GDP-linked Bonds

Joel Bowman and Philip Naylor*

A GDP-linked bond is a debt security with repayments that are linked to the issuing country's GDP. These securities have recently attracted some attention, including within the Group of Twenty (G20), in the context of discussions about possible ways to improve the resilience of the international financial system. In view of this, we discuss the potential benefits and challenges associated with issuing GDP-linked bonds and estimate a range of plausible risk premiums using the capital asset pricing model (CAPM). Our analysis suggests that there is significant uncertainty about how these instruments would be priced and, therefore, the borrowing costs that would be faced by governments. Given that borrowing costs play a crucial role in determining what type of debt governments choose to issue, further work could investigate how private market participants are likely to price GDP-linked bonds in practice.

Introduction

Governments typically issue bonds with fixed coupon payments. However, it is possible to issue bonds with coupon payments that are linked to a government's ability to repay. GDP-linked bonds, for which repayments are linked mechanically to the issuing country's GDP, are a commonly cited example of such an instrument. In principle, this type of debt is attractive because the issuing government's repayments would move with the country's economic growth, thereby improving its ability to service its debt during periods of weak economic activity and resulting in the ratio of debt to GDP being more stable than if the government borrowed using traditional fixed coupon debt. On the other hand, governments would be likely to need to pay a premium to investors in order to entice them to accept the risks associated with variable repayments.

To date, GDP-linked instruments have only been issued by governments as part of debt restructuring processes. For example, securities with some similarities to GDP-linked bonds were issued by several countries as part of the Brady restructuring process that started in 1989, as well as by Argentina in 2005, by Greece in 2012 and, most recently, by Ukraine in 2015. In each case, governments issued GDP-linked warrants, which offered higher returns in the event of a faster-than-expected recovery, thereby encouraging investors to accept a 'haircut' on their existing debt claims. However, these experiences provide limited guidance on the practicality of issuing GDP-linked bonds, as the GDP-linked warrants only provided investors with exposure to upside GDP risk (unlike GDP-linked bonds, which would also create an exposure to downside GDP risk). Also, each of the warrants varied considerably in their complexity and design (Bank of England (BoE) 2015). GDP-linked bonds can be structured in many ways. For example, principal and/or coupon payments could be linked to GDP, or the measure of GDP could be real or nominal.[1] However, regardless of their precise form, the benefits and challenges associated with issuing GDP-linked bonds are likely to be broadly similar. Members of the G20 have recently considered these benefits and challenges, which are explored further in this article.

* The authors are from International Department.

1 To address the challenge of different potential structures, the BoE is currently working on developing a standardised structure for GDP-linked bonds (BoE 2015).

The Benefits of GDP-linked Bonds

GDP-linked bonds have appealing attributes for both issuing governments and for investors. Their wider use could potentially enhance the resilience of the broader international financial system.

The primary benefit to a government of issuing GDP-linked bonds is its effect on debt sustainability. In particular, the government's burden of servicing its debt would be lessened during an economic downturn. More generally, the government's ratio of debt to GDP would be more stable than if it had borrowed using conventional bonds, holding all else constant. This is because the interest burden on GDP-linked debt would be positively related to economic growth, so any additional borrowing to cover debt-servicing costs would be lower during downturns and higher during upturns.

In addition to making a given level of debt more sustainable, GDP-linked bonds could also allow governments to increase their debt without putting at risk their ability to pay during periods of economic weakness. Previous studies have suggested that the use of GDP-linked bonds could increase the level of debt that a government can sustainably service as a share of GDP by up to 100 percentage points (Barr, Bush and Pienkowski 2014). Moreover, the use of GDP-linked bonds could also increase the scope for stimulatory fiscal policy during downturns, as the interest burden would decline as GDP growth eases. This option may be particularly attractive for governments of emerging market economies, which may otherwise face pressure to reduce their debt during a recession in order to restore market confidence. Alternatively, governments could choose to reduce their level of debt by keeping their debt repayments constant and allowing their repayments of principal to increase as their interest costs decline.

