR plays a similar role. Other variations with alternative credit characteristics also exist, for instance Overnight Indexed Swaps (OIS), which are based on an underlying short-term interest rate (for example, the Reserve Bank of Australia cash rate).

All financial derivatives are priced off the swap rate. They are thus potentially useful as a source of interest rates for employee benefit liability valuations, particularly where they are used as risk management instruments. Note that it is common practice to use interest rate swaps for the valuation of life insurance contracts that have embedded derivatives which require hedging strategies to manage interest rate risk.

Data on over-the-counter (OTC) derivatives have historically been scarce due to the nature and the way these transactions are executed. However, as part of the Dodd-Frank reform, all swaps, whether they are cleared or uncleared, are required to be reported to a central facility called the Swap Data Repository (SDR) for surveillance and record keeping purposes. A number of SDRs have been set up globally and collectively they will contain records of all swap transactions executed by registered swap dealers active in credit and interest rate trading since 31 December 2012.

The data used for the following analysis is obtained from the Depository Trust and Clearing Corporation and the Bloomberg Swap Depository. Although the data contained in these two databases only represent swap transactions that were reported to these SDRs, they should nevertheless provide a good representation of the overall interest rate swap market in Australia.

The data includes all Australian dollar denominated interest rate swap transactions that were posted to the two SDRs between 1 October 2013 and 30 September 2014. The data also only includes swaps that are considered to be new trades and excludes transactions such as partial or full unwinds, exercises and amendments.

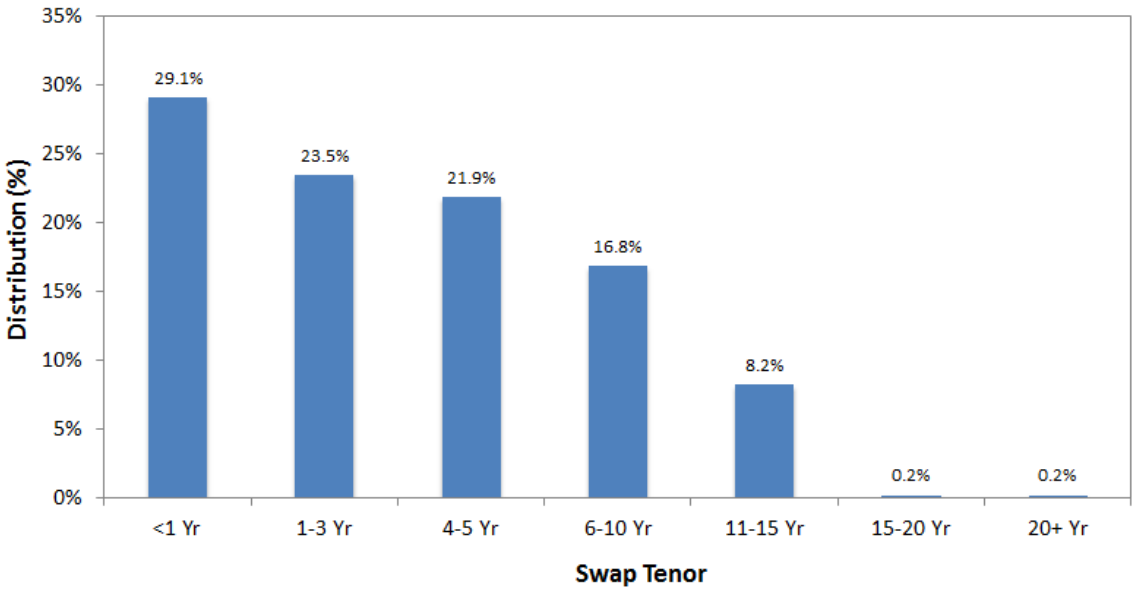


Figure 36: Distribution of turnover of Australian interest rate swaps by tenor. Source: Milliman analysis based upon Depository Trust and Clearing Corporation and the Bloomberg Swap Depository data from October 2013 to September 2014.

The total transacted notional posted on the two SDRs throughout the period was over AUD 1,165 billion. Interest rate swaps with tenors of five years or less make up nearly 75% of the total notional executed but only 50% of the actual number of transactions. Volumes drop off significantly for tenors greater than 10 years with around 0.45% of the notional volume beyond the 15-year point.

The following table shows the 2014 (March to October) average bid-ask spread by swap tenor.

Swap Tenor	Average Bid-Ask Spread
1	0.82%
3	0.73%
5	0.61%
10	0.65%
12	0.68%
15	0.74%
20	0.83%
25	0.82%
30	0.83%

Figure 37: Average bid-ask spreads (% of mid) for Australian interest rate swaps by tenor. Source: Milliman analysis based upon Bloomberg data from February to October 2014.

Note that these are somewhat higher compared with the liquid part of the Government and AAA/AA corporate bond markets.

In summary, swaps are an interesting possible calibration asset, but given the concentrated nature around the short end of the tenors where there is otherwise plenty of liquidity in conventional bonds, they need not feature in the calibration set.

4.3 International Markets

Since the accounting requirements under AASB 119 are almost identical to those of IAS 19, the experience of other international markets in determining an appropriate asset calibration set can be a useful guide in helping determine what might be appropriate for Australia.

The following figure summarises the experience of other countries of interest. Note that the size of the markets generally reflects the total corporate bond market where data on the equivalent subset (AAA-rated, AA-rated, fixed-coupon, local currency denominated corporate bonds) was not readily available. Identifiable subsets have been specified in brackets.

Country	Calibration Assets	Corp Bond Market Size Local Currency (est. High-quality Subset)	Corp Bond Market Size AUD Bn (est. High-quality Subset)	Liquidity Ratio (Corp)	Number of Issuers	Comments
Australia	Currently Government	91 (40)	91 (40)	55%	130+	Fixed-coupon bonds only, local & kangaroos. Subset shows AAA+AA after excluded bonds are filtered.
US	Corporate	7,665 Bn	8,970	67%	1,300+	Mature and deep market exists.
Japan	Government / Corporate	60 Tr (?)	600 (?)	52%	?	Mature, low turnover.
UK	AA Corporate	530 Bn (20 Bn)	975 (35)	N/a	60+	Mature and deep market exists. Subset shows filtered AA corporate issues excluding STG 22 billion of EIB issued bonds.
Germany (Eurozone)	AAA+AA Corporate	400 Bn (~30Bn)	580 (~40)	N/a	20+	Mature and deep market exists.
Canada	AA Corporate (plus Provincials)	470 Bn (115 Bn)	490 (120)	50%	20+	Subset shows combined AAA+AA bonds filtered for fixed coupon bonds, etc.
Sweden	Corporate	370 Bn (10-20 Bn)	55 (<3)	50%	130+	Figures show total market, with no filters applied. Only around a third is fixed coupon & may not be high quality.
Norway	Corporate	690 Bn (18 Bn)	60 (3)	55%	110+	Also includes covered bonds.
Israel	Corporate	113 Bn (nil)	32 (nil)	170%		Credit rating filter excluded, likely to be significant. Given country credit rating no AA bonds observable.
China	Government	9.9 Tr (?)	1,900 (?)	N/a		Poor quality, Low liquidity.
Hong Kong	Government	625 Bn (?)	95 (?)	N/a		Small market.
Brazil / Mexico	Government	USD 260 Bn / USD 133 Bn (nil)	304 / 156 (nil)	N/a		Poor data.
Malaysia	Government	450 Bn (nil)	165 (nil)	N/a		Low liquidity.
Singapore	Government	125 Bn (?)	120 (?)	N/a		Low liquidity.

Figure 38: Calibration asset set used by other markets. Source: A seconded accounting standards expert and Milliman.

The 67% liquidity ratio for the US market could be considered to be an appropriate benchmark when it comes to assessing a liquid market, as it is considered to be the most mature corporate bond market in the world.

The Bank for International Settlements (BIS) compiles data on fixed income markets. The following figures show the development of the amounts of outstanding debt over the last three to four years (by nationality of issuer). The figures show a comparison with Australia to illustrate the differences in the overall size of the debt markets in USD billions. The data may not be directly comparable at the respective country levels when looking at the analysis by country later because the BIS will include all debt including foreign currency denominated debt and debt raised overseas. As we say, the intention is to give a sense of the relative sizes of the markets. We will see that the figures indicate that there is a meaningful Australian bond market in comparison with other mature markets.

Country	Total Debt Securities - All issuers				
	Dec-10	Dec-11	Dec-12	Dec-13	Mar-14
Australia	1,728.4	1,853.8	2,028.2	1,823.5	1,925.0
Canada	1,826.4	1,926.1	2,126.8	2,187.6	2,130.7
Germany	4,490.9	4,383.1	4,355.2	4,356.9	4,323.2
Japan	14,495.6	15,674.1	14,552.6	12,260.7	12,621.7
UK	5,334.9	5,579.5	5,811.6	5,843.8	6,013.1
USA	32,902.6	33,795.7	35,228.7	36,794.0	37,212.1

Country	Total Debt Securities - General Government				
	Dec-10	Dec-11	Dec-12	Dec-13	Mar-14
Australia	373.5	481.4	568.9	511.9	562.7
Canada	1,143.9	1,205.2	1,313.7	1,294.0	1,227.3
Germany	2,040.0	2,079.3	2,177.5	2,254.7	2,250.0
Japan	10,064.1	11,232.2	10,538.6	9,034.8	9,340.7
UK	1,647.9	2,039.8	2,224.1	2,346.4	2,438.9
USA	11,911.0	12,932.1	14,042.4	14,818.8	15,075.0

Country	Total Debt Securities - Corporate				
	Dec-10	Dec-11	Dec-12	Dec-13	Mar-14
Australia	1,354.9	1,372.4	1,459.3	1,311.6	1,362.3
Canada	682.5	720.9	813.1	893.6	903.4
Germany	2,450.9	2,303.8	2,177.7	2,102.2	2,073.2
Japan	4,431.5	4,441.9	4,014.0	3,225.9	3,281.0
UK	3,687.0	3,539.7	3,587.5	3,497.4	3,574.2
USA	20,991.6	20,863.6	21,186.3	21,975.2	22,137.1

Figure 39: Comparison of the size (outstanding USD billions) of the Australian bond market to other large international markets. Source: Bank of International Settlements.

The next figure illustrates the development of the relative size of the government and corporate debt markets over time. While it is affected by the change in the USD/EUR exchange rate over the period shown, we can see that there has been a significant increase in the issue of debt in the last 10 years, although there appears to be a levelling off recently. The dominance of government debt remains. The impact of debt buybacks is being seen and the movement in interest rates will inevitably have some bearing on the issuance of new debt and the continuation of buybacks.

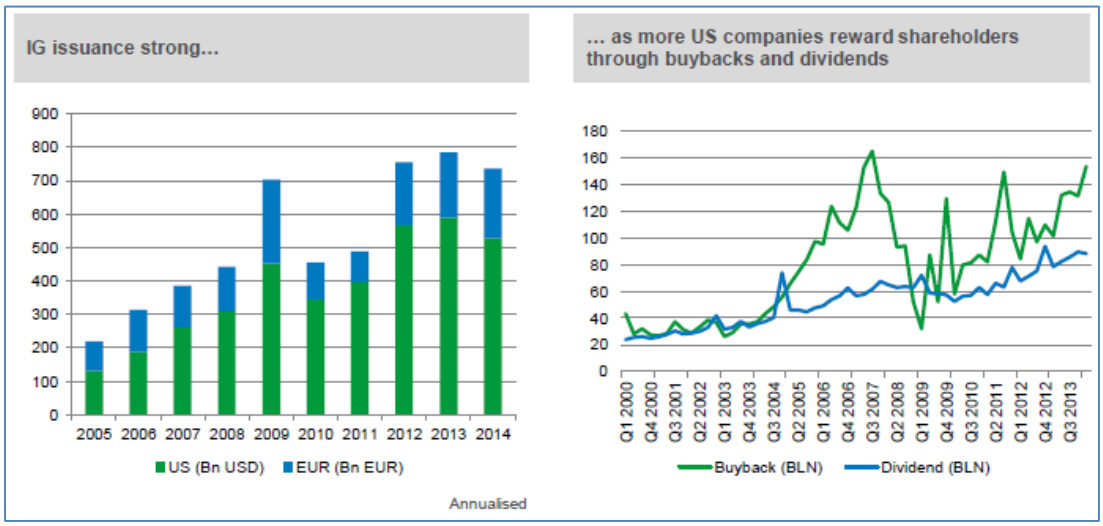


Figure 40: US and European investment grade bond issuance. Source: BlackRock.

In the following sections we address a number of countries with various characteristics that will provide comparisons for our study. In these sections we highlight the information available in respect of the relevant corporate bond markets and comment on the associated government bond markets. The majority of the supporting materials, where related purely to the government bond markets, have been placed in appendices, so that the material on just corporate bonds or direct comparisons with government bond data are emphasised and readily digestible.

4.3.1 United States

The US bond market is by far the biggest and deepest in the world, with a very broad spread of durations and creditworthiness available to investors. The size of the various US debt markets is shown in the following figure.

The bond market as overseen by the Securities Industry and Financial Markets Association (SIFMA) as at Q2 2014 looked like the following:

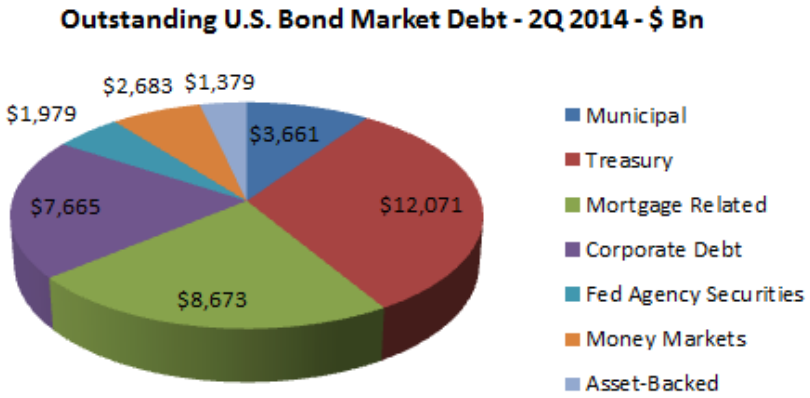


Figure 41: US bond market amounts outstanding (USD billions) as at second quarter 2014. Source: Securities Industry and Financial Markets Association (SIFMA).

SIFMA also compile turnover rates of these markets. Average daily turnover in 2013 was USD 830 billion, whilst in the first 10 months of 2014 it averaged $USD 729 billion. Based on the average daily turnover in the first half of the year and the average amounts outstanding, the liquidity ratios (turnover/outstanding) for each sector of the fixed-income market are shown in the following chart:

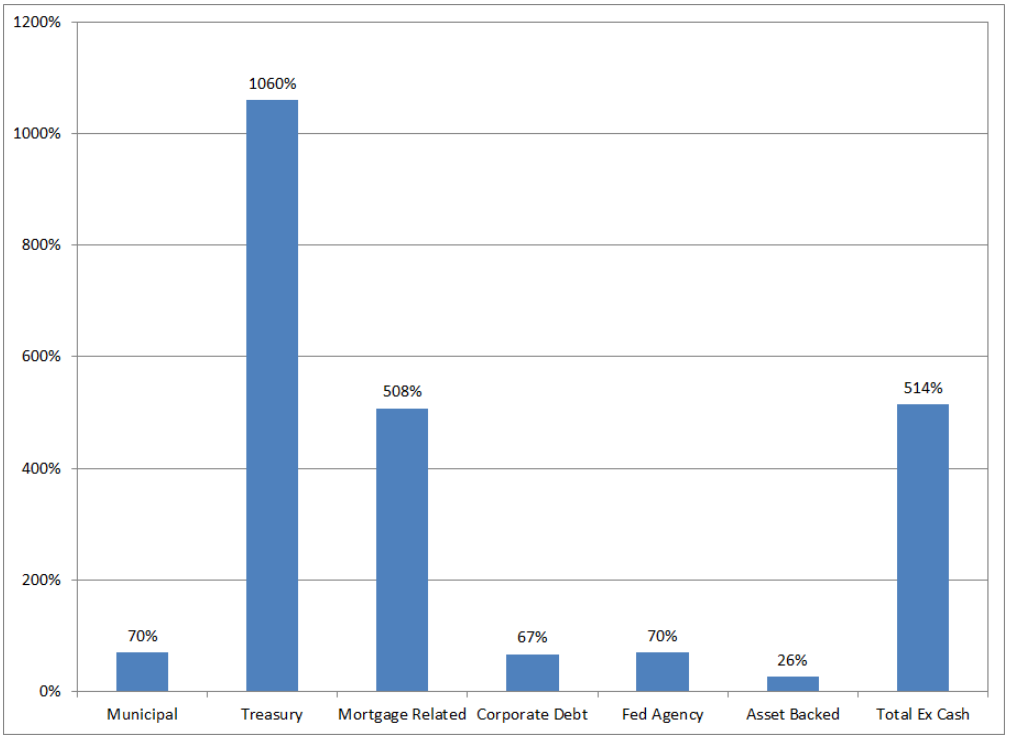


Figure 42: US bond market liquidity ratios. Source: SIFMA.

Treasury stocks turn over 10 times a year, although much of that will be in short-term debt. Municipal bonds have 70% turnover. Mortgage-related debt turns over five times a year. The corporate debt and federal agencies' paper turn over around 70%. This 70% figure could be considered a useful benchmark for a liquid corporate bond market.

According to the New York Stock Exchange, as at the end of 2014 there were more than 9,600 corporate bonds in issue. Many companies had multiple lines. There were almost 1,300 distinct companies that had at least one corporate bond in issue. Around 1,800 of the 9,600 issues had a 'last trade price and date': 650 in 2014. We do not have ratings for the data, so cannot comment on the number of AA bonds that are included.

A commonly used discount rate seems to be based on the Citigroup Pension Discount Curve. However, it doesn't seem to be prescribed in any way. The Society of Actuaries publishes this curve but states that 'the publishing of these statistics does not imply an endorsement of either the methodology for development or use of these statistics for pension accounting or other purposes.' The curve and details of the methodology used can be found at the Society of Actuaries website.[6]

[6] Citigroup Pension Discount Curve, Society of Actuaries. Retrieved 28 April 2015 from https://www.soa.org/Professional-Interests/Pension/Resources/pen-resources-pension.aspx

Towers Watson prepares an annual report on pensions accounting under ASC 715 and seem to support this view. The chart below is taken from their most recent report for different sources of discount rates, together with their calculated average of what was actually used by Fortune 1000 companies:

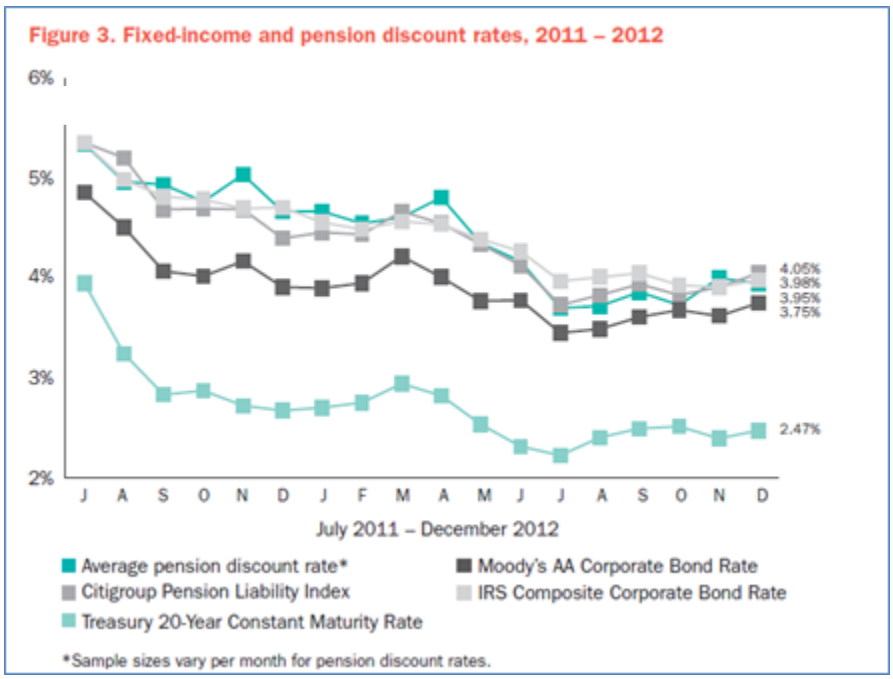


Figure 43: US pension discount rate trends. Source: Towers Watson, Accounting for Defined Benefit Pensions and Other Post Retirement Benefits, January 2014.

The average is also close to the IRS Composite Corporate Bond Rate. Note that there is a time lag before accounts are published and such research pieces are put together. ASC 715 requires that the discount rate should be 'based on a portfolio of high quality debt instruments' Hence, we would conclude for the US market that corporate bonds are the basis for setting discount rates.

4.3.2 United Kingdom

According to the Debt Management Office in the United Kingdom, the total amount of outstanding debt (including inflation uplift for index-linked gilts) was GBP 1,424 billion nominal. The London Stock Exchange publishes data on the instruments listed including gilts but also all the other fixed, floating, index-linked and other structure debt instruments. At the end of October 2014 there were 18,512 instruments listed, representing a total amount on issue of GBP 3.6 trillion. The categories included debt issued by overseas institutions as well as local entities. The paper is issued in sterling as well as other currencies.

Government debt listed includes the conventional and index-linked bonds as well as the undated securities and strips. Corporate debt includes instruments that are straight loans, debentures, structured notes, floating rate notes, preference shares and warrants.

We have screened the data for conventional government bonds as a comparison with the data displayed by the Debt Management Office and also to identify corresponding conventional corporate bonds. The data shows 41 gilts, which would present a coherent observable set of UK government bonds without the complications of index-linked payments, variable dates of maturity, etc. Similarly, we screened the listed corporate bonds and medium term loans, identifying 100 bonds of which 71 had issuance greater than GBP 100m that could be used to derive a corporate bond curve. These are a mixture of instruments issued by financial services sector firms and others, across all credit ratings. The 100 issues have original issuances totalling GBP 21.0 billion, whilst the 71 issues with at least GBP 100 million outstanding individually, cumulatively had GBP 19.6 billion on issue.

The following tables show 71 corporate bonds listed on the London Stock Exchange in order of maturity date, first the financial services sector and then the others:

Maturity date	Company Name	Security Name	Money Raised (£m)
30-Mar-15	LLOYDS BANK PLC	6.625% SUBORD NTS 30/03/15	£ 248
25-Sep-16	LLOYDS BANK PLC	5.5% NTS 25/09/16 GBP1000	£ 150
4-Oct-17	PROVIDENT FINANCIAL PLC	7% NTS 04/10/17 GBP100	£ 120
20-Jan-23	PRUDENTIAL PLC	6 7/8% BDS 20/01/23 GBP(VAR)(BR)	£ 298
6-Apr-23	LLOYDS BANK PLC	9.625% SUBORD BDS 06/04/23	£ 143
7-Jul-23	HSBC BANK PLC	6.5% SUB NTS 7/7/2023 GBP(VAR)	£ 198
22-Apr-25	LLOYDS BANK PLC	7.625% NTS 22/04/25 GBP1000	£ 745
14-Sep-26	BARCLAYS BANK PLC	5.75% SUB NOTES 14/9/2026 GBP(VAR)	£ 349
11-Dec-31	LEGAL & GENERAL FINANCE PLC	5.875% NTS 11/12/31 GBP(VAR)	£ 147
22-Aug-33	HSBC BANK PLC	5.375% SUB NTS 22/8/33 GBP(VAR)	£ 494
14-Nov-36	AVIVA PLC	6.125% RESET SUB NTS 14/11/2036	£ 692
31-Dec-99	RSA INSURANCE GROUP PLC	8.5% CUM STEP UP PERP NTS	£ 448
31-Dec-99	LEGAL & GENERAL GROUP PLC	5.875% UNDATED RESET SUBNTS GBP(VAR)	£ 396
31-Dec-99	NATIONWIDE BUILDING SOCIETY	7.971% PERM INT BEARING SHS TRANCH 1	£ 200
31-Dec-99	COVENTRY BUILDING SOCIETY	6.092% PERM INT BEARING SHS GBP1000	£ 120
Total of financial sector issuances			£ 4,749

Figure 44: London Stock Exchange outstanding debt issuance of financial service providers. Source: London Stock Exchange.

It will be noted that some of the debt in the above table is undated (shown as 31 December 1999). Note that the major banks in the United Kingdom do have numerous other outstanding debt instruments in addition to those listed above.

Maturity date	Company Name	Security Name	Money Raised (£m)	Maturity date	Company Name	Security Name	Money Raised (£m)
8-Dec-14	COMPASS GROUP PLC	7% BDS 08/12/2014	£ 249	8-May-20	INTERNATIONAL PERSONAL FINANCE PLC	6.125% NTS 08/05/20 WI	£ 102
8-Dec-14	SEVERN TRENT UTILITIES FIN PLC	5.25% NTS 8/12/14	£ 149	21-Nov-20	TESCO PERSONAL FINANCE PLC	5% NTS 21/11/20 (WI)	£ 200
15-Dec-14	KINGFISHER PLC	5.625% UNSUB NTS 15/12/14	£ 248	11-Dec-20	PREMIER OIL PLC	STG DEN 5% NTS 11/12/20	£ 150
19-Dec-14	UNILEVER PLC	4% NTS 19/12/14	£ 347	6-Oct-21	NATIONAL GRID PLC	1.25% RPI LKD BDS 06/10/21	£ 283
29-Dec-14	BP CAPITAL MARKETS PLC	4% GTD NTS 29/12/14	£ 499	30-Jan-22	PARAGON GROUP OF COMPANIES PLC	6.125% STG DEN NTS 30/01/22	£ 125
30-Sep-15	SEGRO PLC	6.25% BDS 30/09/15	£ 148	15-Feb-22	ENQUEST PLC	5.5% NTS 15/02/22	£ 155
30-Oct-15	ANGLIAN WATER SERVICE FINANCING PLC	5.25% UNWRAPPED BDS 30/10/15	£ 249	16-Sep-22	LADBROKES GROUP FINANCE PLC	5.125% BDS 16/09/22	£ 100
14-Jun-16	ROLLS-ROYCE PLC	7.375% NTS 14/06/16	£ 199	22-Sep-22	SSE PLC	5.875% BDS 22/09/22	£ 248
30-Jun-16	SMITHS GROUP PLC	7.25% BDS 30/06/16	£ 148	18-Oct-22	A2D FUNDING PLC	4.75% GTD BDS 18/10/22	£ 150
7-Dec-16	BRITISH TELECOMMUNICATIONS PLC	7.5% NTS 07/12/16	£ 694	21-Aug-23	ANGLIAN WATER SERVICE FINANCING PLC	6.875% BDS 21/08/23	£ 198
27-Dec-16	PLACES FOR PEOPLE CAPITAL MARKETS PLC	5% BDS 27/12/16	£ 140	2-Feb-24	NATIONAL GRID ELECTRICITY TRANS.PLC	5.875% BDS 02/02/24	£ 446
10-Jan-17	SAFEWAY PLC	6% NTS 10/01/17	£ 199	23-Feb-24	SEGRO PLC	6.75% NTS 23/02/24	£ 221
7-Jun-17	NATIONAL GRID GAS PLC	6% INSTRUMENTS 07/06/17	£ 248	26-Feb-24	SEVERN TRENT UTILITIES FIN PLC	6.125% GTD BDS 26/02/24	£ 300
16-Jun-17	UNILEVER PLC	4.75% NTS 16/06/17	£ 398	8-Mar-24	EASTERN POWER NETWORKS PLC	5.75% NTS 08/03/24	£ 299
11-Oct-17	NORTHUMBRIAN WATER FINANCE PLC	6% GTD BDS 11/10/17	£ 300	4-Dec-25	VODAFONE GROUP PLC	5.625% NTS 4/12/25	£ 247
14-May-18	UNITED UTILITIES WATER PLC	5.375% BDS 14/05/18	£ 150	23-Feb-26	HAMMERSON PLC	6% BDS 23/2/26	£ 298
20-Jun-18	SEGRO PLC	5.5% NTS 20/06/18	£ 199	30-Sep-26	A2D FUNDING II PLC	4.5% GTD BDS 30/09/26	£ 150
24-Aug-18	TESCO PERSONAL FINANCE PLC	5.2% STG BDS 24/08/18	£ 125	7-Jun-27	LONDON POWER NETWORKS PLC	6.125% NTS 7/6/27	£ 199
4-Dec-18	IMPERIAL TOBACCO FINANCE PLC	6.25% NOTES 4/12/18	£ 199	20-Dec-27	UNITED UTILITIES WATER PLC	5.625% NTS 20/12/27	£ 150
6-Dec-18	ENTERPRISE INNS PLC	6.5% SNR UNSUB NTS 6/12/18	£ 248	21-Apr-28	HAMMERSON PLC	7.25% BDS 21/04/28	£ 198
7-Dec-18	DAILY MAIL & GENERAL TRUST PLC	5.75% BDS 7/12/18	£ 175	27-Jul-28	NATIONAL GRID ELECTRICITY TRANS.PLC	6.5% BDS 27/07/28	£ 360
17-Dec-18	SAFEWAY PLC	6.125% BDS 17/12/18	£ 197	7-Dec-28	BRITISH TELECOMMUNICATIONS PLC	5.75% BDS 7/12/2028	£ 599
18-Jan-19	FIRSTGROUP PLC	6.125% BDS 18/1/19	£ 248	7-Jun-29	SEVERN TRENT UTILITIES FIN PLC	6.25% GTD BDS 7/6/2029	£ 295
30-Sep-19	SEGRO PLC	6% BDS 30/9/19	£ 148	14-Dec-29	TESCO PLC	6% MTN 14/12/29	£ 197
28-Oct-19	GKN HOLDINGS PLC	6.75% BDS 28/10/2019	£ 298	26-Nov-32	VODAFONE GROUP PLC	5.90% EUR MED TRM NTS 26/11/32	£ 446
12-Dec-19	B.A.T.INTERNATIONAL FINANCE PLC	6.375% NTS 12/12/19	£ 496	14-Oct-33	WESSEX WATER SERVICES FINANCE PLC	5.75% GTD BDS 14/10/33	£ 347
13-Dec-19	TESCO PLC	5.5% NTS 13/12/19	£ 347	19-Dec-33	GLAXOSMITHKLINE CAPITAL PLC	5.25% GTD NTS 19/12/33	£ 979
31-Mar-20	HAMMERSON PLC	6.875% BDS 31/3/20	£ 200	20-Jun-35	SEGRO PLC	5.75% NTS 20/06/35	£ 199
Total of non-financial sector issuances							£ 14,883

Figure 45: London Stock Exchange outstanding debt issuance of non-financial service providers. Source: London Stock Exchange.

The data reveals over 60 distinct issuers of corporate bonds of a meaningful size. The Stock Exchange does identify some 135 dated corporate bonds with fixed coupons, some traded outside the United Kingdom. Not all of them are meaningfully large, but this gives an order of magnitude to the amount in issue of pure corporate bonds. Amongst the issuers is the European Investment Bank, which in 2010 and 2011 raised GBP 22 billion of the total GBP 38 billion currently in issue.

Due to the lack of publicly available data, it is necessary to combine a number of sources in order to estimate the current size of the corporate bond market. As shown by the following figure, the UK corporate bond market was around GBP 220 billion as at the end of 2000.

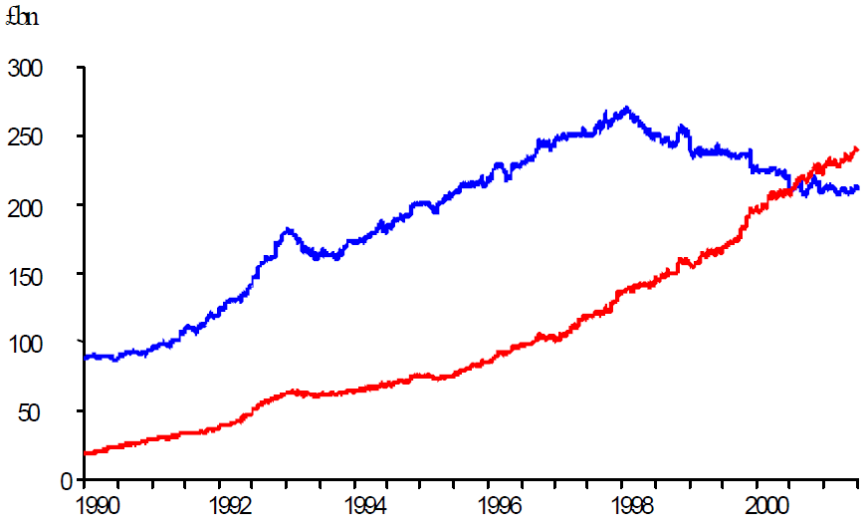


Figure 46: Historic UK gilt (blue line) and corporate (red line) outstanding issuance. Source: Barclays Capital

Until the year 2000, outstanding gilts issuance exceeded the amount of corporate debt. However, in the last 10 to 15 years this turned around with the amount of corporate debt exceeding government issued debt. Since then, net market issuance has averaged around GBP 10 billion to 15 billion per annum, as shown in the following graph.

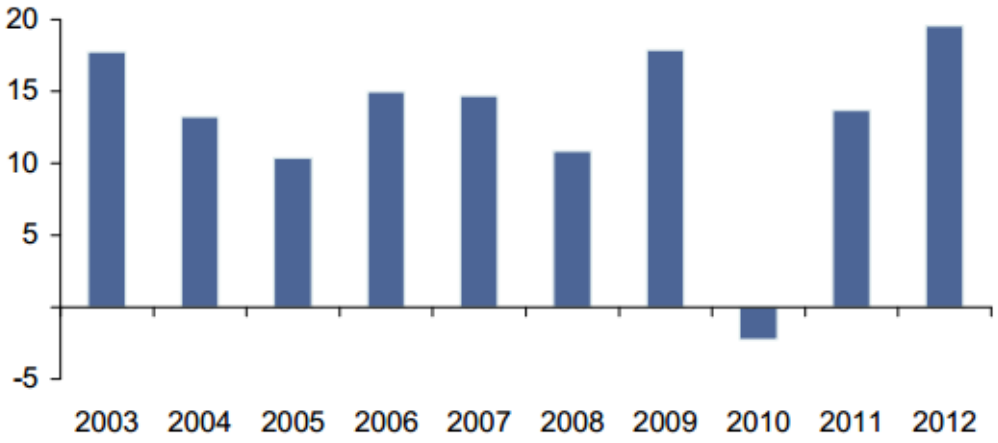


Figure 47: UK Net corporate bond issuance. Source: RBS Group.

Net market issuance has averaged around GBP 12.5 billion since 2001. So the market would be around GBP 400 million as at the end of 2014. This is in the same ballpark to the size of the Barclays Sterling Non-Gilt index of GBP 530 billion[7]. It also broadly matches the figures quoted by the ECB, which suggests at the end of 2013 the UK corporate debt market was EUR 483 billion. We assume this figure includes all types of corporate bonds, not just the fixed-coupon, dated, AA bonds.

[7] Source: Bloomberg.

FRS 17 states that the AA corporate bond rate should be used to discount liabilities.[8]

In terms of a method to derive the yield curve, until the financial crisis, market practice was to use the iBoxx AA >15 years index. When yield curves dropped following the financial crisis and the yield curve shape changed dramatically, there was a movement to derive yields based on the actual duration of the liabilities. There was a range of approaches used to come up with a rate. Over the past year or so, there has been a convergence in market practice to use published corporate bond curves, the most common being the UBS Delta Curve. Meanwhile, however, there are other alternatives available and being used.

Accountancy Age reported in June 2014[9] that 46 out of 51 surveyed companies from the FTSE 100 were using discount rates between 4.4% and 4.6% pa. The iBoxx and Merrill Lynch 15-year AA-rated corporate bond indices were yielding 4.4% pa.

4.3.3 Germany

In Germany the 10- and 30-year government bonds are referred to as Bunds. The five-year federal notes are called Bobls, and the two-year notes are called Schaetze. These are traded across various European exchanges. It should be noted that these are the tenors at the time of issue, not the current duration to maturity. The German Finance Agency, controlled by the Ministry of Finance, manages the federal government's debt issuance. The German market is extremely liquid with very narrow bid/offer spreads. Volume is significant:

Year	EUR billion	Year	EUR billion	Year	EUR billion
2013	5,832	**2010**	5,863	**2007**	6,554
2012	5,501	**2009**	4,762	**2006**	6,942
2011	6,184	**2008**	6,143	**2005**	7,318

Figure 48: Secondary market trading volume of German government bonds.
Source: German Finance Agency.

These figures would be viewed in the context of nominal issue of a little over EUR 1 trillion. Annual turnover is thus about five times issuance. According to the German Boerse, there are 68 government-listed bonds, all with AAA credit ratings, with maturities extending out to 2046 (32 years). Ignoring bonds which mature in 2014, there are 44 instruments with nominal value of EUR 743 billion.

[8] Financial Reporting Council (November 2000), FRS 17 Retirement Benefits, paragraphs 32 and 33. Retrieved 28 April 2015 from https://frc.org.uk/Our-Work/Codes-Standards/Accounting-and-Reporting-Policy/Standards-in-Issue/FRS-17-Retirement-Benefits.aspx.
[9] Rainey, N. (June 2014), Exclusive: IAS19 discount rates for FTSE 100 pensions on the rise, *Accountancy Age*. Retrieved 28 April 2015 from http://www.accountancyage.com/aa/news/2351434/exclusive-ias19-discount-rates-for-ftse-100-pensions-on-the-rise

The German Boerse has a listing of 608 individual corporate bonds. The corporate bond market has a very long maturity profile. The longest dated bond with a credit rating of single A or better on the Frankfurt market matures in 2038 (circa 25 years), whilst BBB-rated debt extends out to 2105 (90 years). Issuance over recent years has been relatively strong after declining significantly during the financial crisis, as shown by the following figure:

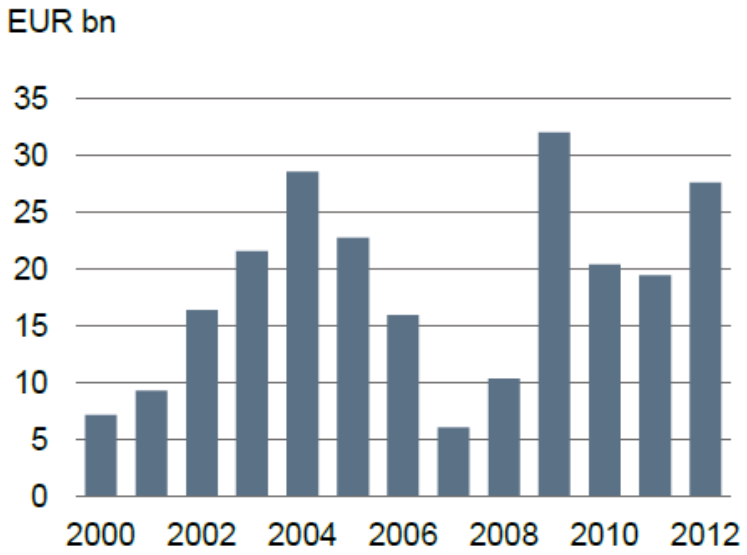


Figure 49: Germany gross corporate bond issuance per annum. Source: ECB, Deutsche Bank.

It is hard to conclude from this exactly how large the German bond market is, although from the above analysis it is likely to be in order of EUR 150 billion. The ECB quoted the corporate bond market at the end of 2013 as being EUR 127 billion. This figure corresponds to the EUR 483 billion we mentioned regarding the UK market. Hence, the latter figure is likely to include, among others, floating rate, index-linked and undated bonds.

These recent trends are similar to the experience of the broader European corporate bond market, as shown the following figure:

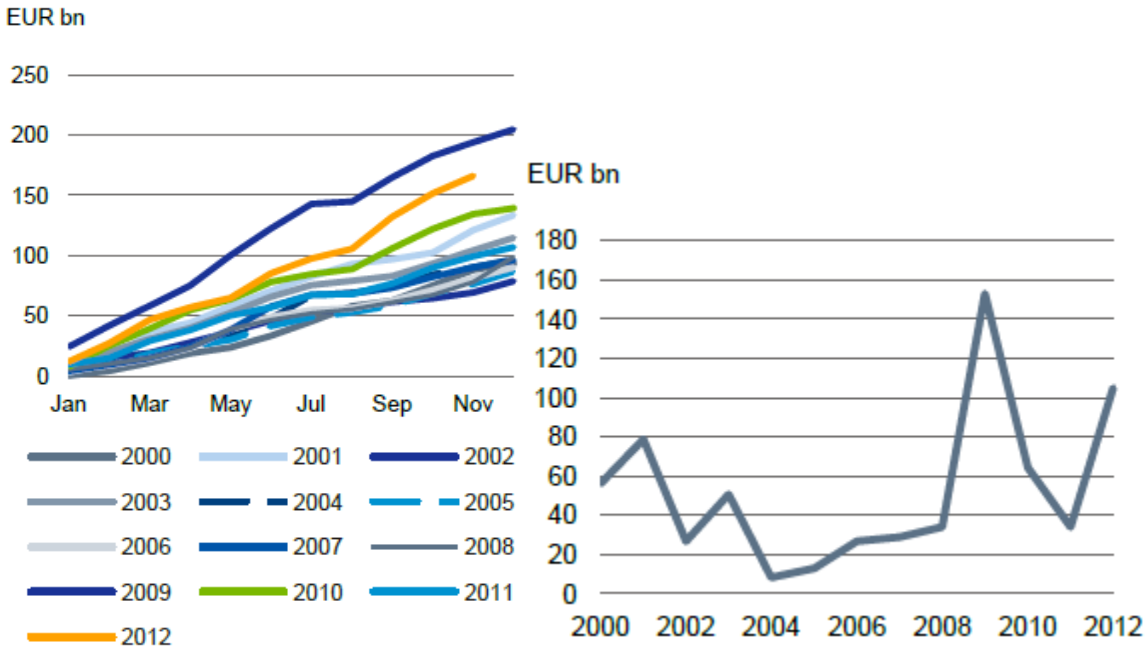


Figure 50: European corporate bond issuance gross (left graph) and net (right graph). Source: ECB, Deutsche Bank.

Although total outstanding amounts were not available, an estimate from the above analysis might be on the order of EUR 400 billion. The above shows that both Germany and, more broadly, Europe support deep corporate bond markets.

Like that of the United Kingdom, this data includes more than pure fixed-coupon AA corporate bonds. We screened the data on the German Boerse for AA bonds and found 334 issues issued by 21 separate issuers, mostly banks and statutory bodies. Hence, the market size for the bonds we are interested in is likely to be in the order of low EUR tens of billions.

The Accounting Standard Committee of Germany was one of the organisations which petitioned the IFRS to expand the definition of quality bonds, suggesting that they used AA- and AAA-rated bonds.[10] Their letter of petition[11] confirms this:

> *"In our jurisdiction and according to the prevalent opinion listed corporate bonds are considered to be HQCB if they receive one of the two highest ratings given by a recognised ratings agency (e.g. 'AAA' and 'AA' from Standard and Poor's Corp.). The information needed for Euro-emissions is often taken from the 'AA'-universes provided by e.g. Barclays, Markit iBoxx or Bloomberg. "*

Hence, we conclude that for Germany and indeed other mature markets in Europe, high-quality AAA plus AA rated corporate bonds is the basis for setting discount rates.

4.3.4 Canada

The Canadian market is an important reference point for this report, as Canada recently moved to use AA corporate bonds for discounting pension plan liabilities.[12] Hence, establishing the depth and liquidity characteristics of this market can provide important information on whether the Australian market compares favourably or unfavourably with it.

The following figure shows the size of the Canadian bond market.

Market Issuer	Amount Outstanding (CAD Billion)
Government of Canada Direct Bonds	488
Provincial Direct and Guaranteed Bonds	526
Financial Corporate Bonds	250
Non-financial Corporate Bonds	218
Other Institution bonds	6
Foreign Debtors	56
Total	1,545

Figure 51: Size of the Canadian bond market (outstanding in CAD billions). Source: Statistics Canada.

The financial and non-financial sector corporate bonds amount to CAD 470 billion, which increases to CAD530 billion when other and foreign issuers are included. However, these figures include all types of bonds, including fixed and floating coupons, and all credit ratings. Looking at market benchmark indices, the market capitalisation of the Barclays Canadian Corporate Bond Index was CAD 274 billion as at the end of October 2014. However, it is not clear as to exactly what the index inclusion rules are for this index, as they are not published. An alternative index is the FTSE TMX Canadian Corporate Bond Index,[13] which only includes fixed-

[10] IFRS Interpretations Committee Meeting, Staff Paper. Retrieved 28 April 2015 from http://www.ifrs.org/Meetings/MeetingDocs/Interpretations%20Committee/2013/November/AP04%20-%20IAS%2019%20Discount%20rate.pdf.
[11] Accounting Standards Committee of Germany, IFRS IC — Potential Agenda Item Request. Retrieved 28 April 2015 from http://www.drsc.de/docs/press_releases/2012/121030_PAIR_IAS19_%20DiscountRate.pdf.
[12] Source: Seconded accounting standards expert.
[13] FTSE TMX Canada Indices. Retrieved 28 April 2015 from http://www.ftse.com/products/FTSETMX/Home/Indices.

coupon bonds. This had a market capitalisation of CAD 396 billion as at 12 December 2014. However, the sub-index of AAA plus AA corporate bonds had a market capitalisation of CAD 115 billion as at this date. This is likely the most equivalent point of comparison to the Australian AAA plus AA corporate bond market.

The above figures broadly match the figures from Bank of Canada as at November 2014.

Government debt is concentrated in maturities with less than 10 years. This is also reflected in where the trading takes place. Daily trading volume by duration to maturity in government debt is reported by the Department of Finance. It has been steadily rising although it is concentrated in bonds with terms under 10 years.

The Department of Finance also produces a comparison of the liquidity ratio (turnover/outstanding) of government debt to other major markets. Canada has matched (and surpasses) the levels seen in the US government bond market at around 17 times. Detailed charts can be found in Appendix A. The following figures show that corporate bond market net issuance over recent years has grown significantly, and is currently around CAD 100 billion.