For investors, GDP-linked bonds would provide an opportunity to gain direct exposure to economic growth. Although equity markets currently provide this to some extent, the relationship between equity returns and economic growth is generally imperfect, in part reflecting differences in the sectorial composition of the equity market and the broader economy. In exchange for investors taking on the risk associated with having a direct exposure to a country's economic growth, investors are likely to demand a higher return.

Finally, it has been claimed that the issuance of GDP-linked bonds could generate positive spillovers. GDP-linked bonds could benefit holders of the issuing government's conventional bonds, as GDP-linked bonds might reduce a government's default risk (Chamon and Mauro 2005). The improvement in debt sustainability could also benefit other nations, since sovereign defaults often lead to contagion and turbulence in foreign financial markets more generally.[2]

Challenges Associated with GDP-linked Bonds

In practice, however, there are several factors that may discourage governments from issuing GDP-linked bonds or dissuade investors from purchasing them. These can broadly be grouped into problems associated with adverse selection, moral hazard and developing a market for a new product.

An adverse selection problem may arise if governments are more likely to issue GDP-linked bonds when they expect growth to be weak and therefore expect repayments to be low in the near term. If investors consider this adverse selection problem to be material, the issuance of GDP-linked bonds could cause them to revise down their expectations of growth for the issuing country. This could lead to higher premiums on both GDP-linked and conventional bonds for the issuer and could, in turn, create debt-servicing challenges for the government.

2 Sovereign defaults could also have adverse spillover effects on other countries' economic growth, although there is a significant degree of uncertainty around the size of these effects. In related research, De Paoli, Hoggarth and Saporta (2009) found a wide distribution in the size of effects of past sovereign defaults on domestic economic growth.

Concerns have also been raised in the literature that GDP-linked bonds could introduce moral hazard, because governments may have some incentive to stymie growth in an effort to reduce their borrowing costs. However, this incentive should not be overstated and ignores damage to the government's general revenue as well as the significant domestic political pressures to support growth and keep unemployment low (Chamon and Mauro 2005; Griffith-Jones and Sharma 2006). Governments that issue GDP-linked bonds could also have an incentive to manipulate published GDP data to show lower growth in order to reduce the cost of servicing their debt. This incentive could, in turn, undermine investor confidence in GDP-linked bonds and increase the premium that investors demand for holding these securities. However, these challenges could be mitigated by strengthening the independence of national statistical agencies or by involving international organisations in data verification.

As with any new financial instrument, the development of a market for GDP-linked bonds could also face some initial challenges as issuers and investors gain familiarity with the product. These challenges could include concerns about a lack of liquidity, a lack of existing markets for hedging GDP growth risk and difficulties in pricing – especially given the potentially complex nature of some GDP-linked products (Griffith-Jones and Sharma (2006); also discussed below). To a large degree, these issues could be expected to dissipate as markets for GDP-linked bonds become more established. However, the high initial costs of issuing the first GDP-linked bonds may discourage governments from doing so. The 'first-mover' problem is often cited as a reason why international coordination is needed to develop the market for GDP-linked bonds. For example, Brooke *et al* (2013) suggest that international organisations could play a role in helping to coordinate GDP-linked bond issuances by a number of countries. Greater coordination could also potentially alleviate the adverse selection problem described previously, particularly if the group of issuing governments includes some sovereign entities with relatively high credit ratings.

Costs of GDP-linked Bonds

In assessing the benefits and challenges of issuing GDP-linked bonds, a critical consideration is the borrowing costs for the government. Given that there is no clear historical precedent, the cost of issuing GDP-linked bonds, which includes the premiums demanded by investors, is highly uncertain. However, it is likely that investors would demand a higher return on GDP-linked bonds than they would on conventional bonds. If the premium is too high, the government's borrowing costs over the life of the bond would outweigh the benefits associated with the lower burden of servicing these bonds during economic downturns.