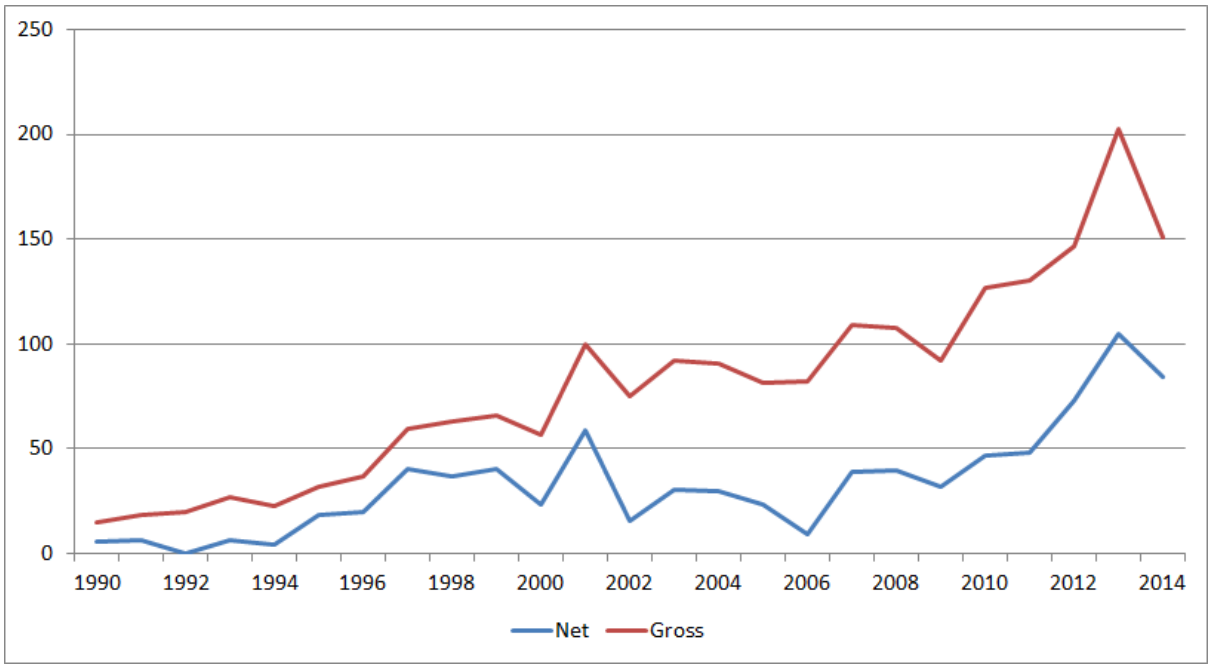


Figure 52: Canadian corporate bond market gross (red) and net (blue) issuance (CAD billions). Source: Bank of Canada.

Overall, total long-term corporate debt (bonds and debentures) as at the end of September 2014 was CAD 467 billion.[14] This figure looks reasonable given the above annual net issuance levels over the last 10 years and is consistent with the Statistics Canada analysis.

The Investment Industry Regulatory Organisation of Canada publishes data on the turnover of the corporate bond market. For the year to 30 June 2014, turnover was CAD 235 billion. This results in a liquidity ratio for the Canadian corporate bond market of around 50%.

We identified 51 issues and 24 issuers of corporate bonds in the local market. There were also five provincial issuers that had 27 instruments in issue.

[14] Source: Bank of Canada.

Fiera Capital produces a "CIA Method Accounting Discount Rate Curve" every month based on 124 corporate and provincial bonds.[15] While this is a standard used by many actuarial firms, there are some notable large consultancies that use slight variations on this curve.

4.3.5 Sweden

Sweden has a moderately sized government and corporate bond market. There is around SEK 590 billion (AUD 88 billion) of outstanding government debt.

As at October 2014, corporate bond market outstanding issuance was SEK 370 billion (circa AUD 55 billion), represented by 2,400 listed corporate bonds.[16] To be clear, the research by Riksbank was of the corporate debt issued by non-financial institutions in Swedish Kronor. An important development in this market since 2011 has been the move by companies to raise tradable debt instead of bank loans. While it is not stated explicitly, it may be assumed that the debts are arranged subject to a mortgage or other encumbrance of company assets. The lack of clarity means we cannot tell if any security is to a specific asset or a general priority over all company assets. The following figure shows healthy issuance levels in recent years.

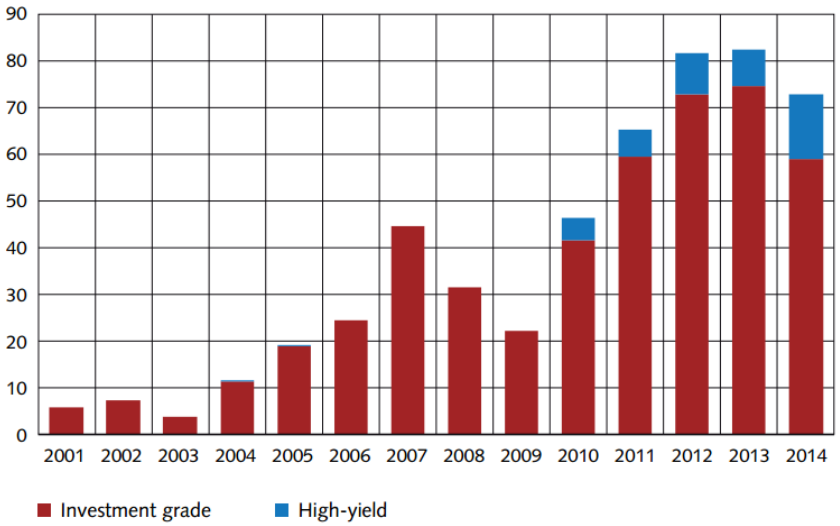


Figure 53: The Swedish corporate bond market issuance by broad credit grade (SEK billions). Source: Riksbank.

[15] Fiera Capital, CIA Curve. Retrieved 28 April 2015 from http://www.fieracapital.com/en/institutional_markets/cia_rate_curve/cia_curve/.
[16] Source: Riksbank.

The proportion of securities without credit ratings has grown over recent years, as shown in the following figure.

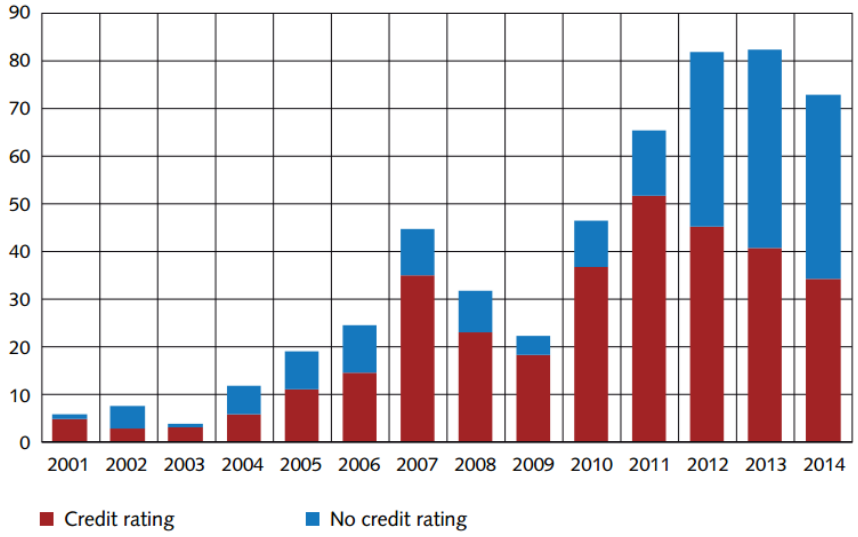


Figure 54: The Swedish corporate bond market issuance by credit rating (SEK billions). Source: Riksbank.

The proportion of the market that is represented by fixed coupon bonds is relatively low, representing only around a third of issuances over recent years. Thus the size of the fixed coupon market is circa SEK 120 billion (circa AUD 20 billion).

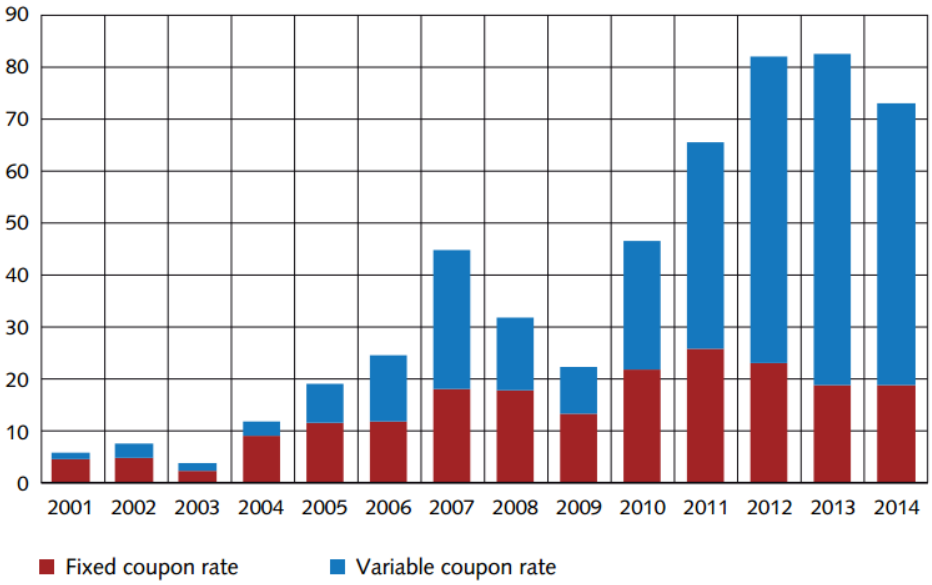


Figure 55: The Swedish corporate bond market issuance by coupon type (SEK billions). Source: Riksbank.

The following figure shows the distribution of debt by year of maturity out to 15 years. It is clearly concentrated in the first 5 years.

Combining Figures 54 and 55 gives us the impression that there is perhaps SEK 20 billion rated fixed-coupon corporate debt, but it could be as low as SEK 10 billion if the ratings are equally spread across fixed- and variable-coupon issues.

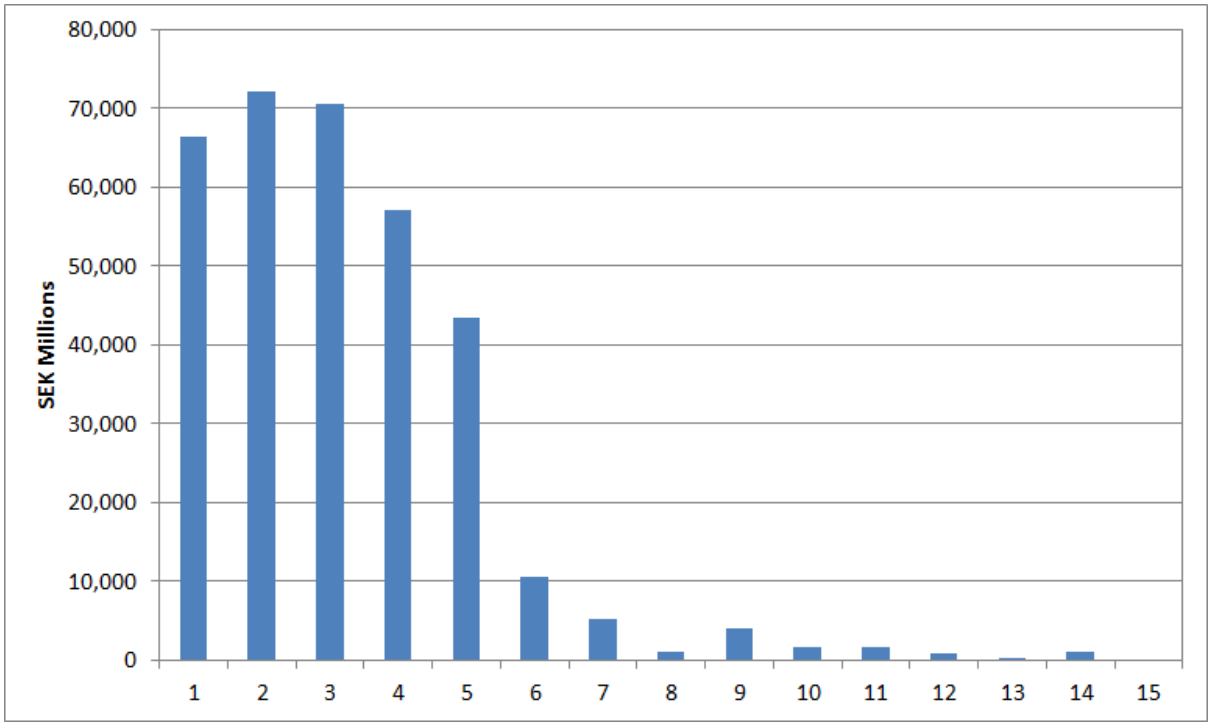


Figure 56: Swedish corporate bond market outstanding issuance by term (SEK billions). Source: Nasdaq Nordic.

Finally, turnover in the market is shown in the following figure:

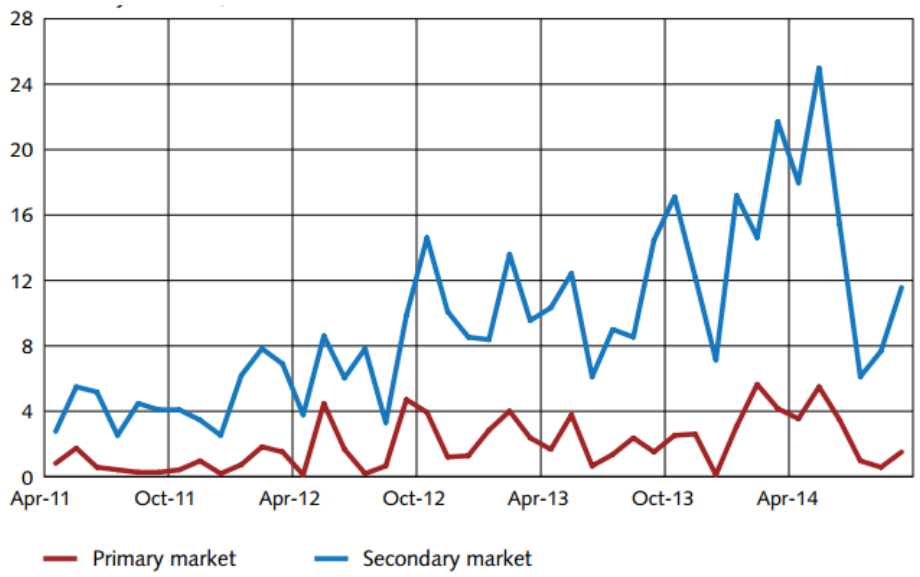


Figure 57: Swedish corporate bond market monthly turnover (SEK billions). Source: Riksbank.

Over the last year, turnover was circa SEK 175 billion. With an average outstanding amount of circa SEK 350 billion (accounting for stronger issuance in 2014 compared with five years ago), this results in a turnover figure of around 50%. Note that the majority of trade is OTC.

According to the Swedish stock market there were 137 institutions with, cumulatively, 745 instruments listed in the circa SEK 350 billion.

Until 2010, Sweden used government bonds as the basis for setting discount rates. They then started to refer to the yield on mortgage bonds. Now, according to a study[17] in 2013 by the University of Gothenburg on 'An analysis of how the changes in interpretation and application of IAS 19 paragraph 83 resulted in a new accounting practice in Sweden,' there is dispersion on rates between mortgage bonds and government bonds. To quote from the report:

> *"IAS 19 paragraph 83 addresses the estimation of the discount rate used for determination of the present value of defined benefit pension plans. Until 2010, the paragraph was consistently applied within Sweden, when all companies agreed that the yield on government bonds should be used as a reference for the discount rate. A number of companies then started to refer to the yield on mortgage bonds, a reference rate that is not one of the stated alternatives in the paragraph. This action has been debated among the accounting practitioners in Sweden, as a possible deviation from the standard. A new interpretation and application of the paragraph has led to the emergence of a new accounting practice within Sweden, without an actual change in the regulation. "*

A seconded accounting standards expert has stated that actuaries in Sweden now use corporate bonds for discounting pension plan liabilities.

[17] Martinsson, F., Edqvist, K. & Hagberg, A. (2013), The Emergence of an Accounting Practice, University of Gothenburg School of Business, Economics and Law. Retrieved 28 April 2015 from https://gupea.ub.gu.se/bitstream/2077/32979/1/gupea_2077_32979_1.pdf.

4.3.6 Norway

The Oslo Bors is the only regulated market for securities trading in Norway. It provides various statistics to characterise the Norwegian debt markets. The following figure shows that there has been a significant increase in the size of the corporate bond market in recent years, as a result of a large increase in covered bonds.

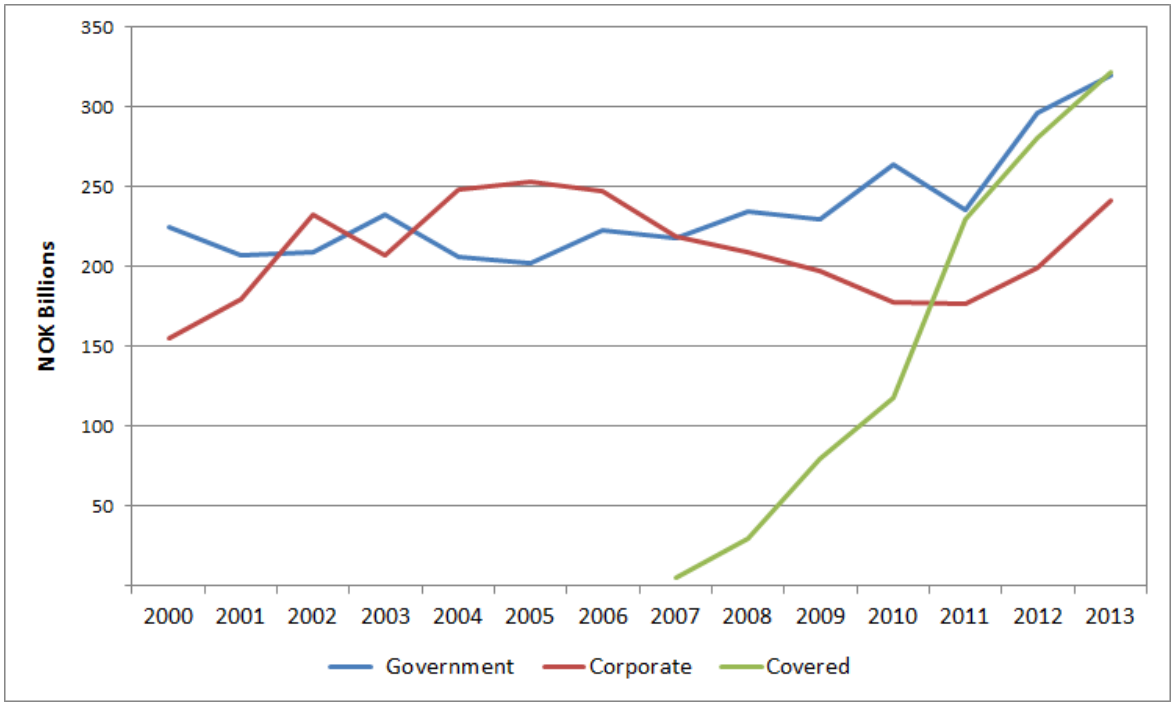


Figure 58: Norwegian bond market outstanding by sector (NOK billions). Source: Oslo Bors.

The following figure summarises the key elements of the government and corporate bond markets:

Sector	Number of Securities	Number of Issuers	Outstanding (NOK Billions)	Turnover (NOK Billions)	Liquidity Ratio
Government	188	91	436	336	77%
Corporate Bonds	529	178*	355	165	47%
Covered Bonds	142	16*	334	211	63%
Corp + Covered Bonds	671	194	690	377	55%
Total	859	285	1,126	712	63%

Figure 59: Norwegian bond market characteristics by sector. Source: Oslo Bors.

**There will be some overlap in the number of issuers (the same entity may be issuing various securities) – another table from this source suggests 113 issuers of corporate bonds*

The corporate bond market has a large number of securities on issue across a relatively large number of issuers, with around NOK 355 billion (AUD 60 billion) on issue. The issuance of covered bonds is also relatively significant at NOK 334 billion (AUD 57 billion), although the number of issuers is relatively narrow.

According to a 2013 report by SEB,[18] the corporate bond market is characterised as having:

- Around 81% of issuance denominated in NOK (19% in USD)
- Around 8% have a credit rating of AA (0% in AAA)
- Around 40% of issuance is in fixed coupon bonds

[18] Source: SEB GROUP

Taking the above into account, it is clear that only a very small proportion (circa 2.5%) of the market relates to high-quality, fixed-coupon, NOK denominated debt. A rough conservative (i.e., maximal) estimate of the size of the market is around NOK 18 billion, assuming that these figures also apply to covered bonds.

The liquidity ratio of the corporate and covered bond markets is 47% and 63%, respectively (55% weighted average).

In a paper[19] published by the Financial Supervisory Authority of Norway, it was suggested that there has been a move to covered bonds since 2012. Up to 2012 the understanding was that no deep market for high-quality corporate bonds existed in Norway. The interest rate on government bonds was therefore used as a basis for the discount rate. For the accounting year 2012, many entities had changed the discount rate used when calculating pension obligations from 2011 to 2012. These entities used the interest rate on covered bonds to estimate the discount rate.

4.3.7 Israel

According to advice received from a seconded accounting standards expert, Israel has recently moved to using corporate bonds for employee benefit discount rate purposes.

According to the Tel Aviv Stock Exchange,[20] where 90% of bond trading activity takes place, the market capitalisation of non-government bonds was USD 88 billion as at December 2013. The market capitalisation of government bonds at this date was USD 138 billion. Issuance of corporate bonds has been around USD 8 billion to 10 billion in recent years. Turnover in the corporate bond market also looks strong, at around USD 0.6 billion per day, which equates to around USD 150 billion per year, and a liquidity ratio of around 170%. However, only around a third of the 600 bonds on issue have fixed coupons. Thus, a rough estimate of the maximum size of the fixed-coupon corporate bonds is around USD 30 billion, although it would likely be less than this once credit ratings are taken into account (for which data was not available). It is also worth noting that the country credit rating of Israel is single A, which may mean that the corporate bond market is likely to consist of lower-rated corporate bonds compared with other developed countries.

4.3.8 Japan

The Japanese bond markets are mature and deep. The size of the market is outlined in the following table:

	Outstanding Yen Trillion	Source
Government Bonds	1,097	Bank of Japan
Bank Debt	510	Bank of Japan
Corporate Bonds	61	JSDA

Figure 60: Amount outstanding. Source: Investment in Japan.

Total corporate bonds outstanding amounts to JPY 61 trillion or AUD 610 billion, larger than in all countries with the exception of the United Kingdom and the United States. Data from the Asian Development Bank (shown in the appendix beside other government debt data) gives a similar set of historical figures for corporate bonds. It suggests that the above figures relating to bank debt should not be treated as corporate.

Turnover is dominated by the activity in government bonds as shown in the following figures. While the US$ equivalent of the government bonds broadly matches the BIS data earlier, the combined bank and corporate bond outstanding in the above table exceeds the BIS figures. This is possibly due to some double counting,

[19] Financial Supervisory Authority of Norway (2013), Certain Accounting-related Issues Based on the Review of Financial Statements in 2013. Retrieved 28 April 2015 from www.finanstilsynet.no/Global/English/Circulars/Circular_11_2013.pdf.
[20] Tel-Aviv Stock Exchange (2013), 2013 Annual Review. Retrieved 28 April 2015 from www.tase.co.il/Resources/PDF/Newsjournal/2013_AnnualReview_Eng.pdf.

although even then, the above figure relating to bank debt at JPY 510 trillion (USD 4.3 trillion) exceeds the corporate debt number of USD 3.3 trillion).

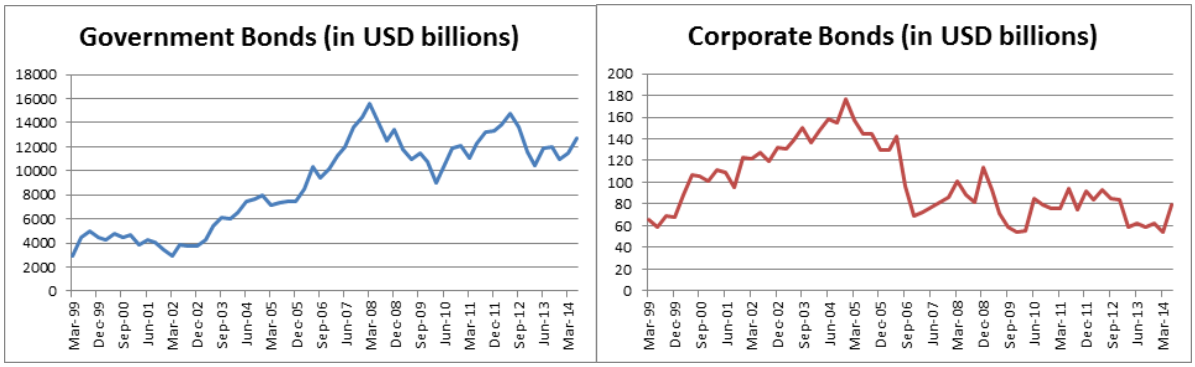


Figure 61: Quarterly turnover in Japanese government and corporate bonds. Source: Bloomberg.

For government bonds, since 2008 average quarterly turnover has been around USD 12,000 billion or JPY 1,418 trillion, indicating an annual liquidity ratio of around 520%. Similarly corporate bonds have a turnover of around USD 70 billion or JPY 8 trillion since 2008, indicating a liquidity ratio of 52% per annum.

The debt market as a whole is considered to be sufficiently deep and liquid. Japanese GAAP allows for 'safe and secure long-term bonds,' which includes government bonds, government agency securities and high-grade corporate bonds.[21] This reflects that the government debt market is much larger than the corporate debt market. In practice, the discount rate used in GAAP disclosures does tend to be higher than pure government debt yield. A similar approach is taken to using high-grade corporate bonds for GAAP and IAS 19 disclosures. A seconded accounting standards expert stated that corporate bond yields are used as the basis for IAS 19 disclosures. The evidence of the foregoing indicates that there is no single market practice although there is a leaning towards high-grade corporate bonds.

4.3.9 Asia ex-Japan

In this section we look specifically at Malaysia, Singapore, Hong Kong and China. Markets such as Thailand and India also have defined benefit pensions, but their corporate bond markets are characterised by low issuance, low liquidity and in some cases poor credit ratings, leading to the use of government debt as the benchmark for discount rates.

In Malaysia and Singapore there are very few defined benefit retirement funds. Those that do exist tend to have some integration with the dominant defined contribution provident funds. The large offset that the state provident funds provide for the majority of employees means that the remaining defined benefit promise is often very small. Consequently, the provisions (or physical assets) that are set aside are often deemed to be immaterial. Hence, there is little formal attention given to their actuarial valuation assessment. Having said that, in the main the liabilities are typically assessed by one of the large international firms and the IAS 19 standards are applied.

Neither market has a deep corporate bond market. Meanwhile, government debt is held tightly by the highly regulated life and non-life insurance companies. The Malaysia debt market amounts to USD 330 billion with a little over USD 190 billion issued by the government.[22] The Singaporean bond market amounts to USD 250 billion, 60% of which is government-related debt.[23] The result is that, with little in the way of supply and a

[21] Kwansei Gakuin University Repository (March 2011), Determinants of Changes and Levels in Discount Rates for Defined-Benefit Pension Plans. Retrieved 28 April 2015 from http://kgur.kwansei.ac.jp/dspace/bitstream/10236/7605/1/11-4.pdf.
[22] Asian Bonds Online, Malaysia: Market Summary. Retrieved 28 April 2015 from http://asianbondsonline.adb.org/malaysia/market_summary.php.
[23] Asian Bonds Online, Singapore: Market Summary. Retrieved 28 April 2015 from http://asianbondsonline.adb.org/singapore/market_summary.php.

stable exchange rate when global macro-economics are not quite so frenetic. discount rates are typically set by reference to US government bonds for these markets.

Currently the Hong Kong bond market is almost USD 200 billion, split roughly 60/40 government-related and corporate.[24] Like Singapore, Hong Kong has a relatively small pensions market. Most of the defined benefit plans have been converted to defined contribution. The implementation of the Mandatory Provident Fund in the private sector means that there are very few new plans being established, with those that have, still have very small populations. However, HKIAS 19, the local accounting standard, follows IAS 19 and the strict interpretation would be that corporate AA Bonds should be used as the benchmark for setting the discount rate. However, like Singapore, high-quality debt is tightly held by the highly regulated insurance firms, and consequently there is little depth or liquidity in such securities.

In China, the private sector pension arrangements are managed though provincial social security funds. These are defined contribution funds for employee contributions. The employer contributions are used to manage the defined benefit element of the social security program. In practice it is essentially pay as you go, as the incoming contributions are being used to fund the woefully underfunded past service positions. Corporate debt (and the rating of it) is in its infancy. Whereas in Hong Kong and Singapore corporate debt is of the order 30% of GDP, in China it is less than 15%. Moreover, recent defaults have led to poor liquidity in a market where the bureaucracy of issuing new debt is extremely burdensome, with the market being poorly regulated and sparsely rated. That said, the country is large and the Asian Development Bank reports outstanding local currency bonds amounting to USD 5.1 trillion as at the end of September 2014. Corporate bonds outstanding at the end of September 2014 amounted to USD 1.8 trillion. Currently, the central bank has reduced its issuance while it runs an experiment to allow local governments to issue bonds. Guangdong (immediately north of Hong Kong) was the first to trial this and issued five-, seven-, and 10-year paper—total issuance was RMB 14.8 billion (USD 2.4 billion).[25] Without a credible corporate debt market, the benchmark for discount rates is central government bonds.

4.3.10 South America

A paucity of data in South America makes using the debt market as a guide for setting long-term discount rates very difficult. In general, government debt is the benchmark used.

The following figure from the BIS provides an indication of the size of the bond markets in Latin America's largest countries. Note that these are international debt figures; local bond data was not available in the BIS data.

Country	General Government	Corporates	All Issuers
Argentina	45	7	52
Brazil	60	260	320
Chile	4	33	37
Colombia	23	23	46
Mexico	58	133	191
Peru	14	19	33
Uruguay	13	0	13
Venezuela	35	22	57
Total	254	495	749

Figure 62: Amount outstanding (USD billions) of South American bond markets as at June 2014. Source: BIS.

[24] Asian Bonds Online, Hong Kong, China: Market Summary. Retrieved 28 April 2015 from http://asianbondsonline.adb.org/hongkong/market_summary.php.
[25] Asian Bonds Online, People's Republic of China: Market Summary. Retrieved 28 April 2015 from http://asianbondsonline.adb.org/china/market_summary.php.

The Brazilian and Mexican debt markets clearly dominate, both overall as well as for corporate debt. Many corporate bonds are not traded for extended periods, and the absence of price quotes prevents large institutional investors from holding such securities. As a result, when Latin American companies want to raise capital, they have to go either to the US or euro debt markets.

In conclusion, for the main markets the following approaches are used by at least one of the large multinational actuarial firms—for 2014, the discount rate was determined as follows:

- Brazil:
  - Long-term inflation: 4%
  - Risk-free yield (treasury note B – NTN B): 7% nominal
- Argentina:
  - Inflation: 30% to 35% (private estimations)
  - Yield (discount bond in ARS – 20 years): 40% nominal
- Chile:
  - Target inflation: 2% to 4%, currently 3.5%
  - Yield (government bond 10-year – average): 4.5% nominal
- Mexico (and other Latin-American countries):
  - Yield: 7% nominal.

4.3.11 Conclusion

The four major markets that use corporate bonds as the reference assets for IAS 19 discount rate purposes are the United States, Japan, the United Kingdom and the Eurozone. Each of these countries or regions supports a deep and liquid corporate bond market, with liquidity ratios of circa 50% to 70%. At the other end of the spectrum, there are a number of relatively poor quality, small or illiquid corporate bond markets, including China, Hong Kong, South America/Brazil, Malaysia and Singapore, all of which use government bonds for IAS 19 discount rate purposes. Between these extremes lie Canada, Sweden and Norway, all of whom use corporate bonds for IAS 19 discount rate purposes.

Having recently moved to the use of corporate bonds, the Canadian market is the most comparable with Australia. The equivalent AAA + AA corporate bond market in Canada has a market capitalisation of AUD 120 billion, which is around 2.5 times that of Australia. Other markets that have recently moved to the use of corporate bonds are Sweden and Norway, both of which are smaller than Australia, at AUD 20 and 60 billion respectively (but significantly smaller when considering only fixed-coupon bonds). All three of these markets have corporate bond market liquidity ratios of around 50%, which are below the equivalent ratio for Australia of 55%. Thus there are multiple existing international precedents for the use of corporate bonds, all of which appear to have comparably deep and liquid markets compared to Australia. Thus we can conclude the following:

Conclusion 4: Australia is comparable with other international markets using corporate bonds, having similar liquidity ratios, and a deeper market compared with the comparable markets of Sweden and Norway, although market depth appears to be lower than Canada.

4.4 Why Now?

According to Black et al. (2012), the stock of bonds issued by Australian corporations has grown at an average real rate of 4% p.a. since the early 20th century. The following diagram shows the very long-term history of the size of the market in both absolute dollar terms and relative to GDP.

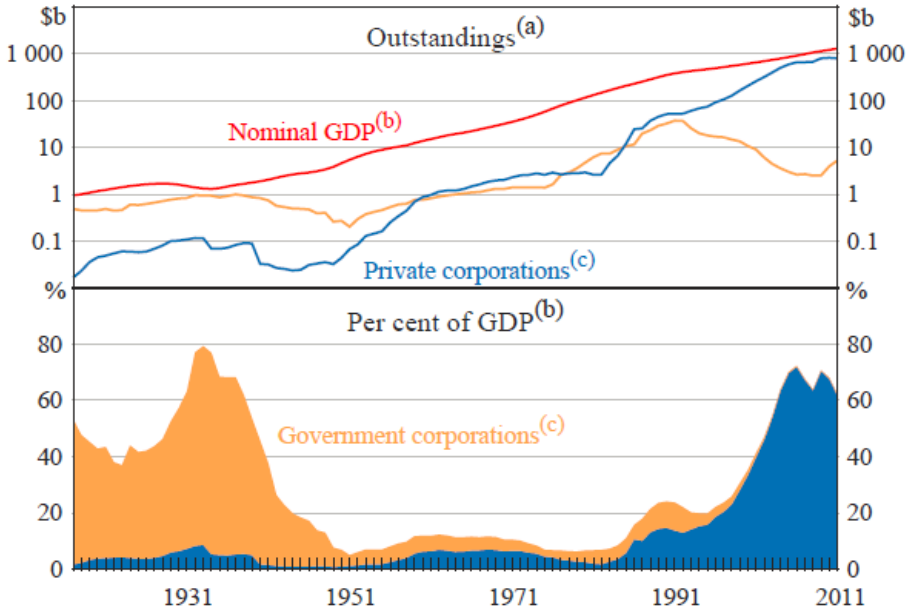


Figure 63: Long-term trends in Australian corporate bond market outstanding ($ billions top panel and % GDP bottom panel). Both government and private corporations are shown. Source: Black et al. (2012)
Notes: a) Log scale; b) Five-year rolling average GDP; c) data on bonds issued offshore not available prior to 1983.

The size of the total private corporate bond market has never been as large as it has been over the last five years, both in absolute dollar terms as well as a percentage of GDP. Note that government corporations issued a significant amount of debt in the first half of the century to fund public works programs in response to World War I and the Great Depression. The following figure looks at the recent two decades in further detail:

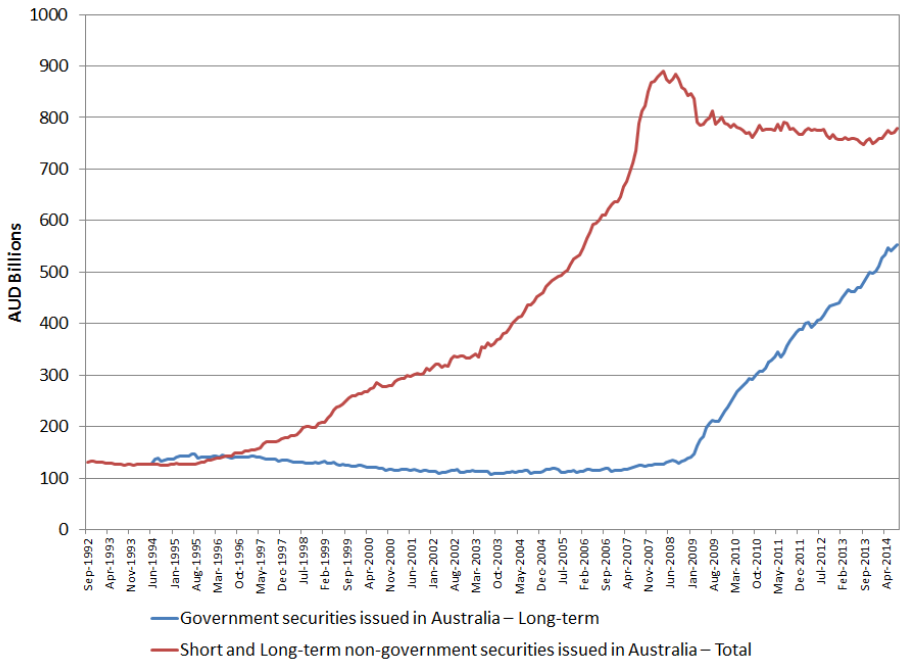


Figure 64: Growth in the Australian government and corporate bond market issuance. Source: Milliman analysis based upon RBA data.

The market for government debt has grown exceptionally strongly over recent years since the financial crisis of 2008 as the government has sought to support the economy with an expansionary fiscal policy. By contrast, the corporate bond market grew significantly in the two decades prior to the crisis but has plateaued since. The following graphs looks into this in further detail in terms of both issuance and outstanding broken down by onshore (AUD-denominated) versus offshore (foreign-currency-denominated):

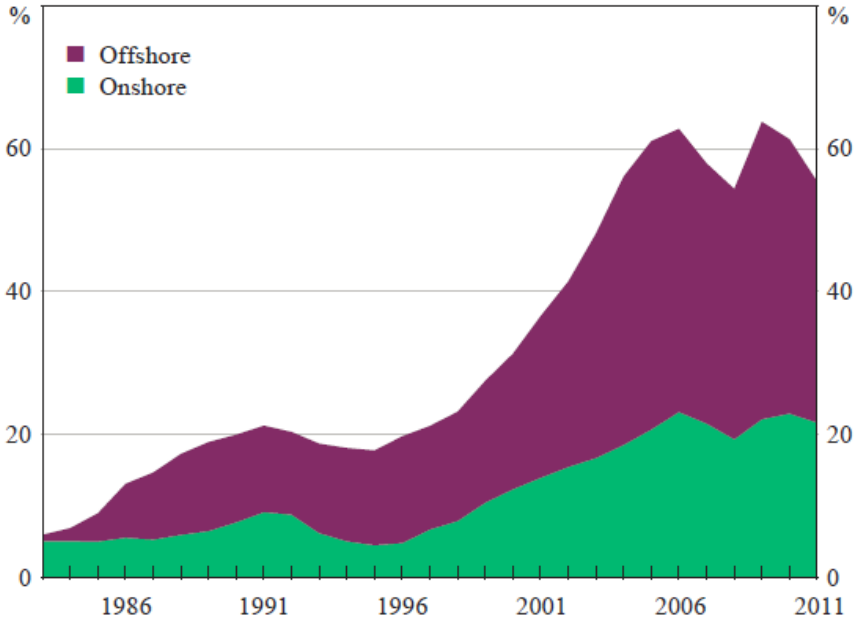


Figure 65: Australian corporate bond market outstanding as a percentage of GDP by currency. Source: Black et al. (2012).

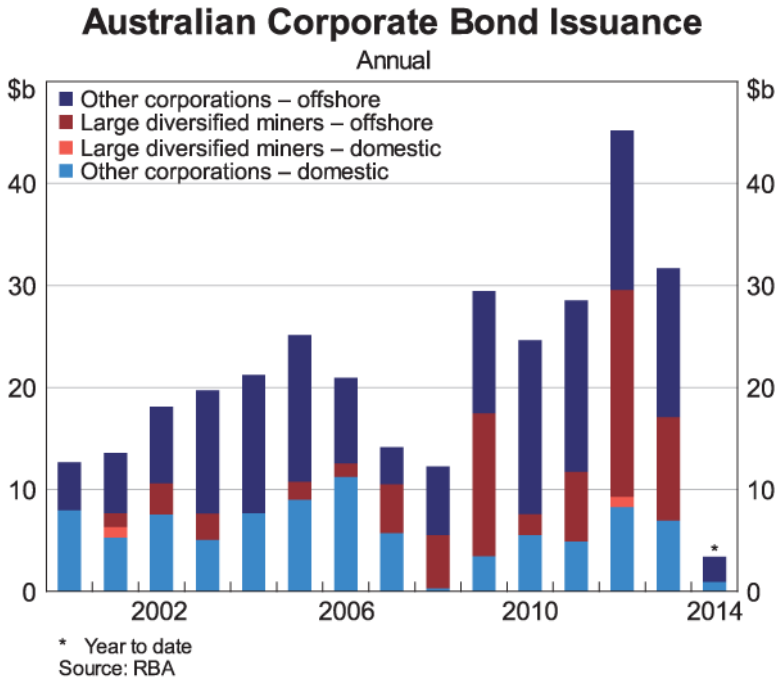


Figure 66: Australian corporate bond market issuance by issuer type and currency. Source: Debelle (2014).

The onshore market has been at a stable level of outstanding over the last five years, mirroring the development of the offshore market. Issuance over the last five years has been dominated by non-AUD-denominated debt, with a significant component of this coming from the large diversified miners. AUD-denominated corporate debt issuance has on average reduced slightly from its pre-global financial crisis levels, averaging around $5 billion p.a. It seems to fluctuate broadly with the level of economic activity. Recent

activity this year has been primarily in a significant pick-up in lower-rated issuance at longer maturities domestically. This is a welcome sign as it indicates that the market is becoming more mature, as pricing spreads become more attractive to corporates.

The following figure shows the breakdown in issuance over the last 30 years by credit rating:

Period	AAA	AA	A	BBB
1983 - 1989	32%	57%	11%	0%
1990 - 1992	22%	70%	8%	0%
1993 - 2007 H1	28%	46%	22%	3%
2007 H2 - 2011	30%	45%	19%	7%

Figure 67: Percentage of Australian corporate bond issuance by issuer credit rating. Source: Black et al. (2012) using RBA data.

This analysis shows that there has been an increase in credit rating diversity of corporate bonds over the last 30 years, as lower-rated entities access debt markets.

The corporate bond market has been in a relatively stable state over recent years, as characterised by the relatively flat levels of new issuance, total outstanding notional amounts and turnover (as previously noted). Whilst it is impossible to forecast where the market may go in the future, there are a number of important trends in the key drivers of the market:

- The continued support of the government to issue debt, particularly at longer maturities (such as the recent issuance of a 20-year treasury bond). This provides an important pricing reference point for corporate debt, and facilitates credit risk management options of market players. This will eventually ease off once the federal government is able to move the budget out of significant deficit territory.
- The ongoing need for banks to raise debt capital to finance loan growth (particularly for mortgage books) and potentially higher capital requirements under recommendations to lift bank capital ratios.
- The outlook for Australia economic activity. Positive and consistent economic growth will continue to support the confidence of the market. When this evaporates, as it did in 2008–2009, the market for new issuance dries up significantly.

The other important development is that recent regulation is leading to a transfer of liquidity from the OTC market to exchanges such as the ASX. For example, the ASX bond market currently trades 54 government and corporate bonds, which are available to both retail and institutional investors. The new legislation, the Simple Corporate Bonds Bill, which passed though Australian Parliament in August 2014, introduced a new streamlined disclosure regime for issuers of simple corporate bonds on the ASX. Although liquidity in these securities on the ASX is still currently low, it is expected to grow as the range and number of securities continues to grow as a result of these developments.

In summary, the AA corporate bond market has likely reached a state of sufficient depth, liquidity and maturity over recent years that it meets the primary requirements for inclusion in the asset calibration set. Whilst there doesn't appear to have been an explicit threshold reached in the last year or two, the market has exhibited stability over the last five years, which is a desirable characteristic for a long-term asset calibration set. This is further supported by a significant and growing government bond market with the RBA willing to foster increased maturity, and the ongoing needs of corporate Australia, particularly banks, to access the market to support their debt financing requirements. Thus:

Conclusion 5: Now appears to be a good time to move to a corporate bond basis, as the markets have exhibited stability for a number of years since the Global Financial Crisis, supported by a growing government bond market and a move towards central clearing houses for market transparency.

5 METHODOLOGY

5.1 Requirements

Actuaries require a set of spot interest rates that are equivalent to zero-coupon bonds in order to discount projected future cash flows at all durations. As the securities in the asset calibration set are not generally zero-coupon bonds, their market yields are not spot interest rates, but rather represent yields to maturity. Moreover, the durations of the longest bonds are generally shorter than the durations of the most remote liability cash flows. Techniques are therefore required in order to translate these into equivalent spot rates (interpolation) and to extend the yield curve beyond the last available security (extrapolation).

When assessing the techniques for both of these purposes, the following conditions and desirable properties should be considered:

- Forward rates should not be negative.
- Forward rates should not be discontinuous (i.e., exhibit material jumps).
- Forward rates should be as smooth as possible.
- The method should be as objective and transparent as possible.
- Results should have reasonable goodness of fit measures, for accuracy, stability and robustness.

5.2 Interpolation

5.2.1 General Considerations

Interpolation refers to the process of fitting a yield curve to the set of calibration assets. This can be achieved by specifying the forward rates, spot rates or discount factors. Defining one uniquely specifies the other two. A yield curve is sought which best fits the market prices of securities within the asset calibration set. A typical choice is to seek a yield curve which minimises the sum of the square of the differences between the modelled metric (e.g. spot rate) and the metric implied from bond prices.

A key choice in this process is the trade-off between fit and smoothness. Smoothness is a desirable property, as it avoids large and potentially discontinuous jumps in forward rates, which are hard to intuitively justify. The problem is that goodness of fit measures generally worsen as smoothness increases. The choice of asset calibration set also impacts this fitness versus smoothness choice, i.e. a broader asset calibration set involves a more heterogeneous set of bonds. Hence, for a methodology which doesn't attempt to explicitly explain this heterogeneity the worse the goodness of fit, and the more sensitive the yield curve results are to the choice of method. The following figure illustrates these properties, based upon the Commonwealth and semi-government bond markets:

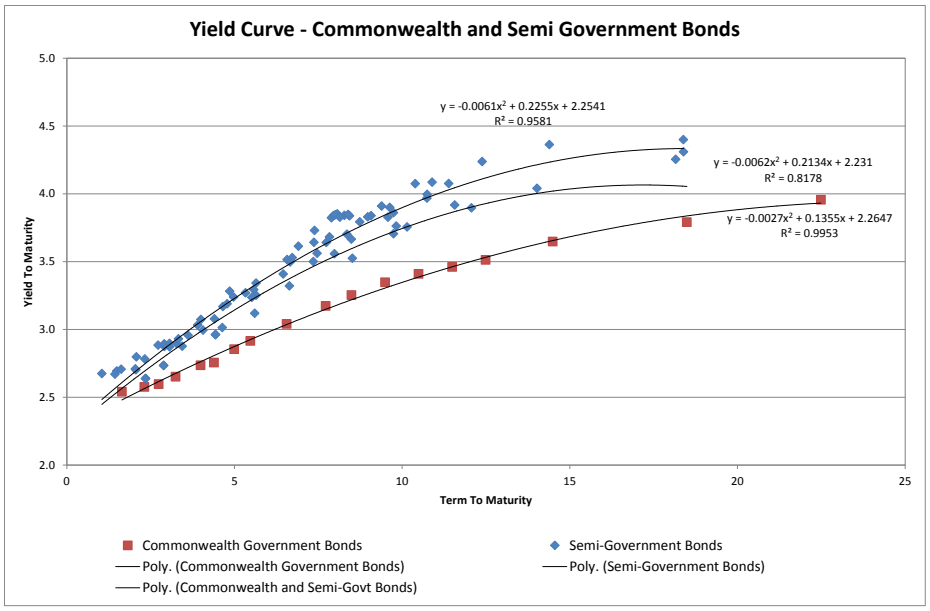


Figure 68: Commonwealth and semi-government yield curves fitted using a quadratic function on yield to maturity data, by term to maturity. Source: Milliman analysis based upon Bloomberg data as at 24 October 2014.