The total premium paid on GDP-linked bonds, relative to conventional bonds, would be composed of four sub-premiums (Blanchard, Mauro and Acalin 2016):

- A *liquidity premium* is required to compensate investors for the degree of difficulty in converting the asset into cash at fair market value.
- A *novelty premium* is the additional return investors would demand on new, unfamiliar investment products.
- A *default premium* is required to compensate investors for the risk that the debtor will not make the required repayments (this could theoretically be negative, if GDP-linked bonds were to make debt more sustainable).
- A *growth risk premium* is unique to GDP-linked bonds and is required to compensate investors for taking on some of a country's economic growth risk.

The liquidity and novelty premiums could be high initially but would be likely to decrease over time and could become negligible if the market for GDP-linked bonds were to develop sufficiently.

For example, Costa, Chamon and Ricci (2008) found that the novelty premium on Argentina's GDP-linked warrants declined by about 600 basis points during the first year and a half. The default risk of GDP-linked bonds would be closely linked to the size of the premiums on existing debt, but would also depend on the extent to which investors perceive the issuance of GDP-linked bonds as having changed the sustainability of the issuer's debt. The growth risk premium will depend on investors' outlooks for the issuing country's GDP growth and the level of uncertainty surrounding these projections.

Assessing the likely size of the growth risk premium is therefore critical in determining the viability of GDP-linked bonds, because the liquidity and novelty premiums are likely to dissipate over time and the default premium is likely to be closely linked to the default premiums inherent in other sovereign securities on issuance. The literature has therefore focused on estimating the size of the growth risk premium as the most important medium-term independent influence on the cost of issuing GDP-linked bonds.

The growth risk premium

Previous studies have estimated that the benefits of issuing GDP-linked bonds are likely to outweigh the costs if the growth risk premium is less than 200–350 basis points (Barr *et al* 2014; Blanchard *et al* 2016). Other studies have estimated that the growth risk premium is likely to be somewhat lower, at around 150 basis points or less (Miyajima 2006; Kamstra and Shiller 2009). While this suggests that governments would benefit from issuing GDP-linked bonds, there is considerable uncertainty surrounding the estimates of the growth risk premium.

Previous estimates of the growth risk premium have generally been underpinned by the CAPM.[3] The CAPM estimates investors' required returns from an asset given the degree of systematic 'risk' – that is, risk that cannot be avoided by holding a diversified portfolio of assets. The premise underlying the CAPM is that investors are risk averse and care only about the mean and variance of expected returns. More precisely, the CAPM calculates the price of a risky security using the relationship between the relative riskiness of the security and that of the 'market portfolio', as shown in Equations (1) and (2) below.

$$\hat{r}_i = r_f + \beta_i\left[E\left(r_m\right) - r_f\right] \tag{1}$$

$$\beta_i = \frac{cov\left(r_i, r_m\right)}{var\left(r_m\right)} = \left(\rho_{r_i, r_m}\right)\left(\frac{\sigma_{r_i}}{\sigma_{r_m}}\right) \tag{2}$$

Where, in the context of GDP-linked bonds, $\hat{r}_i$ is the required return on a GDP-linked bond, r_f is the risk-free rate, $E\left(r_m\right)$ is the expected return on a 'market portfolio' and β_i is the 'beta' of a GDP-linked bond (the measure of risk). The beta is estimated by dividing the covariance of returns on the GDP-linked bond and the market portfolio (that is, the degree to which they move together) by the variance of the returns on the market portfolio (the spread of returns). Beta can also be expressed as the product of the correlation coefficient between returns on the GDP-linked bond and the market portfolio $\left(\rho_{r_i, r_m}\right)$ and the ratio of the respective standard deviations of returns on the GDP-linked bond and market portfolio $\left(\sigma_{r_i} / \sigma_{r_m}\right)$. Intuitively, the beta term suggests that investors should seek higher returns on an asset

3 Previous studies have also developed various models to assess the sensitivity of the theoretical price of GDP-linked bonds to a number of variables. Miyajima (2006), using a discounted cash flow model, shows that the theoretical price of GDP-linked bonds is sensitive to investors' central projections of a country's GDP growth as well as the uncertainty around these estimates. Chamon and Mauro (2005), using a Monte Carlo framework, found that GDP-linked bonds reduce the probability of default and therefore the required return on conventional bonds assuming that default occurs as soon as the debt-to-GDP ratio exceeds a critical level. More recently, Barr *et al* (2014) explored the benefits of GDP-linked bonds using a calibrated model of endogenous sovereign default.

if its returns are highly correlated with, and more volatile than, the market portfolio – since it exposes the investors to a higher degree of systematic risk.