Even with a very rough and simple approach based upon a quadratic function on yield to maturity data, the trade-off between fit and smoothness is evident. The Commonwealth Government yield curve is an extremely good fit, explaining 99.5% of variability in yields. The semi-government curve is also a very good fit, although not quite as good as the Commonwealth curve, explaining 95.8% of variability. Note that these are clearly two separate markets, with a significant and clear spread between them, with no overlap in their ranges. However, when these two markets are combined, the goodness of fit measures decline significantly to 81.8%. The last fitted forward rate is also likely to be subject to greater uncertainty and potentially variability that isn't representative of genuine market conditions, which can be amplified due to the extrapolation process. Fit could be marginally improved by using alternative methods with greater degrees of freedom, but it will not resolve the issue. Hence where there is a clearly distinct set of market prices for a deep and liquid market, consideration should be given to limiting the asset calibration set to the minimum homogenous set possible.

5.2.2 Non-parametric Methods: Bootstrapping

Non-parametric methods for fitting yield curves involve deriving spot or forward rates directly from observed market prices. Bootstrapping is a non-parametric technique to construct a yield curve by calculating spot yields from redemption yields on a series of coupon-paying bonds. The approach uses recursive formulae to identify spot yields at successive coupon and redemption payment dates under available bonds. It requires the asset calibration set to be very homogenous so that there are little to no residual pricing variances that can cause forward rates to become discontinuous. As the technique derives forward rates between each coupon date, it also requires the coupon and maturity payment dates across bonds to be in alignment. Whilst for the swap market this is not a problem, for the physical bond market it is, as cash-flow payment dates are rarely aligned across large numbers of bonds.

Given the cash-flow payment date differences and the potential for a relatively heterogeneous calibration set that includes both domestic and foreign issuers of AAA and AA debt, this approach is unlikely to be useful for interpolation purposes.

5.2.3 Parametric Methods

Parametric methods involve the use of various mathematical functions to derive a yield curve. These approaches are commonly used by central banks to derive yield curves on their sovereign debt. A number of papers have been published by various central banks on this topic, including Anderson et al., 2001, Bolder et

al., 1999, and Dombrecht et al., 2005. Dombrecht, in particular, provides an excellent summary of the various methods used across a number of central banks, as outlined in the figure below:

Country	Method	Yield Curve Definition	Longest Maturity
Belgium	Function Fitting: Svensonn	Weighted Prices	16 years
France	Function Fitting: Svensonn	Weighted Prices	10 years
Germany	Function Fitting: Svensonn	Yields	10 years
Norway	Function Fitting: Svensonn	Yields	10 years
Spain	Function Fitting: Svensonn	Weighted prices	10 years
Switzerland	Function Fitting: Svensonn	Yields	30 years
Finland	Function Fitting: Nelson-Siegel	Weighted Prices	12 years
Italy	Function Fitting: Nelson-Siegel	Weighted Prices	30 years
Australia	Merill Lynch exponential spline (MLES)	Weighted Yields	10 years
Canada	Merill Lynch exponential spline (bb)	Weighted Yields	30 years
Japan	Smoothing splines	Prices	10 years
Sweden	Smoothing splines and Svensonn	Yields	10 years
UK	Spline: Variable Penalty Roughness (VRP)	Yields	30 years
USA	Smoothing splines	Yields	10 years

Figure 69: Summary of interpolation methods used by central banks. Source: Dombrecht et al., 2005.

It is clear that there is no overall preferred methodology used by central banks, with a number of interpolation methods used. Both yields and prices are used to define the yield curve, with some countries applying weighting factors, but others choosing not to. There are two main classes of methods: spline models and function fitting approaches.

Under a spline model, polynomial functions are used to fit the yield curve over particular tenors, with different functions being used for other tenors. This technique requires that the resulting curve is sufficiently smooth at the border between two tenor regions. The VRP method used in the UK is an example of a spline method. It applies a 'roughness' parameter which varies with maturity, which enables steeper curvature to be obtained at the shorter end of the yield curve.

Under a function fitting approach, a number of basis functions are used which specify the entire yield curve over the full spectrum of tenors. It is worth noting that despite its name, under this classification MLES is actually a function fitting approach, as the functions fitted under MLES span all durations considered.

Bolder and Gusba (2002) assess both spline and function fitting approaches in detail. The following figure details the specific methods investigated:

Type	Name	Yield curve definition
Spline	McCulloch	Discount rates
Spline	Fisher, Nychka, and Zervos (FNZ)	Discount rates
Spline	FNZ forward	Forward rates
Spline	FNZ spot	Spot rates
Functional	MLES-Exponential	Discount rates
Functional	MLFS-Fourier	Discount rates
Functional	MLES-Benchmark	Discount rates
Functional	Svensson	Forward rates

Figure 70: Parametric interpolation methods assessed by Bolder and Gusba (2002)

The authors calibrate each approach to the Canadian government bond market across a range of historical dates from 2000 to 2002, and they assess the methods across a range of metrics including:

- Accuracy of modelled prices or yields against actual bond prices and yields, as measured through root mean square error and mean absolute error
- Nature of pricing errors, reflecting the risk that the quoted price is not actually representative of the price which could be obtained in an open market transaction
- Computational effort

The paper concludes that the FNZ forward model and the Svensson model perform poorly under these metrics. The McCulloch, FNZ spot, MLES Fourier and MLES Exponential performed well and were selected for further investigation. In these investigations, a single bond is eliminated from the fitting data and the modelled price of the excluded bond is compared to its actual price. The conclusion from this investigation was that the MLES-Fourier and McCulloch models tended to over-fit the data and consequently tended to perform relatively poorly out of sample. Furthermore, this poor out-of-sample performance contributes to a lower degree of stability among these two models.

The paper concluded that, of the four models considered in the out-of-sample testing, the MLES-spot and the FNZ-Zero performed the best. These models (MLES-Exponential and the FNZ-Zero) were, in the author's opinion, the most desirable term-structure estimation models among the eight separate models when applied to the Government of Canada bond market. There was relatively little to distinguish between the two models, other than the significantly faster computational speed of the MLES model.

5.2.3.1 Security Weighting

Independent of the interpolation approach, a method needs to be chosen to assign weights to the bonds in the asset calibration set. Ideally, higher weights would be given to bonds which are subject to small degrees of price uncertainty, and less weight given to bonds where there is greater uncertainty that the quoted market price is representative of the desired risk.

Possible approaches include:

- Weight by market capitalisation. In general, the deeper and more liquid bonds convey more accurate pricing information, and thus it may be desirable that more liquid bonds are given greater weight. If market capitalisation is a reasonable proxy for security depth and liquidity, it may provide a reasonable weighting scheme.
- Equally weight. This has the benefit of simplicity, but it makes no allowance for varying degrees of price uncertainty across securities. This is the approach used in the government bond yield curve example outlined in section 5.3.1.
- Weighting by inverse duration, so longer duration bonds are assumed to have lower weighting. The rationale for this approach is that longer duration bonds are expected to have more volatile prices and greater uncertainty. Hence pricing errors may be expected to be, on average, larger for longer duration bonds. This approach was used in Bolder and Gusba (2002). As outlined earlier by Dombrecht et al., 2005, all the central banks which apply a weighting use this method or another that is equivalent to it.
- Combination of approaches. If price uncertainty depends on both maturity and the size of the issue, it may be desirable to weight using both market capitalisation and duration.

5.2.3.2 Spline Fitting

A spline is a collection of piecewise polynomials which is fit to the prices of the asset calibration set, subject to certain conditions. For fitting a yield curve, the polynomials will be functions of duration or tenor.

The spline has a number of 'knot points': Suppose a knot point is at Duration 3, and the next knot point is at Duration 5. One piecewise polynomial will be fitted between Durations 3 and 5, and other polynomials will be

used outside of this range. A typical choice is to use cubic polynomials. If this choice is made, an additional requirement is added for the fitted curve to be sufficiently smooth: It should have a continuous second derivative at all durations (including the knot points).

Spline methods have a number of limitations:

- Where data is sparse, spline methods may produce unacceptably 'wiggly' fitted results between data points.
- The choice of knots is subjective and can influence the results of the fitting algorithm.
- Linear interpolation methods may produce 'kinks,' bringing about discontinuous jumps in the resulting forward rates.

Both the McCulloch and the FNZ methods fit cubic splines. The McCulloch method fits to discount rates, whilst the FNZ method may be chosen to fit to discount rates, spot rates or forward rates. The key difference between them is that the FNZ method is an example of a smoothing spline approach. Under a smoothing spline, an extra term is added to the objective function being minimised, as a proxy for the smoothness of the spline—formally, it is a measure of the spline's curvature.

The relative importance of the smoothing term was, in the original paper outlining the FNZ model, taken to be constant. Subsequent authors, e.g. Anderson and Sleath (2001) have suggested a penalty function which varies by duration. This form of penalty function gives rise to the VRP class of models used by the Bank of England.

An advantage of introducing a smoothing term is that it effectively reduces the number of parameters in the model. This allows use of a greater number of knot points without the associated problems of numerical instability in the algorithm or over-fitting the yield curve. For example, in the paper by Bolder and Gusba (2002), six knot points were used for the McCulloch approach and 20 were used for the FNZ approaches. An outline of the mathematics of these models is beyond the scope of this paper but can be found in the literature referenced above.

It is worth noting that spline methods are typically more attractive where a heterogeneous calibration set exists, and each calibration asset can be considered to exhibit sufficiently similar characteristics. This differs from the homogenous asset calibration set used here. Where homogenous data exists, spline methods can produce unacceptable levels of instability in the fitted curve. Smoothing spline methods provide some help with this problem, although difficulties in defining which knots to use remain, for example if two otherwise identical bonds with different issuers (and hence yields) exist, choosing where to fit knots based on these points can be problematic.

5.2.3.3 Function Fitting

Function fitting methods use regression techniques to fit the yield curve (e.g. spot rates or bonds prices), with an objective function set to minimise pricing errors (sum of squared errors). The key difference to the spline approach is that the function used is not piecewise, but rather is used across the entire yield curve.

In some methods the term structure is estimated by using one approach for all durations, whilst in others different methods are used, depending on whether spot rates are derived at observable durations or unobservable durations which require extrapolation. The most prominent examples of the first method are the Svensson and Nelson-Siegel method,[26] where the same parametric form is used throughout the whole term structure. On the other hand, some capital market model vendors such as Barrie and Hibbert apply splines for the observable durations and use the Nelson-Siegel method to extrapolate to unobservable durations.

[26] This is the method used by the European Central Bank and many other central banks when assessing the published zero-coupon rates.

5.2.3.4 Merrill Lynch Exponential Spline (MLES) and Merrill Lynch Fourier Spline (MLFS)

The MLES model has a number of basis functions which span the entire range of durations considered. The yield curve is expressed as a linear combination of the basis functions which gives the best fit to bond prices (or spot rates etc.) over observable durations. In this context, *best fit* is normally measured using a sum-of-square error statistic. Although this approach contains the word *spline* in its name, it is not a spline method as previously discussed, as it fits to all observable durations and does not use knot points.

Under this approach, there is freedom as to the choice of the mathematical form of the basis functions. This is the key difference between the exponential and Fourier forms of the Merrill Lynch models: The functions are exponential in MLES but trigonometric in MLFS.

A key consideration is the number of basis functions to use. Using more will generate a better fit to the underlying data, but introduces the risk of over-fitting, which may introduce numerical instabilities into the fitting algorithm, leading to misrepresentation of the nature of the risk being captured in the asset calibration set. Bolder and Gusba (2002) used nine basis functions for their MLES and MLFS analysis.

The figure below demonstrates the shape of the basis functions in the MLES model:

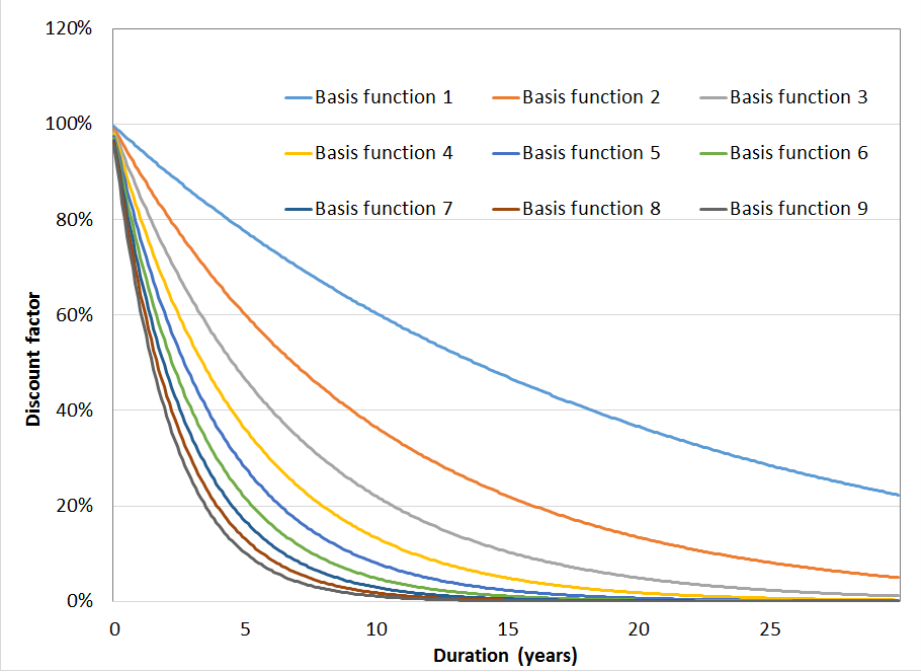


Figure 71: MLES basis functions

It is worth noting that a variation on the MLES method is used by the Reserve Bank of Australia (RBA) to derive the spot yield curve on Commonwealth Government bonds on a daily basis, which has been used by RBA analysts in various papers (e.g., Finlay et al., 2008, and Finlay et al., 2012). The method used by the RBA uses hyperbolic basis functions, rather than the exponential or trigonometric functions discussed here.

An overview of the mathematics underlying the MLES and MLFS methods can be found in Bolder and Gusba (2002).

It is worth noting that the MLES method has an additional useful characteristic. The model provides an in-built extrapolation methodology by evaluating the fitted curve beyond the fitted data. One of the parameters within each of the basis functions used represents an unconditional forward rate (UFR), with the resulting forward curve tending towards this value over long maturities. This parameter can be determined separately from the other parameters which are fitted to the yield data, for example by reference to macroeconomic arguments. This is further discussed in Section 5.3.

5.2.3.5 Nelson-Seigel and Svensson

The Nelson-Seigel approach specifies two parameterised curves across all durations which define the instantaneous forward curve. The first curve has three parameters; the second curve has one. An optimisation process is then used to find the parameters which give the best fit to the objective function (prices, yields etc.). The Svensson model is an extension of the Nelson-Seigel model. The Svensson model introduces an extra term, with two more parameters to be fitted, into the yield curve function. Otherwise, the approach is identical to the Nelson-Seigel method. For interested readers, a mathematical description of these curves can be found in Bolder and Gusba (2002).

The first curve in the Nelson-Seigel is an exponential curve, which may be upwards or downward sloping, depending on the parameters chosen. The next curve adds a 'hump' to the yield curve. The location of the hump, and whether it is a maximum or minimum, is altered by parameter choice. In the Svensson model, the third curve is also hump-shaped. The figure below demonstrates a Nelson-Seigel yield curve, and the shape of the underlying two curves (the first exponential increasing and the other hump-shaped).

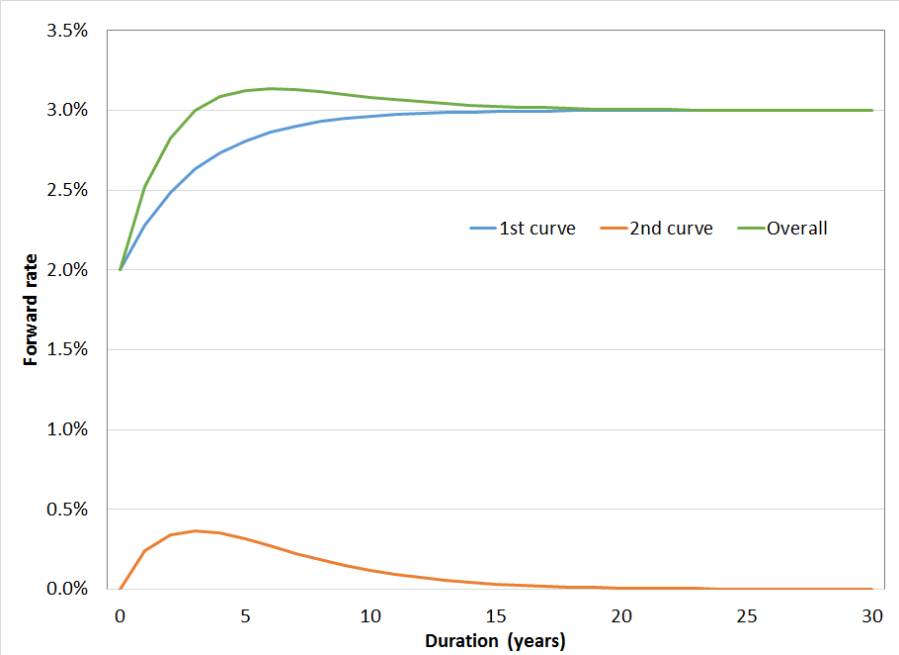


Figure 72: Example of a Nelson-Seigel yield curve

As with the MLES method, the Svennson and Nelson-Seigel methods both provide in-built extrapolation which can be set to tend towards an unconditional forward rate parameter determined prior to the fitting process. Explicit parameters within the functional forms of both models can be used to control the speed of this extrapolation, although this comes at the cost of otherwise using these parameters to provide a better fit to the observed data.

5.2.4 Spread Approaches

An alternative approach is to determine a risk-free yield curve using one of the techniques or via referencing an externally published one, such as the RBA Commonwealth Government bond spot yield curve.[27] To determine a yield curve on risky assets of a particular credit rating, a spread to the risk-free curve is applied. There are various approaches to determining the spread:

- Use a constant spread for a particular asset 'bucket' across all durations.
- Use a duration-dependent spread across the term structure, typically an upward sloping one.
- Use a structural model which attempts to explain spreads according to some underlying more complex model. For example, the Merton model attempts to model and fit credit spreads based on an explicit model of the capital structure of the debt issuer.
- Use some other model of credit spreads, for example, a reduced form approach to modelling credit events (and hence credit spreads).

A constant spread has the benefit of simplicity. However, if spreads are strongly duration-dependent, the yield curve produced may not be representative of market yields. Using a term structure raises the question of how to determine the best fit of spreads. In general, one of the approaches outlined above will typically be required. If the same approach is used to determine both the curve of spreads and the risk-free curve, the result may be similar to applying that technique directly to the risky asset without first determining the spread curve. However, it may be desirable to use a relatively simple method to fit the spread curve (e.g., a linear function).

More complex methods require significant additional data (for example of the underlying capital structure of the issuing entities) and, given their indirect nature and any structural assumptions embedded within the models, are not guaranteed to provide a better fit to underlying bond yields and spreads.

Overall, this approach is not recommended, as it either results in poor fits to market prices, or it does not simplify the process in any way.

5.2.5 Conclusion and Recommendation on Interpolation Method

Non-parametric approaches are not a viable option, and there appears little benefit to using spread approaches. Hence a parametric approach will be required. Given the findings from other authors who have assessed the various parametric approaches, the MLES method appears to be a favourable solution. It also has the benefit of being conceptually similar to the preferred approach used by the RBA to derive the yield curve on Commonwealth Government bonds, although the choice of basis functions differs.

The suggested weighting scheme will be based upon weighted (inverse) duration. This is also the methodology used by Fiera Capital to derive the corporate bond curve in Canada.[28]

The Svensson model also appears relatively popular, and we have examined this model to provide an alternative point of comparison.

Conclusion 6: The Merrill Lynch Exponential Spline (MLES) model is recommended for the interpolation process to derive the best fit for the yield curve out to durations of 10 years.

[27] Refer to zero-coupon interest rates at Reserve Bank of Australia, Statistical Tables. Retrieved 28 April 2015 from http://www.rba.gov.au/statistics/tables/index.html#interest-rates.
[28] Fiera Capital, 2012.

5.3 Extrapolation

5.3.1 Accounting Standard Requirements

AASB 119 provides the following guidance on extrapolation:

> *In some cases, there may be no deep market in bonds with a sufficiently long maturity to match the estimated maturity of all the benefit payments. In such cases, an entity uses current market rates of the appropriate term to discount shorter-term payments, and estimates the discount rate for longer maturities by extrapolating current market rates along the yield curve.*

AASB 119 does not therefore define how extrapolation should be carried out; only that extrapolation is required along the yield curve.

5.3.2 Philosophical Approaches

Any approach to extrapolation of a yield curve is by definition subjective, with no data points to fit to. There are two broad philosophical approaches to extrapolating yield curves:

- Approaches that extrapolate from some observed or fitted market parameters or features at a point in time
- Approaches that emphasise liability stability across time, typically consistent with some long-term macroeconomic reasoning

The advantage of the first approach is that it is simple. The key disadvantage of this approach is that it can be extremely sensitive to the original data fitted, and where liability exposures are extremely long duration (as they are for defined benefit pension liabilities), this can result in significant balance sheet volatility that is arguably artificial in nature and difficult to mitigate or hedge.

To avoid this situation, alternative approaches attempt to dampen this volatility by assuming a constant long-term forward rate, on the basis that whilst it is unobservable from market information, it can be estimated through subjective macroeconomic approaches. This has the benefit of making the liability more stable, reducing balance sheet volatility.

5.3.3 Spreads to Other Yield Curves with Deep Markets

One approach to extrapolate a yield curve for a risky asset is to use a spread function above a related yield curve. Under this approach, a choice needs to be made to the reference yield curve. Options include:

- Commonwealth Government bonds
- Semi-government bonds
- A-rated corporate bonds
- Interest rate swaps
- Overseas bonds

It is worth noting that Canada faces a similar issue to Australia in that it needs to extrapolate a corporate bond yield curve. Based on the Canadian Institute of Actuaries Discount Rate Task Force's analysis and the guidance provided by the Canadian audit firms' Technical Partners Committee, it was concluded that the most appropriate approach for extrapolating the yield curve consistent with current accounting standards was to use Canadian provincial bonds (equivalent to Australian semi-government bonds) of equivalent credit rating with a suitable spread adjustment. The critical reason this was accepted was because this market is very deep beyond 10-year terms (with 71 AA-rated issues of at least $100 million market capitalisation each). As shown in Section 4.1, this is not the case for the Australian semi-government bond market at the current time, which is very thin beyond 10-year terms.

This is in fact the main limitation with using any of the above Australian bond markets as reference points—they are all very thin beyond the 10-year to 15-year terms. Long-term rates will thus be highly dependent upon an extremely small number of securities, potentially as low as one, and therefore may not be representative of the true market price. The Commonwealth Government bond market does extend out to 22 years, but note that there are only three securities beyond 12-year maturities, all of which currently have the lowest amounts of issuance of all Commonwealth Government bonds. Even if this yield curve could be used as a reference point out to 22 years, an extrapolation technique would need to be introduced anyway beyond this point. Hence, this approach is unlikely to achieve any material benefit but may come at additional cost of greater complexity and effort.

Whilst overseas bond markets do have longer durations than 10 years, there is significant added complexity in having to account for the additional country spread risk.

5.3.4 Non-Parametric Approaches

5.3.4.1 Constant Spot Rates

One approach is to assume constant spot rates beyond the last available point. This has the advantage of perhaps being the simplest method to use. The main problem with it is that under certain market conditions, it can lead to noticeable discontinuities in the extrapolated forward rates. This is not a desirable property, as it implies a material change in expectations of future monetary policy (i.e., cash rates) which is extremely difficult to justify, and which could enable arbitrage opportunities to exist in certain circumstances (should the liability be able to be realised in other ways).

5.3.4.2 Constant Forward Rates

When extrapolating yield curves based on forward rates, it is generally assumed that the longest market-observed forward rate remains constant at the unobserved, longer durations. This approach guarantees that forward rates are not discontinuous at the point of extrapolation or beyond, and the spot rates will gradually converge to the last forward rate. Extrapolated forward rates remain fully consistent with the market prices of the asset calibration set. All other sources of pricing information are considered irrelevant.

The main limitation with this approach relates to liabilities that have significant exposure to long-term extrapolated interest rates, such as those relating to defined benefit pension schemes. As the last market forward rate is assumed to continue indefinitely, fluctuations in this single forward rate can dominate changes in the liability. The entire process can potentially and effectively be reduced to determining this single forward rate, as it is the primary assumption affecting liability valuation. In this case, the interpolation method and robustness of market prices at the last observable maturity become even more critical. In extreme cases, very low (e.g., zero or negative) or extremely high long-term forward rates could be inferred from the observable data and extrapolated indefinitely into the future.

5.3.4.3 Modified and Ultimate Unconditional Forward Rates

To address the above issue, some actuaries use moving-average forward rates rather than relying solely on one year's forward rate. When using a moving average, consideration should be given to both volatility and consistency with observed/interpolated rates. A longer moving-average period will reduce volatility of the method, but will be less consistent with observed/interpolated forward rates. On the other hand, a shorter moving-average period will result in improved consistency, but the method may be quite volatile.

There may also be additional sources of information which will influence long term interest rate expectations, including:

- The last observable forward rates on Commonwealth Government bonds and interest rate swaps, both of which can be readily sourced from public information
- Economic views
- Expectations on demand-supply imbalances that may exist at long durations

It would be possible to use any or a combination of the above information sources along with a function to blend the last observable forward rate to an ultimate long-term forward rate. The downside to these approaches is that they become increasingly subjective.

One approach that is becoming popular is to derive an unconditional forward rate (UFR), based upon a subjective macro-economic view. This is the approach used for the valuation of long-term insurance liabilities in the European Union. Solvency II uses a technique that determines a very long-term fixed interest rate and interpolates between this and the liquid part of the curve. The justification for this approach is that the valuation of technical provisions and the solvency position of an insurer should not be heavily distorted by strong fluctuations in short-term observed interest rates. Thus a greater emphasis is placed on long-term stability. This is particularly important for currencies where liquid reference rates are only available for short-term maturities and simple extrapolation of these short-term interest rates may cause excessive volatility. A similar argument could be made with respect to long-term defined benefit pension liabilities.

The UFR is not conditional upon any capital market variables subject to short-term market variability. The rate should be relatively stable over time and subject to change only due to fundamental changes in long-term expectations. Macroeconomic methods are used to do this. The components of the ultimate long-term forward rate are:

- Expected real short-term cash rate
- Long-term expected inflation
- Long-term duration premium, which includes the following:
    - A risk premium that compensates investors for bearing capital risk
    - The impact of demand-supply imbalances for long-term securities, primarily reflecting strong institutional demand in order to match long-term insurance and pension liabilities
    - Convexity effects

The following figure provides an example of the assumptions used for the European Union under Solvency II, and those used recently for Australia by Mulquiney et al. (2013), as well as the view of Milliman's authors:

Component	EU Solvency II	Australia (Mulquiney)	Australia (Milliman)
Expected real short term cash rate	2.2%	2.0%	2.2%
Long term expected Inflation	2.0%	2.5%	2.5%
Long term duration premium	0.0%	1.3%	0.0%
UUFR – Risk Free	4.2%	5.8%	4.7%
Credit Spread (AAA+AA)			1.0%
UUFR – AAA+AA Corporate Bonds			5.7%

Figure 73: Ultimate unconditional forward rates for risk free bonds in EU and Australia. Sources: CEIOPS, Mulquiney et al. (2013) and Milliman.

Our assumptions are based upon the following logic. Risk-free rates should converge to a common rate globally, which capital flows will encourage, as reflected under Solvency II as the 2.2% figure. Long-term inflation is at the midpoint of the RBA's long-term inflation target of 2% to 3%. Duration premiums have structurally declined and are expected to continue to do so as the weight of demand from an increasing pool of defined contribution retirement assets creates demand-supply imbalances in long-term debt as they seek to match long-term retirement liabilities. Hence, we agree with the Solvency II approach. A rough estimate of an average AAA + AA credit spread would be around 1%.

Once the UFR has been defined, a method for transitioning from the last available forward rate to it needs to be determined. There are a few choices here:

- Linear interpolation
- The Smith-Wilson technique, which is used for Solvency II
- Other parametric techniques, such as MLES, Nelson-Seigel, Svensson or splines

Mulquiney et al., 2013, conclude that for the Australian Commonwealth Government bond market, a linear interpolation path is plausible although other paths are also possible.

A residual consideration is the speed at which the curve converges to the ultimate forward rate. This impacts the stability of the curve over time. The quicker the convergence, the more stable the illiquid long duration part of the yield curve is. The slower the convergence, the more sensitive illiquid long-duration yields will be to changes in market conditions. Examples of convergence durations include:

- CEIOPS (2010) used a convergence duration of 90 years.
- From an analysis of US, UK and Canadian government bond yield curves, Mulquiney et all, 2013, conclude that a convergence duration of 60 years appears reasonable, although a range of anywhere between 40 and 100 years could also be justified. They also conclude that a relatively slow convergence speed is supported from a back-testing of an interest rate hedging strategy against long-term AUD liabilities.

For some parametric techniques, the speed of convergence to the UFR is implicitly set by the choice of basis functions and the parameters resulting from the fit to observed yields. For others, an explicit assumption is possible.

The following figure provides an illustration of the differences between the three non-parametric approaches, including linear convergence to an unconditional forward rate at 60 years:

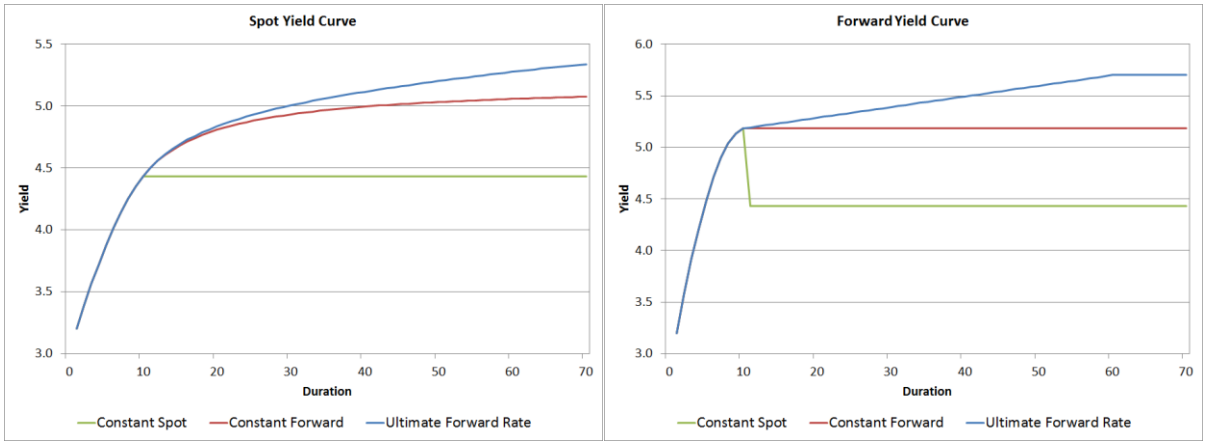


Figure 74: Comparison of spot (left) and forward (right) yield curves under the three non-parametric extrapolation methods.

Note that the above curves are illustrative only. Their relativities are entirely dependent upon both variable market conditions and the UFR assumptions made. In this example, a discontinuity in the forward rates is exhibited under the constant spot rate methodology.

5.3.5 Parametric Approaches

5.3.5.1 Smith-Wilson

The Smith-Wilson method is a hybrid interpolation and extrapolation methodology. It takes as its input:

- A yield curve, assumed to be fully defined up to the last liquid point (LLP)
- An unconditional forward rate (UFR) to which forward rates converge at long durations (past the LLP)

Before the LLP, there are assumed to be a number of durations at which the forward rates are specified. The Smith-Wilson approach uses these forward rates at the specified durations and provides a formula for calculating forward rates at other durations. With a large number of bond prices as inputs, the Smith-Wilson method does not give a robust method for smoothing out the variation in yield due to different bonds.

Under the Smith-Wilson method, the key parameter determining the speed of convergence is called α. The value of α is ultimately dependent upon expert judgement. CEIOPS took the approach of setting α to 0.1

assuming this led to adequate convergence—if adequate convergence is not obtained, α is increased in steps sequentially until convergence is reached.

CEIOPS (2010) state the advantages of the Smith–Wilson approach as including:

- The yield curve is stable and robust.
- It reflects market conditions as well as long-term economic views.
- It gives relatively smooth extrapolated forward and spot rates in the extrapolated part of the curve.

However, some industry commentators have criticised the Smith-Wilson approach, such as Kocken et al., 2012. Typical criticisms include:

- With a large number of bond prices as inputs, the Smith-Wilson method does not give a robust method for smoothing out the variation in yield due to different bonds.
- It is very hard to achieve robust asset-liability matching under the Smith-Wilson method.
- The method can, in certain circumstances, lead to negative forward rates in the extrapolated portion of the curve, which is undesirable.

Considering the above limitations, the Smith-Wilson method is not recommended for deriving and extrapolating discount rates for the purposes of this paper.

5.3.5.2 MLES, Nelson-Seigel and Svennson

As noted in Section 5.2.3.4, the MLES interpolation method also defines an extrapolated curve, which converges to the input UFR assumption.

In the case of MLES, the speed of convergence is determined implicitly by the choice of basis functions and the fit of data. Additional basis functions and penalty parameters can be used to control the speed of this convergence.

In the case of Nelson-Seigel or Svennson, parameters can be reserved to explicitly determine the effective speed of convergence from the last available market maturity to the UFR, although using the parameter in this way reduces the freedom of the model to fit to observed yields. Alternatively, the parameter can remain free to better fit observed yields.

5.3.6 Conclusions and Recommendations

The constant forward rate and parametric ultimate forward rate methods are the primary extrapolation methods that could be justified. The choice between these is dependent largely upon whether consistency with observed rates at a point in time or liability stability across time is more important. Note that both methods are entirely consistent with observable market prices—each of the extrapolation methods discussed only applies to maturities beyond the last available data observation.

Given the focus on market consistency of the accounting standards and the entire lack of subjective assumptions required, the constant forward rate methodology is recommended for extrapolation purposes.

Thus:

Conclusion 7: The constant forward rate method from the last market data point is recommended for the extrapolation process.

6 ANALYTIC RESULTS

6.1 Asset Calibration Set

The following asset calibration sets have been analysed, based upon those as defined in Section 4.1:

- Commonwealth Government bonds
- Semi-government bonds
- Commonwealth plus semi-government bonds
- AAA-rated corporate bonds, covering both domestic and foreign (kangaroo) issuers
- AA-rated corporate bonds, covering both domestic and foreign (kangaroo) issuers
- AA + AAA-rated corporate bonds, covering both domestic and foreign (kangaroo) issuers.

These data sets have been analysed using market data as at 26 November 2014.

6.2 Example Calculations

6.2.1 Interpolation

Two alternative interpolation approaches have been investigated. These include the MLES and Svensson models. For the MLES method, 9 fitting functions were used. Both of these models have been calibrated to data as at 26 November 2014 on both unweighted and inverse duration weighted bases.

For each dataset, weighting and interpolation methodology, we looked at the goodness of fit, as measured by the adjusted R-squared statistic applied to the difference between modelled and actual bond prices.

An adjusted R-squared statistic value close to 100% indicates a very good fit, whilst lower values (closer to 0%) indicate poor fits. The following figure shows the results of the interpolation analysis across the various data sets:

	Svensson		MLES	
	Unweighted	Inverse Duration Weight	Unweighted	Inverse Duration Weight
Comm govt	99.8%	99.95%	99.95%	99.9%
Semi-govt	99.3%	99.3%	99.2%	99.2%
Comm + semi-govt	96.8%	96.7%	96.6%	96.6%
AAA corporates	91.5%	91.3%	85.1%	84.1%
AA corporates	93.3%	93.3%	92.7%	92.6%
AAA+AA corporates	91.8%	91.6%	91.5%	91.5%

Figure 75: Comparison of Svensson and MLES interpolation models using goodness of fit adjusted R-squared results on prices across various asset calibration sets and two weighting methodologies.

It is apparent that both methods achieved very good results across the data sets, with no statistically-significant difference present between them. There are also no statistically-significant differences in the results between the two weighting methods. Hence, preferences for weighting can rest on theoretical considerations, with the inverse duration method considered more robust against pricing errors.

Not surprisingly, R-squared results are extremely good (>98%) for AAA rated bonds, both Commonwealth Government and semi-government. Whilst still considered a very good result in absolute terms, AAA-rated corporate bonds were marginally below the AA-rated bonds. The reason for this is due to the very small pool of AAA corporate securities.

The figure below shows the modelled yield-to-maturity for each bond in the AAA + AA corporate bond data set, compared to the actual yield-to-maturity, using the MLES method with inverse duration weightings. Note that these are the same bonds as those discussed and analysed in Section 4.1.

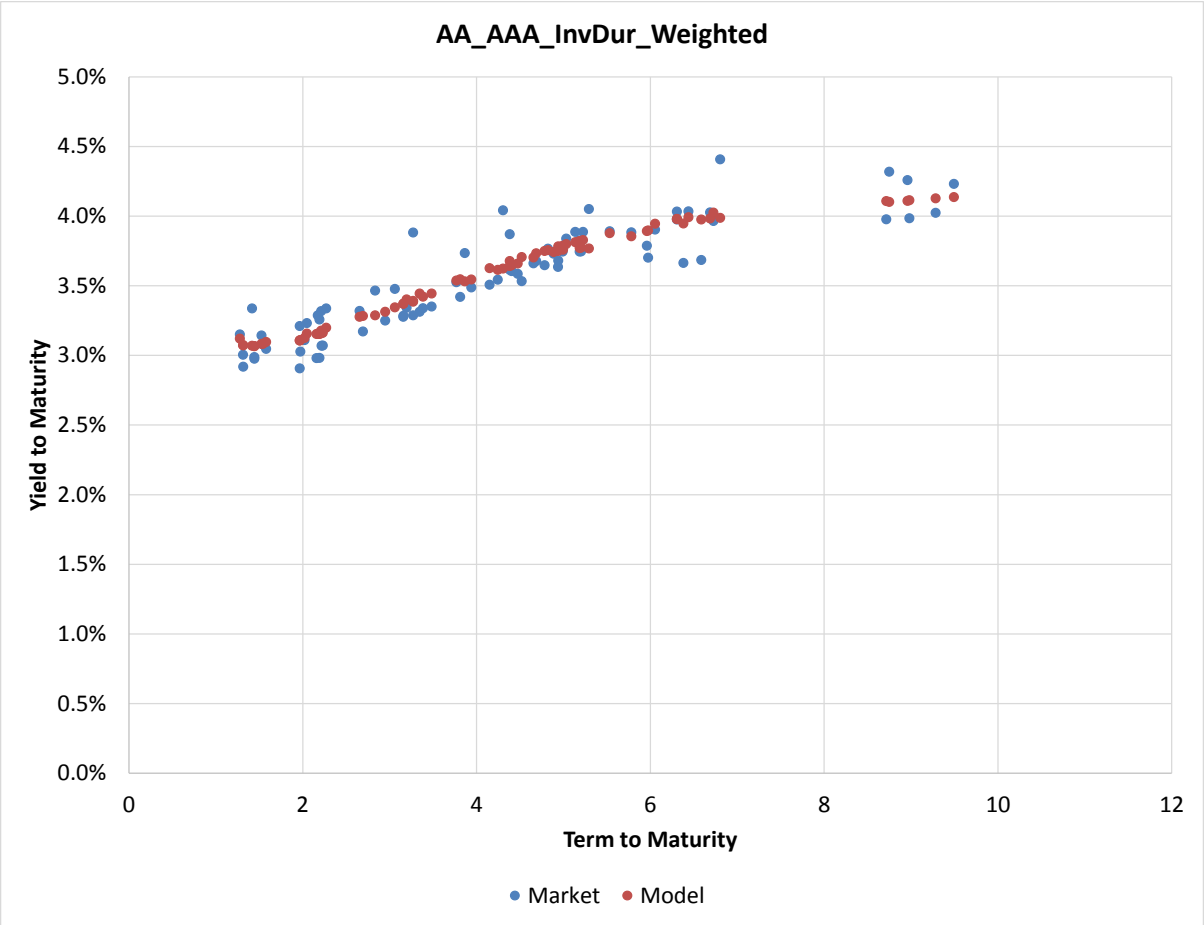


Figure 76: Modelled (red) versus market (blue) yields to maturity for AAA and AA corporate bonds using the MLES method with inverse duration weightings.

The bond values with lower yields are typically AAA-rated; and those with higher yields are typically AA-rated. This is borne out by the equivalent graphs for AAA-rated corporates and AA-rated corporates fitted separately, as shown in the following figures:

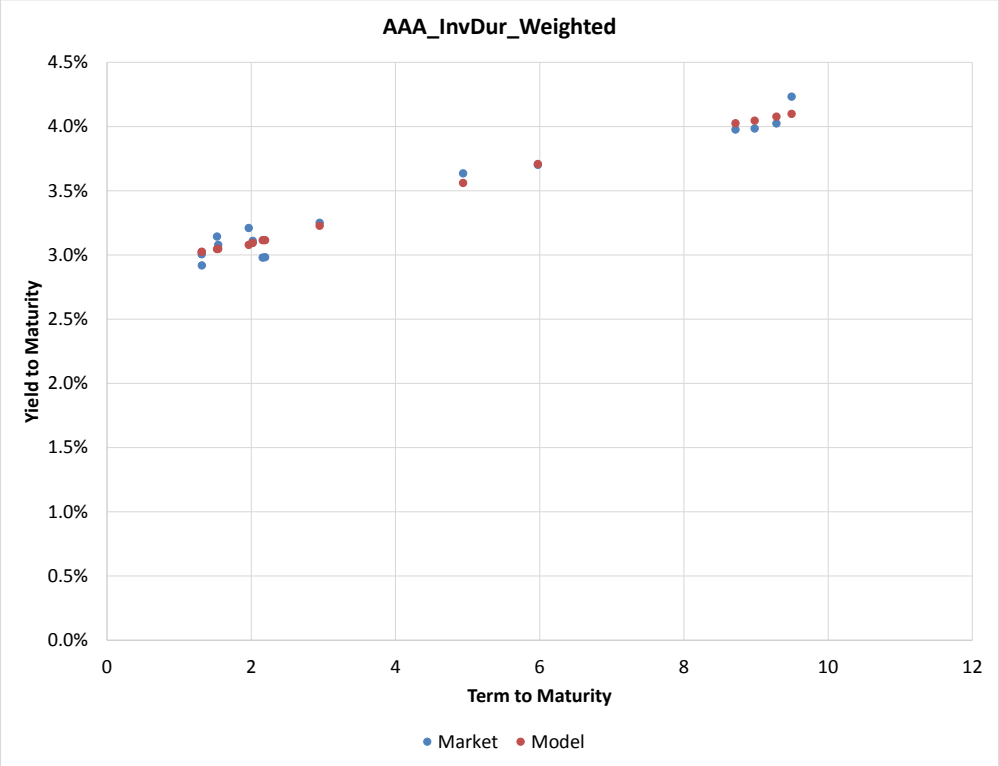


Figure 77: Modelled (red) versus market (blue) yields to maturity for AAA corporate bonds using the MLES method with inverse duration weightings.

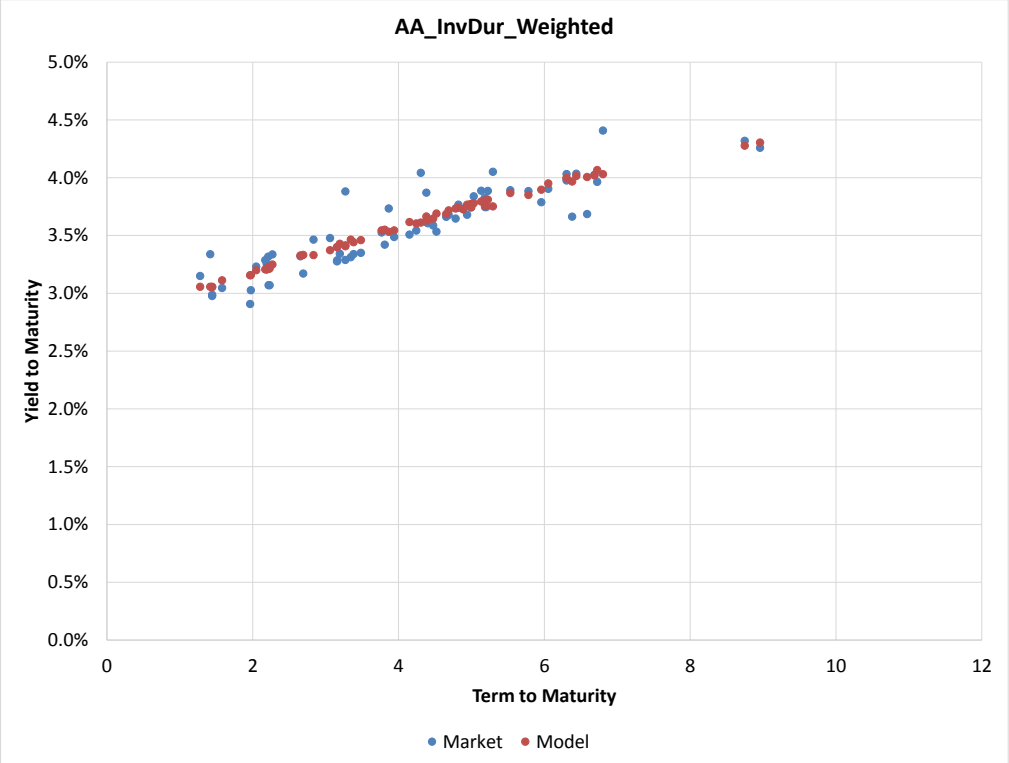


Figure 78: Modelled (red) versus market (blue) yields to maturity for AA corporate bonds using the MLES method with inverse duration weightings.

It is clear from the above that more satisfactory fits are achieved on the individual data sets than on the combined one, although the small number of AAA bonds limits the impact of this. This is expected from fitting a single curve to a heterogeneous calibration set. One possible alternative method that could be used would be to derive the yield curves separately for AAA and AA corporate bonds, and then calculate a weighted average curve using some defined basis such as the total market level notional amounts outstanding as the weights. This would have the benefit of making the individual interpolation results more robust, although it would introduce an additional weighting variable that may be theoretically unrelated to the time value of money. It may also introduce additional roughness (i.e., less smoothness and more inflection points) into the resulting yield curve. Given the lack of AAA bonds in the calibration set, such a method is largely infeasible at this time.

The following figure shows the resulting spot and forward yield curves for the three corporate bonds' calibration sets using the MLES method:

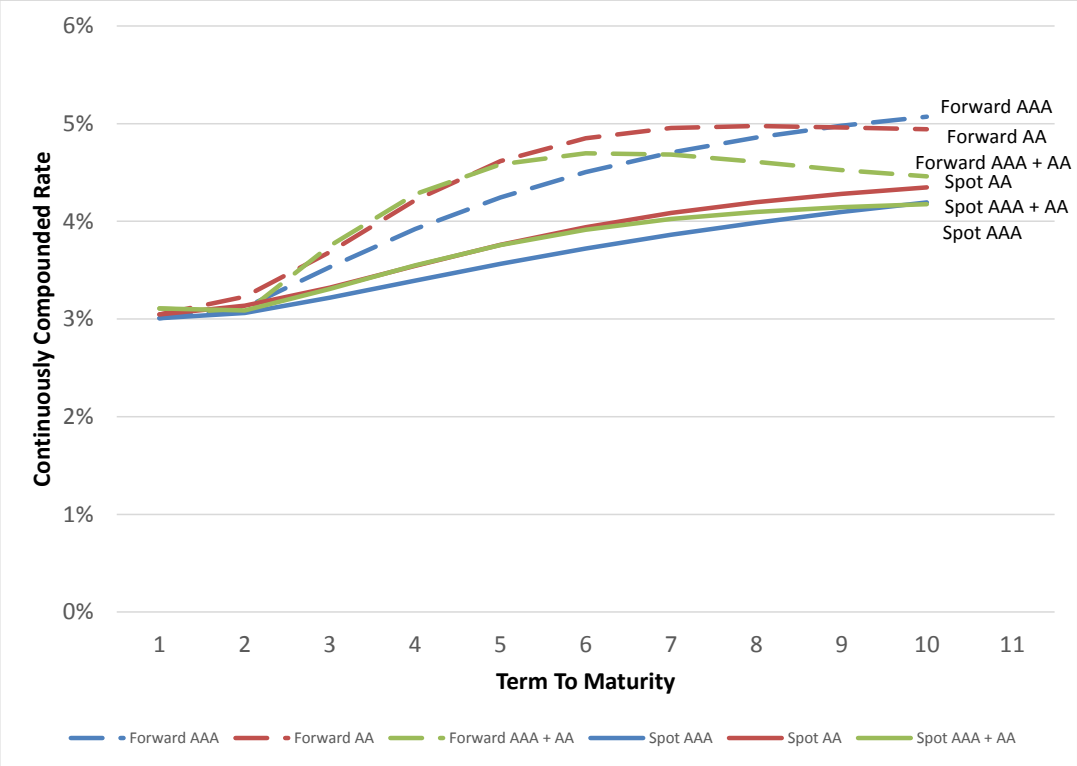


Figure 79: Modelled spot and forward yield curves for AAA, AA and AAA + AA corporate bond data sets using the MLES method with inverse duration weighting, by term to maturity.

One of the interesting features of the above results is that on the calibration date selected, the combined AAA+AA 10-year forward rate is below both of these rates. This is an important result given the sensitivity of constant forward rate extrapolation to the last available 10-year forward rate. This feature is not methodology specific, with the same results being evident using the Svensson method as shown in the following figure:

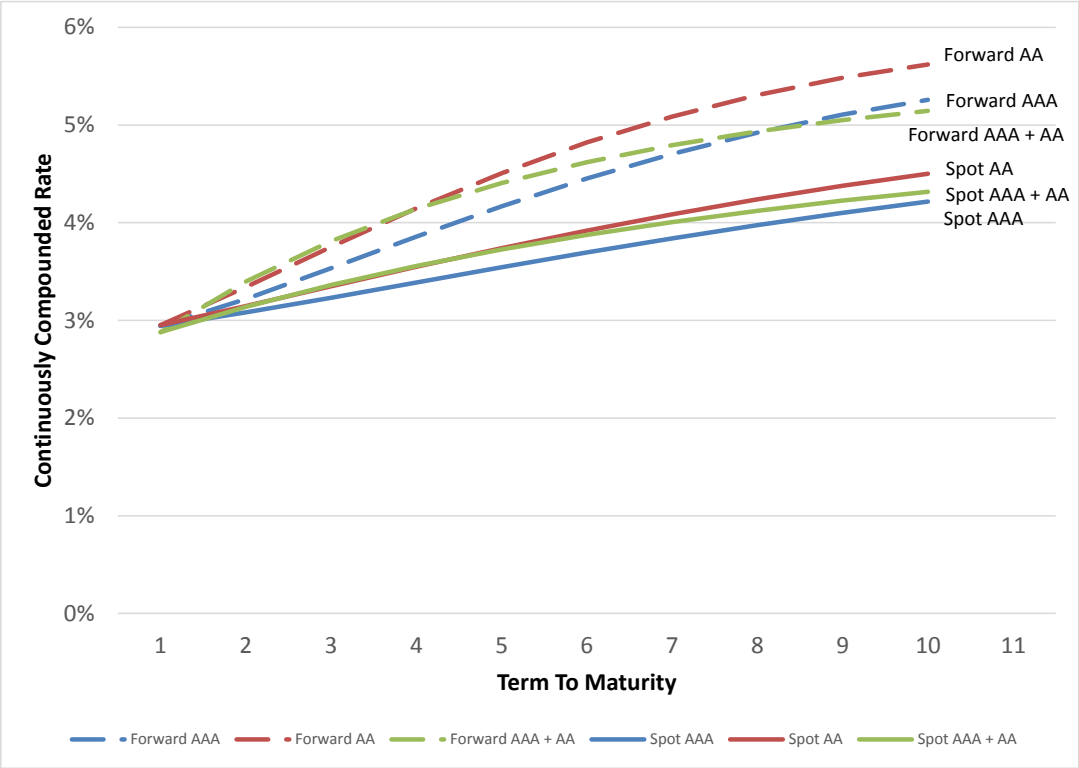


Figure 80: Modelled spot and forward yield curves for AAA, AA and AAA+AA corporate bond data sets using the Svensson method with inverse duration weightings, by term to maturity.

The MLES method tested provides some additional freedom over the Svensson method to adjust the shape of the curve at the short end, due to the additional parameters available within the model. This is a minor benefit, and there appears to be little evidence to separate the two techniques based upon the calibration results shown. Hence it is suggested that other considerations should play the dominant role in deciding which of these methodologies is appropriate. Given the conclusions of Section 5.3, we recommend the use of the MLES method. We also recommend weighting by inverse duration, since there are no material differences between goodness of fit between the alternatives, and this will theoretically lower the impact of any pricing errors.

6.2.2 Extrapolation

Based upon the MLES calibration results for the AAA + AA corporate bond asset calibration set, the following figures show the spot and forward yield curves under the three of the extrapolation methods discussed in Section 5.4, based upon market data as at 26 November 2014. The three methods shown are constant spot rates, constant forward rates and extrapolation to an assumed UFR using the MLES functional form and fitted parameters.

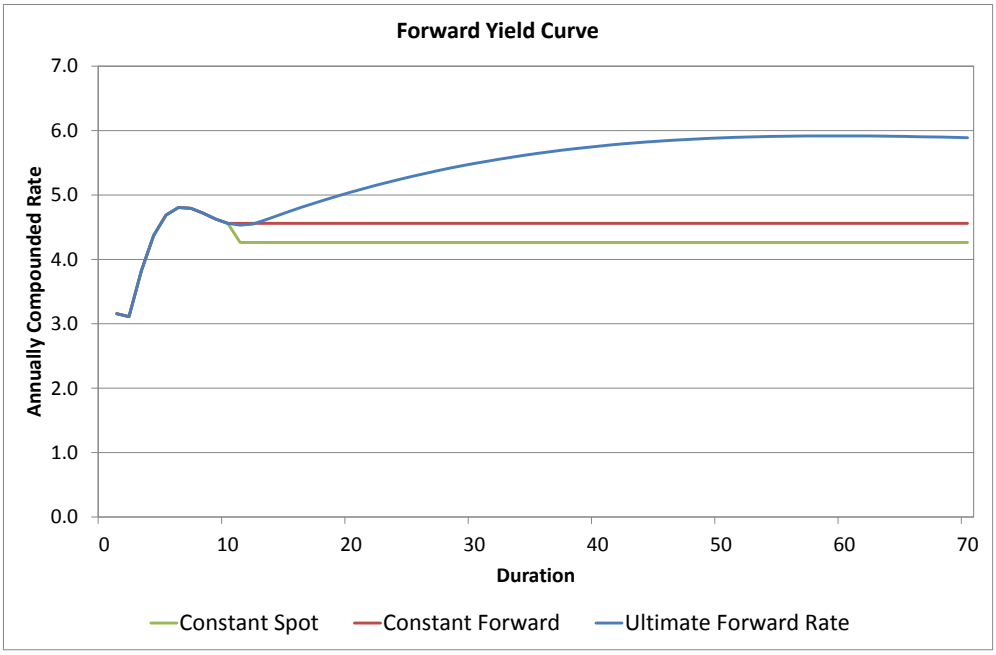


Figure 81: MLES forward yield curves for AAA+AA corporate bonds by extrapolation method.

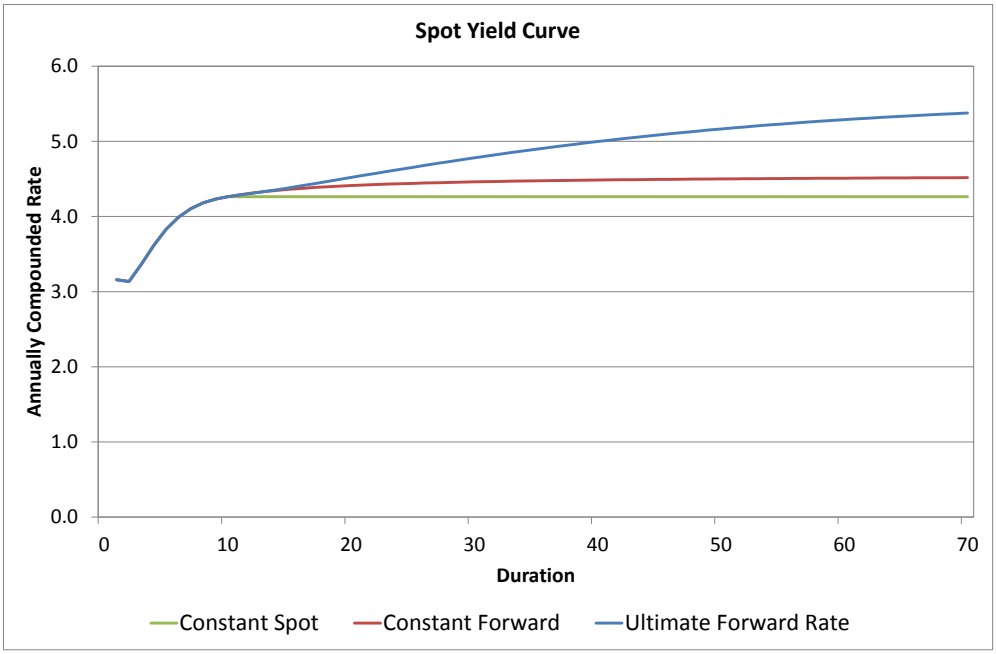


Figure 82: MLES spot yield curves for AAA+AA corporate bonds by extrapolation method.

Note that the relativities between the various approaches are entirely dependent upon changeable market conditions and the UFR assumptions. Note also the discontinuity in the forward rates under the constant spot rate methodology.

The final figures show the full spot and forward yield curves under the recommended MLES interpolation and constant forward rate extrapolation methodology in both graphical and tabular forms:

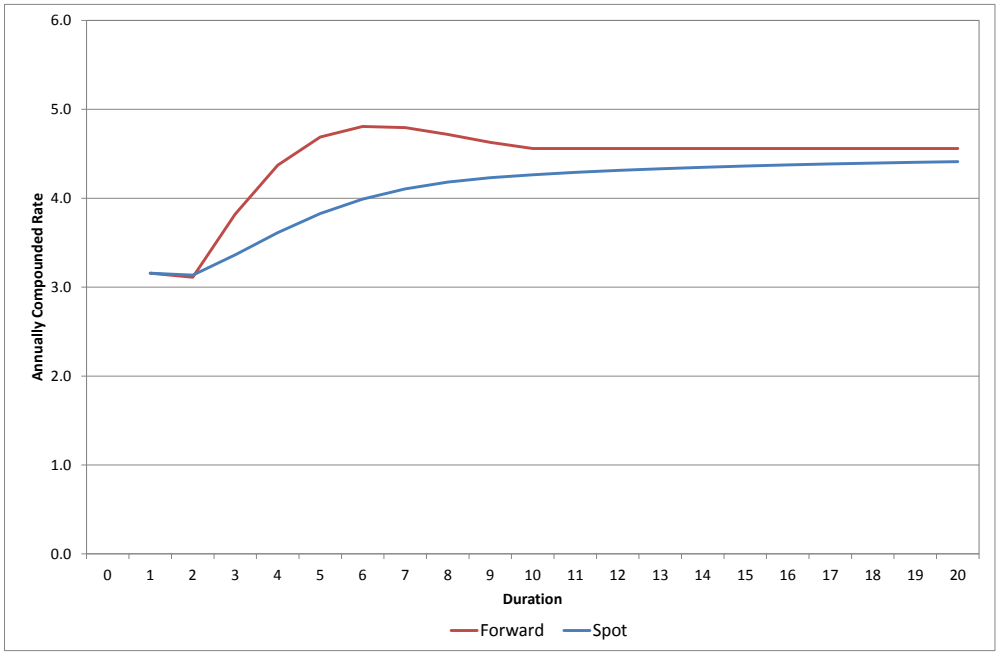


Figure 83: Spot and forward yield curves for AAA + AA corporate bonds using an MLES interpolation and constant forward rate extrapolation method.

Duration	Spot	Forward	Duration	Spot	Forward
1	3.16	3.16	**11**	4.29	4.56
2	3.13	3.11	**12**	4.31	4.56
3	3.36	3.82	**13**	4.33	4.56
4	3.61	4.37	**14**	4.35	4.56
5	3.83	4.69	**15**	4.36	4.56
6	3.99	4.81	**16**	4.37	4.56
7	4.10	4.79	**17**	4.39	4.56
8	4.18	4.72	**18**	4.40	4.56
9	4.23	4.63	**19**	4.40	4.56
10	4.26	4.56	**20**	4.41	4.56

Figure 84: Spot and forward yield curves for AAA + AA corporate bonds using an MLES interpolation and constant forward rate extrapolation method

Thus from this analysis we can conclude:

Conclusion 8: The MLES and constant forward rate methods result in suitable yield curves for AASB 119 discounting rate purposes, with sufficiently accurate calibration results for current market conditions.

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8 APPENDIX A: INTERNATIONAL GOVERNMENT BOND MARKETS

United States

The total debt outstanding is USD 18 trillion, of which USD 12 trillion is tradable by the public. The remainder is either intergovernmental holdings or a relatively small amount of non-tradable public debt. The following figure shows the distribution of publicly held government debt in the United States:

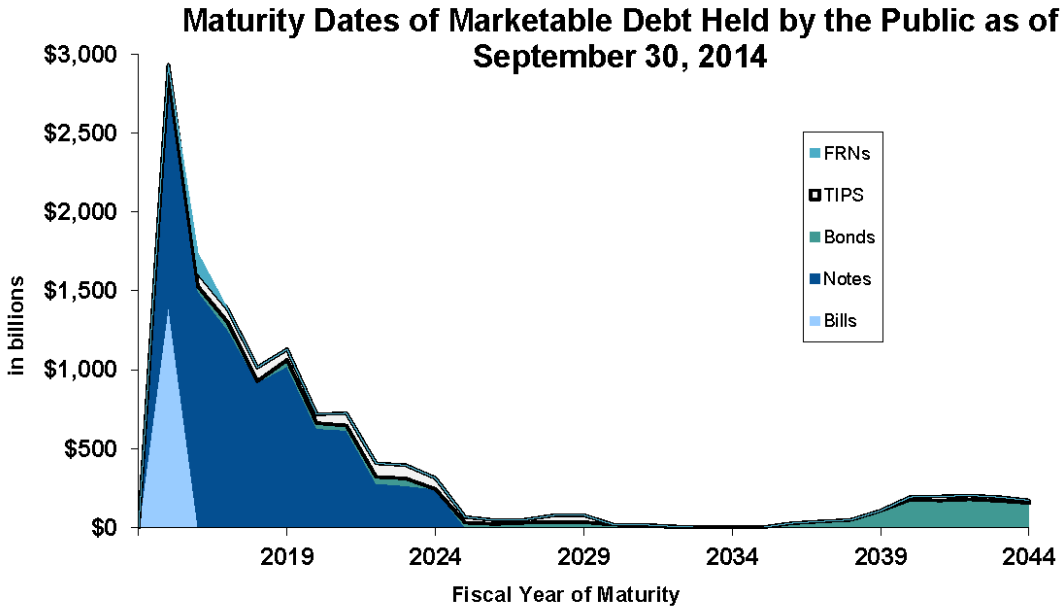

Figure 85: US government debt held by the public.
Source: U.S. Government Accountability Office (November 2014), Financial Audit: Bureau of the Fiscal Service's Fiscal Years 2014 and 2013 Schedules of Federal Debt. Retrieved 28 April 2015 from http://www.treasurydirect.gov/govt/reports/pd/feddebt/feddebt_ann2014.pdf.

United Kingdom

The following figure shows the distribution of the conventional gilts (i.e. excluding IL gilts and undated gilts) outstanding debt by maturity year:

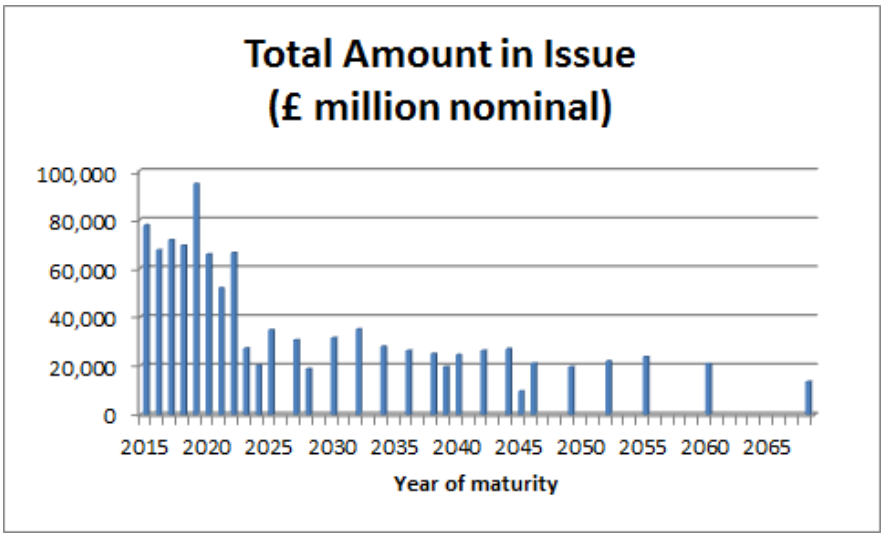

Figure 86: UK total outstanding issuance of conventional gilts by maturity year. Source: UK Debt Management Office.

The following table has been extracted from the London Stock Exchange data to show the distribution of debt issued by the UK government:

Maturity date	Security Name	Money Raised (£m)	Maturity date	Security Description	Money Raised (£m)
22-Jan-15	2.75% GILT 22/01/15	£ 28,215	7-Sep-24	2.75% GILT 07/09/24	£ 17,212
7-Sep-15	4.75% GILT 07/09/15	£ 34,956	7-Mar-25	5% GILT 2025	£ 26,344
7-Dec-15	8% GILT 2015	£ 1,623	7-Dec-27	4.25% GILT 7/12/2027	£ 22,333
22-Jan-16	2% GILT 22/01/16	£ 31,200	7-Dec-28	6% GILT 2028	£ 13,638
7-Sep-16	4% GILT 7/09/2016	£ 30,297	7-Dec-30	4.75% GILT 07/12/30	£ 28,653
22-Jan-17	1.75% GILT 22/1/17	£ 72,224	7-Jun-32	4.25% GILT 07/06/2032	£ 14,955
25-Aug-17	8 3/4% GILT 2017	£ 728	7-Sep-34	4.5% GILT 7/9/2034	£ 45,567
7-Sep-17	1% GILT 7/9/2017	£ 26,951	7-Mar-36	4.25% GILT 07/03/36	£ 20,568
7-Mar-18	5% GILT 07/03/18	£ 29,398	7-Dec-38	4.75% GILT 07/12/38	£ 17,989
22-Jul-18	1.25% GILT 22/7/18	£ 73,998	7-Sep-39	4.25% GILT 7/9/39	£ 18,795
7-Mar-19	4.5% GILT 07/03/2019	£ 36,990	7-Dec-40	4.25% GILT 07/12/40	£ 8,844
22-Jul-19	1.75% GILT 22/07/19	£ 29,913	7-Dec-42	4.5% GILT 7/12/42	£ 23,748
7-Sep-19	3.75% GILT 07/09/19	£ 30,761	22-Jan-44	3.25% GILT 22/01/44	£ 44,079
7-Mar-20	4.75% GILT 2020	£ 30,440	22-Jan-45	3.5% GILT 22/01/45	£ 5,107
22-Jul-20	2% GILT 22/07/20	£ 8,608	7-Dec-46	4.25% GILT 7/12/46	£ 16,616
7-Sep-20	3.75% GILT 7/9/20	£ 20,364	7-Dec-49	4.25% GILT 07/12/49	£ 17,022
7-Jun-21	8% GILT 2021	£ 1,512	22-Jul-52	3.75% GILT 22/07/52	£ 5,945
7-Sep-21	3.75% GILT 07/09/21	£ 29,022	7-Dec-55	4.25% GILT 07/12/55	£ 18,238
7-Mar-22	4% GILT 07/03/22	£ 38,533	22-Jan-60	4% GILT 22/01/60	£ 4,421
7-Sep-22	1.75% GILT 07/09/22	£ 56,071	22-Jul-68	3.5% GILT 22/07/68	£ 9,140
7-Sep-23	2.25% GILT 07/09/23	£ 22,376	Total issued debt		£ 1,013,392

Figure 87: UK total outstanding issuance of conventional gilts by maturity date. Source: London Stock Exchange.

Canada

The following figure shows the maturity distribution of outstanding government bonds:

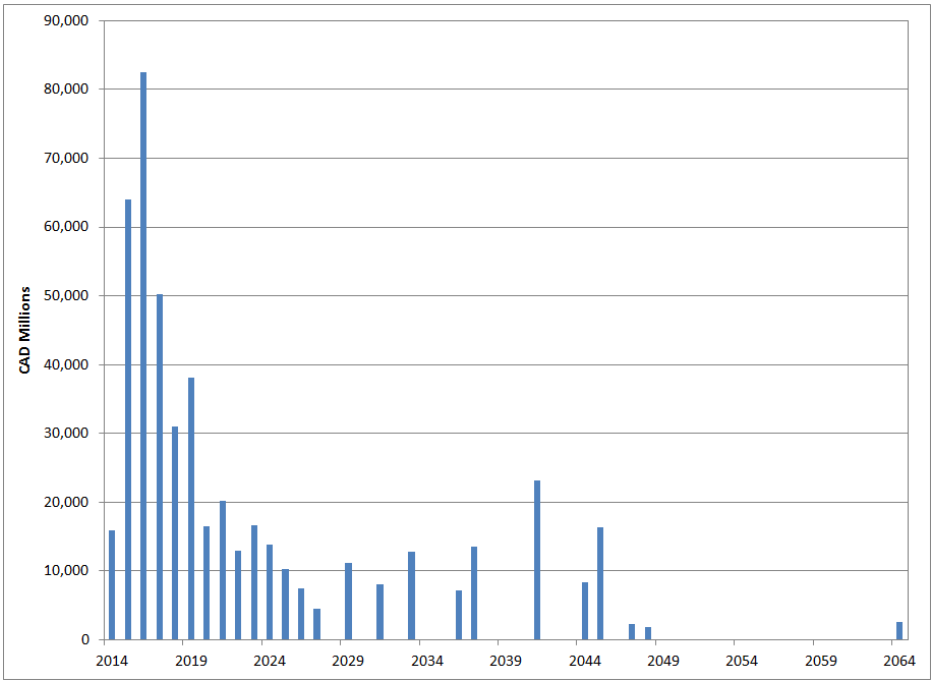

Figure 88: Maturity profile of the Canadian government bond market (Outstanding in CAD Millions). Source: Bank of Canada.

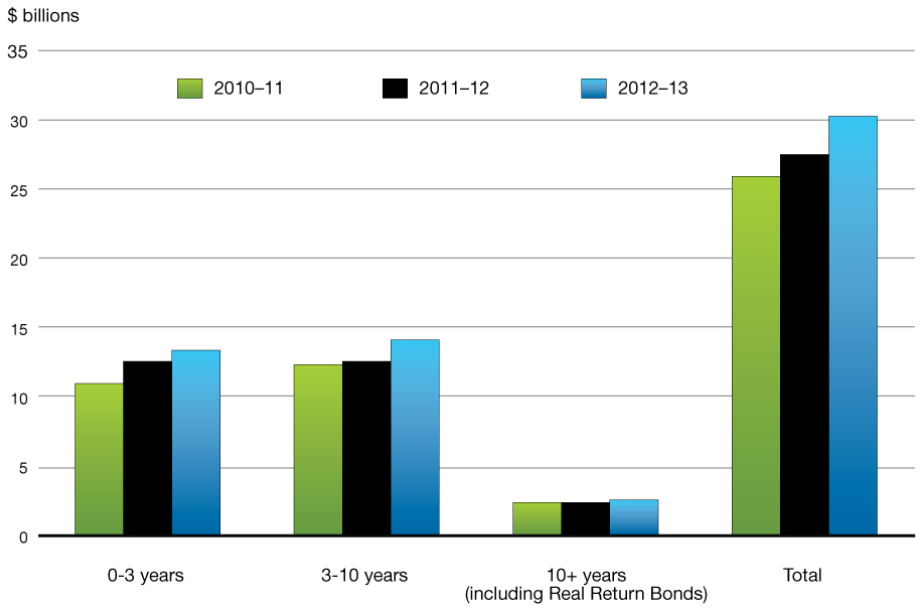

Figure 89: Canadian government bond market turnover (CAD billions). Source: Canadian Department of Finance.

The Canadian Department of Finance also produces a comparison of the liquidity ratio (turnover/outstanding) of government debt to other major markets, as shown in the following figure:

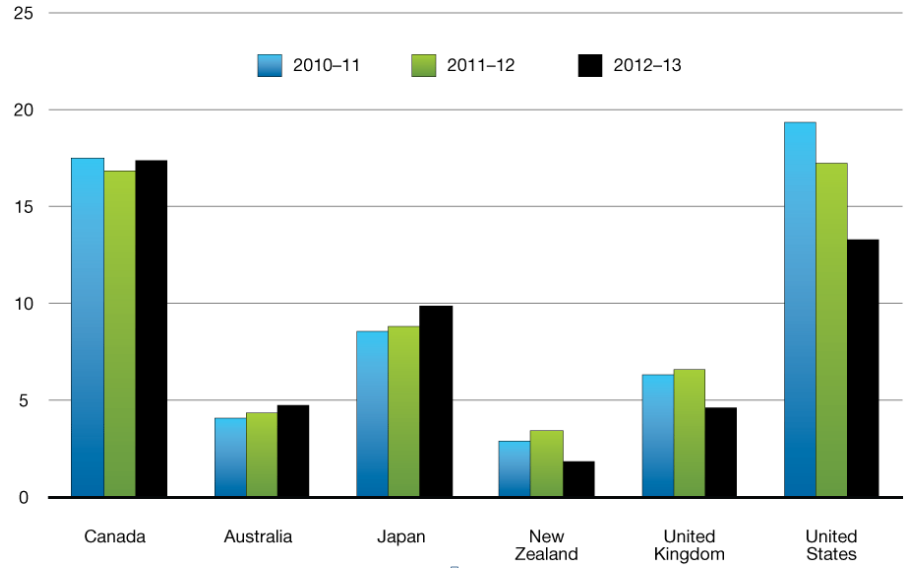

Figure 90: Canadian government bond market liquidity ratios (turnover / outstanding) for various countries. Source: Canadian Department of Finance.

Germany

German government bonds are shown in the following table:

Type of Security	Coupon	Maturity Date	9/30/2014	Type of Security	Coupon	Maturity Date	9/30/2014
30-Year Federal Bonds	2.500	15/08/2046	7,000,000,000	**10-Year Federal Bonds**	2.250	04/09/2021	16,000,000,000
30-Year Federal Bonds	2.500	04/07/2044	16,000,000,000	**10-Year Federal Bonds**	3.250	04/07/2021	19,000,000,000
30-Year Federal Bonds	3.250	04/07/2042	15,000,000,000	**10-Year Federal Bonds**	2.500	04/01/2021	19,000,000,000
30-Year Federal Bonds	4.750	04/07/2040	16,000,000,000	**10-Year Federal Bonds**	2.250	04/09/2020	16,000,000,000
30-Year Federal Bonds	4.250	04/07/2039	14,000,000,000	**10-Year Federal Bonds**	3.000	04/07/2020	22,000,000,000
30-Year Federal Bonds	4.000	04/01/2037	23,000,000,000	**10-Year Federal Bonds**	3.250	04/01/2020	22,000,000,000
30-Year Federal Bonds	4.750	04/07/2034	20,000,000,000	**10-Year Federal Bonds**	3.500	04/07/2019	24,000,000,000
30-Year Federal Bonds	5.500	04/01/2031	17,000,000,000	**10-Year Federal Bonds**	3.750	04/01/2019	24,000,000,000
30-Year Federal Bonds	6.250	04/01/2030	9,250,000,000	**10-Year Federal Bonds**	4.250	04/07/2018	21,000,000,000
30-Year Federal Bonds	4.750	04/07/2028	11,250,000,000	**10-Year Federal Bonds**	4.00	04/01/2018	20,000,000,000
30-Year Federal Bonds	5.625	04/01/2028	14,500,000,000	**10-Year Federal Bonds**	4.250	04/07/2017	19,000,000,000
30-Year Federal Bonds	6.500	04/07/2027	11,250,000,000	**10-Year Federal Bonds**	3.750	04/01/2017	20,000,000,000
10-Year Federal Bonds	1.000	15/08/2024	14,000,000,000	**30-Year Federal Bonds**	5.625	20/09/2016	750,000,000
10-Year Federal Bonds	1.500	15/05/2024	18,000,000,000	**10-Year Federal Bonds**	4.000	04/07/2016	23,000,000,000
10-Year Federal Bonds	1.750	15/02/2024	18,000,000,000	**30-Year Federal Bonds**	6.000	20/06/2016	3,750,000,000
30-Year Federal Bonds	6.250	04/01/2024	10,250,000,000	**Federal Treasury Notes**	0.250	10/06/2016	13,000,000,000
10-Year Federal Bonds	2.000	15/08/2023	18,000,000,000	**Federal Treasury Notes**	0.250	11/03/2016	13,000,000,000
10-Year Federal Bonds	1.500	15/05/2023	18,000,000,000	**10-Year Federal Bonds**	3.500	04/01/2016	23,000,000,000
10-Year Federal Bonds	1.500	15/02/2023	18,000,000,000	**Federal Treasury Notes**	0.250	11/09/2015	15,000,000,000
10-Year Federal Bonds	1.500	04/09/2022	18,000,000,000	**10-Year Federal Bonds**	3.250	04/07/2015	21,000,000,000
10-Year Federal Bonds	1.750	04/07/2022	24,000,000,000	**Federal Treasury Notes**	0.250	13/03/2015	15,000,000,000
10-Year Federal Bonds	2.000	04/01/2022	20,000,000,000	**10-Year Federal Bonds**	3.750	04/01/2015	23,000,000,000
Total issuance of Federal Bonds							743,000,000,000

Figure 91: German government debt (EUR). Source: German Finance Agency, http://www.deutsche-finanzagentur.de/fileadmin/user_upload/institutionelle-investoren/pdf/Einzelaufstellung_Bundeswertpapiere_en.pdf

Sweden

The characteristics of the government bond market are shown in the following figure:

Name	Coupon (%)	Maturity date	Duration (years)	Outstanding (SEK)	Annual Turnover to 31 Oct 2014 (SEK m)	Liquidity Ratio
RGKB 1049	4.5	12/08/2015	0	72	442	6.1
RGKB 1050	3	12/07/2016	1	53	811	15.2
RGKB 1051	3.75	12/08/2017	2	66	207	3.1
RGKB 1052	4.25	12/03/2019	4	89	974	10.9
RGKB 1047	5	01/12/2020	6	77	154	2.0
RGKB 1054	3.5	01/06/2022	7	66	83	1.3
RGKB 1057	1.5	13/11/2023	8	60	511	8.5
RGKB 1058	2.5	12/05/2025	10	51	301	6.0
RGKB 1056	2.25	01/06/2032	17	11	8	0.7
RGKB 1053	3.5	30/03/2039	24	44	27	0.6
Total				589	3,519	6.0

Figure 92: The Swedish government bond market characteristics (SEK billions). Source: Nasdaq Nordic.

Norway

Norwegian government debt is shown in the following table:

Ticker	Issuer(s)	Maturity Date	Outstanding (NOK Millions)
NST25	DEN NORSKE STAT	17.12.14	20,000
NST26	DEN NORSKE STAT	18.03.15	23,000
NST27	DEN NORSKE STAT	17.06.15	22,000
NST28	DEN NORSKE STAT	16.09.15	25,000
NST471	DEN NORSKE STAT	15.05.15	59,919
NST472	DEN NORSKE STAT	19.05.17	65,737
NST473	DEN NORSKE STAT	22.05.19	61,000
NST474	DEN NORSKE STAT	25.05.21	63,000
NST475	DEN NORSKE STAT	24.05.23	47,000
NST476	DEN NORSKE STAT	14.03.24	45,000

Figure 93: Norwegian government debt. Source: Oslo Bors

Japan

The Ministry of Finance in Japan publishes the following table on a quarterly basis. As at the end of September 2014 government debt was over JPY 1,000 trillion.

Category			Yen 100 Millions	Yen 100 Millions
Government Bonds			8,678,240	
General Bonds			7,586,841	
	(Reconstruction Bonds)			-81,346
		Long-term (10 years or more)		5,154,033
		Medium-term (from 2 to 5 years)		2,054,622
		Short-term (one year or less)		378,186
Fiscal Investment and Loan Program Bonds			1,001,075	
		Long-term (10 years or more)		761,992
		Medium-term (from 2 to 5 years)		239,084
Others			90,323	
	Subsidy Bonds			1,375
	Subscription / Contribution Bonds			27,333
	Development Bank of Japan			13,247
	Nuclear Damage Compensation and Decommissioning Facilitation Corporation			46,244
	Japan Expressway Holding and Debt Repayment Agency Bonds			2,124
Borrowings			544,724	
	Long-term (over one year)			160,842
	Short-term (one year or less)			383,883
Financing Bills			1,166,187	
Total			10,389,150	

Figure 94: Japanese government debt. Source: Japan Ministry of Finance.

Some slightly dated data from the Asian Development Bank shows the amount of debt outstanding in the following table:

	FY1990	FY2000	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
JGB	158.1	239.6	455.7	488.8	527.5	558.0	598.2	646.8
JGB (TB)	8.2	29.6	29.9	24.8	22.8	21.0	32.9	30.0
Other Public	27.1	42.9	84.5	89.2	94.4	99.1	105.8	111.5
Bank Debenture	67.7	48.2	25.5	22.9	22.0	20.9	18.9	16.7
Corporate etc.	26.0	61.9	54.5	54.3	56.7	58.1	61.4	64.0
Non-resident	6.0	8.2	6.7	6.5	8.1	9.3	9.0	9.5
Total	293.1	430.5	656.9	686.6	731.5	766.4	826.3	878.5
Source: Japan Securities Dealers Association.								

Figure 95: Outstanding amount of bonds, FY 1990 to FY 2010 (JPY trillion).
Source: Asian Development Bank.

9 APPENDIX B: SECURITIES IN THE ASSET CALIBRATION SET

The figure below details the list of securities that meet the definition of the asset calibration set: combined domestic and foreign issuer, AA- and AAA-rated fixed-coupon AAA-denominated bonds.

Asset Class	Issuer Name	Security Name	Sector	Combined Credit Rating	Maturity Date	Coupon
Corporate	Australian Rail Track Corp Ltd	ARTAUS 3 3/4 04/29/16	Industrials	AA	29/04/2016	3.75
Corporate	Westpac Banking Corp	WSTP 6 3/4 05/09/16	Financials	AA	9/05/2016	6.75
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 6 3/4 05/09/16	Financials	AA	9/05/2016	6.75
Corporate	Westpac Banking Corp	WSTP 7 1/4 11/18/16	Financials	AA	18/11/2016	7.25
Corporate	National Australia Bank Ltd	NAB 6 5/8 03/09/16	Financials	AA	9/03/2016	6.625
Corporate	National Australia Bank Ltd	NAB 4 5/8 06/27/16	Financials	AA	27/06/2016	4.625
Governments	Australian Postal Corp	AUSPOS 5 1/2 02/06/17	Government	AA	6/02/2017	5.5
Corporate	Westpac Banking Corp	WSTP 6 02/20/17	Financials	AA	20/02/2017	6
Corporate	National Australia Bank Ltd	NAB 6 02/15/17	Financials	AA	15/02/2017	6
Corporate	Commonwealth Bank of Australia	CBAAU 6 12/15/16	Financials	AA	15/12/2016	6
Corporate	National Australia Bank Ltd	NAB 5 08/08/17	Financials	AA	8/08/2017	5
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 5 7/8 02/13/17	Financials	AA	13/02/2017	5.875
Corporate	National Australia Bank Ltd	NAB 6 03/06/17	Financials	AA	6/03/2017	6
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 5 07/25/17	Financials	AA	25/07/2017	5
Corporate	Australian Rail Track Corp Ltd	ARTAUS 7 1/4 12/20/17	Industrials	AA	20/12/2017	7.25
Corporate	Westpac Banking Corp	WSTP 4 1/4 01/24/18	Financials	AA	24/01/2018	4.25
Corporate	National Australia Bank Ltd	NAB 5 09/20/18	Financials	AA	20/09/2018	5
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 4 1/8 02/07/18	Financials	AA	7/02/2018	4.125
Corporate	National Australia Bank Ltd	NAB 4 05/23/18	Financials	AA	23/05/2018	4
Corporate	Commonwealth Bank of Australia	CBAAU 4 1/4 01/25/18	Financials	AA	25/01/2018	4.25
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 4 1/4 04/17/18	Financials	AA	17/04/2018	4.25
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 4 1/2 11/06/18	Financials	AA	6/11/2018	4.5
Corporate	National Australia Bank Ltd	NAB 4 3/8 04/03/18	Financials	AA	3/04/2018	4.375
Corporate	National Australia Bank Ltd	NAB 7 1/4 03/07/18	Financials	AA	7/03/2018	7.25
Corporate	Westpac Banking Corp	WSTP 4 1/2 09/04/18	Financials	AA	4/09/2018	4.5
Corporate	Commonwealth Bank of Australia	CBAAU 4 1/4 04/24/19	Financials	AA	24/04/2019	4.25
Corporate	Westpac Banking Corp	WSTP 4 3/8 04/16/19	Financials	AA	16/04/2019	4.375
Corporate	Westpac Banking Corp	WSTP 4 1/2 02/25/19	Financials	AA	25/02/2019	4.5
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 3 3/4 07/25/19	Financials	AA	25/07/2019	3.75
Corporate	National Australia Bank Ltd	NAB 4 1/4 05/20/19	Financials	AA	20/05/2019	4.25
Corporate	National Australia Bank Ltd	NAB 4 11/27/19	Financials	AA	27/11/2019	4
Corporate	National Australia Bank Ltd	NAB 4 3/4 11/25/19	Financials	AA	25/11/2019	4.75
Corporate	Commonwealth Bank of Australia	CBAAU 3 3/4 10/18/19	Financials	AA	18/10/2019	3.75
Corporate	Commonwealth Bank of Australia	CBAAU 5 09/24/19	Financials	AA	24/09/2019	5
Corporate	Westpac Banking Corp	WSTP 4 11/06/19	Financials	AA	6/11/2019	4
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 4 3/4 08/06/19	Financials	AA	6/08/2019	4.75
Corporate	National Australia Bank Ltd	NAB 4 1/8 06/06/19	Financials	AA	6/06/2019	4.125
Corporate	National Australia Bank Ltd	NAB 4 3/4 09/10/19	Financials	AA	10/09/2019	4.75
Corporate	National Australia Bank Ltd	NAB 4 1/2 01/22/19	Financials	AA	22/01/2019	4.5
Corporate	Trustee of Virtue Trust/The	VIRTUE 7.2 03/15/20	Industrials	AA	15/03/2020	7.2
Governments	Australian Postal Corp	AUSPOS 5 11/13/20	Government	AA	13/11/2020	5

Corporate	**Macquarie University**	**MAQUNI 6 3/4 09/09/20**	**Consumer Discretionary**	**AA**	**9/09/2020**	**6.75**
Corporate	Commonwealth Bank of Australia	CBAAU 7 1/4 02/05/20	Financials	AA	5/02/2020	7.25
Corporate	**Westpac Banking Corp**	**WSTP 7 1/4 02/11/20**	**Financials**	**AA**	**11/02/2020**	**7.25**
Corporate	Commonwealth Bank of Australia	CBAAU 4 3/4 06/10/20	Financials	AA	10/06/2020	4.75
Corporate	**Westpac Banking Corp**	**WSTP 4 7/8 12/10/19**	**Financials**	**AA**	**10/12/2019**	**4.875**
Corporate	Westpac Banking Corp	WSTP 4 3/4 02/19/20	Financials	AA	19/02/2020	4.75
Corporate	**Australia & New Zealand Banking Group Ltd**	**ANZ 4 3/4 02/03/20**	**Financials**	**AA**	**3/02/2020**	**4.75**
Corporate	National Australia Bank Ltd	NAB 5 01/17/20	Financials	AA	17/01/2020	5
Corporate	**University Of Melbourne**	**UNIMEL 4 1/4 06/30/21**	**Consumer Discretionary**	**AA**	**30/06/2021**	**4.25**
Corporate	University of Sydney	UNISYD 4 3/4 04/16/21	Consumer Discretionary	AA	16/04/2021	4.75
Corporate	**National Australia Bank Ltd**	**NAB 5 05/07/21**	**Financials**	**AA**	**7/05/2021**	**5**
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 5 1/4 12/18/20	Financials	AA	18/12/2020	5.25
Corporate	**Westpac Banking Corp**	**WSTP 5 03/19/21**	**Financials**	**AA**	**19/03/2021**	**5**
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 4 7/8 03/19/21	Financials	AA	19/03/2021	4.875
Corporate	**Westpac Banking Corp**	**WSTP 4 3/8 08/20/21**	**Financials**	**AA**	**20/08/2021**	**4.375**
Governments	Australian Postal Corp	AUSPOS 5 1/2 11/13/23	Government	AA	13/11/2023	5.5
Kangaroo	**Transpower New Zealand Ltd**	**TPNZ 4 1/4 08/06/21**	**Utilities**	**AA**	**6/08/2021**	**4.25**
Kangaroo	Transpower New Zealand Ltd	TPNZ 5 3/4 08/28/23	Utilities	AA	28/08/2023	5.75
Kangaroo	**Network Rail Infrastructure Finance PLC**	**UKRAIL 6 11/15/16**	**Industrials**	**AA**	**15/11/2016**	**6**
Kangaroo	National Bank of Abu Dhabi PJSC	NBADUH 5 03/07/18	Financials	AA	7/03/2018	5
Kangaroo	**National Bank of Abu Dhabi PJSC**	**NBADUH 4 3/4 03/19/19**	**Financials**	**AA**	**19/03/2019**	**4.75**
Kangaroo	Metropolitan Life Global Funding I	MET 4 1/2 04/16/19	Financials	AA	16/04/2019	4.5
Kangaroo	**Metropolitan Life Global Funding I**	**MET 4 3/4 09/28/17**	**Financials**	**AA**	**28/09/2017**	**4.75**
Kangaroo	Metropolitan Life Global Funding I	MET 4 1/2 10/10/18	Financials	AA	10/10/2018	4.5
Kangaroo	**Metropolitan Life Global Funding I**	**MET 4 3/4 09/17/21**	**Financials**	**AA**	**17/09/2021**	**4.75**
Kangaroo	Cie de Financement Foncier SA	CFF 6 1/4 01/30/17	Financials	AA	30/01/2017	6.25
Govt Agency	**Airservices Australia**	**AIRSER 5 1/2 11/15/16**	**Government**	**AAA**	**15/11/2016**	**5.5**
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 5 1/4 03/23/16	Financials	AAA	23/03/2016	5.25
Corporate	**Suncorp-Metway Ltd**	**SUNAU 4 11/09/17**	**Financials**	**AAA**	**9/11/2017**	**4**
Corporate	Westpac Banking Corp	WSTP 5 3/4 02/06/17	Financials	AAA	6/02/2017	5.75
Corporate	**Suncorp-Metway Ltd**	**SUNAU 4 3/4 12/06/16**	**Financials**	**AAA**	**6/12/2016**	**4.75**
Corporate	Commonwealth Bank of Australia	CBAAU 5 3/4 01/25/17	Financials	AAA	25/01/2017	5.75
Corporate	**Suncorp-Metway Ltd**	**SUNAU 3 3/4 11/05/19**	**Financials**	**AAA**	**5/11/2019**	**3.75**
Govt Agency	Airservices Australia	AIRSER 4 3/4 11/19/20	Government	AAA	19/11/2020	4.75
Corporate	**Westpac Banking Corp**	**WSTP 5 1/4 11/21/23**	**Financials**	**AAA**	**21/11/2023**	**5.25**
Corporate	Australia & New Zealand Banking Group Ltd	ANZ 5 08/16/23	Financials	AAA	16/08/2023	5
Corporate	**Commonwealth Bank of Australia**	**CBAAU 4 3/4 05/27/24**	**Financials**	**AAA**	**27/05/2024**	**4.75**
Corporate	National Australia Bank Ltd	NAB 5 03/11/24	Financials	AAA	11/03/2024	5
Kangaroo	**DNB Boligkreditt AS**	**DNBNO 6 1/4 06/08/16**	**Financials**	**AAA**	**8/06/2016**	**6.25**
Kangaroo	Canadian Imperial Bank of Commerce/Canada	CM 6 1/4 03/22/16	Financials	AAA	22/03/2016	6.25
Kangaroo	**BNZ International Funding Ltd/London**	**BZLNZ 6 1/4 06/14/16**	**Financials**	**AAA**	**14/06/2016**	**6.25**

Figure 96: Securities in the asset calibration set.

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