The growth risk premium is calculated by multiplying the beta of the asset with the expected market premium $\left(E\left(r_m\right)-r_f\right)$. This means that if a country's GDP growth is closely correlated with returns on the market portfolio and/or is relatively volatile it will have a higher beta and, hence, a higher growth risk premium.

The CAPM, like all financial models, is subject to a number of assumptions and is only illustrative (see Fama and French (2004)). In practice, there is considerable uncertainty involved in pricing financial instruments using the CAPM. In view of this, the robustness of the estimates are tested in three ways by: considering several alternative market portfolios; examining a variation of the CAPM that focuses on downside risks that investors face – the downside CAPM (D-CAPM); and adopting a rolling estimation approach in order to examine the variability of the premiums over time.

Effects of different assumptions about the market portfolio

While the market portfolio should include all types of assets held by investors, such a portfolio is not observable in practice (Roll 1977). This is important, since the market portfolio influences the estimate of both β_i and $\left[E\left(r_m\right)-r_f\right]$ and can therefore have a significant effect on the estimated cost of debt $(\hat{r}_i)$.

For these reasons, studies that have estimated the growth risk premium on GDP-linked bonds have considered several possibilities for the market portfolio: a US equity index, US GDP growth, a world equity index and world GDP growth (Borensztein and Mauro 2004). To highlight the impact of the market portfolio on the growth risk premium, we estimate the growth risk premium for all G20 members (excluding the European Union), using these four market portfolios.[4] More specifically:

- To measure the return on the market portfolio r_m we use annual data from 1989 to 2015 for four different benchmarks: world real GDP growth, US real GDP growth, world equity market returns deflated by a global measure of consumer prices (i.e. a world CPI), and US equity market returns deflated by the US CPI.
- For the expected market rate of return $E\left(r_m\right)$, we use the International Monetary Fund's (IMF) April 2016 *World Economic Outlook* projected growth rates five years ahead for world real GDP growth and US real GDP growth and assume that the expected market rate of return on world equities and US equities is equal to the long-run average return on US equities of 6.5 per cent (Siegel 2014).
- To measure the return on country *i's* hypothetical GDP-linked bond, $\hat{r}_i$, we use that country's real GDP growth rate.
- We assume a real risk-free rate r_f of zero, which is broadly consistent with US 10-year Treasury inflation-index bond yields at around the time of publication.[5]

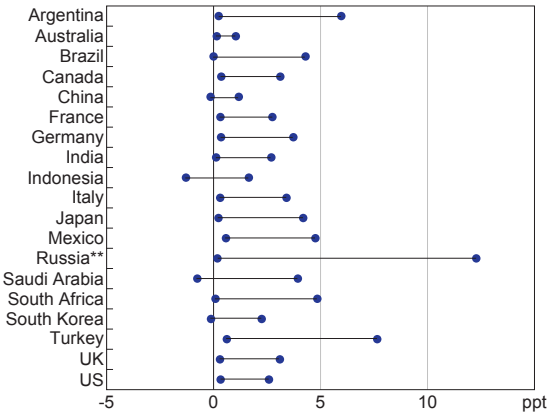
Our results show that the choice of the market portfolio has a large effect on the estimate of the growth risk premium across our sample of countries (Graph 1).[6] Consistent with the literature, for all of the 19 countries examined, the growth risk premium was highest when world GDP growth was

4 The data for real GDP and for CPI are from the IMF's *World Economic Outlook* database. The MSCI World Index is used for world equities and S&P 500 is used for US equity market returns, both of which are price, rather than total return, indices and are sourced from Bloomberg. Equity returns data are lagged by one year, consistent with the methodology used in the existing literature.

5 Although the real risk-free rates are currently low, assuming a real risk-free rate of zero produces projected market risk premiums that are close to the historical medians when using US and world equity markets as the market benchmark, but produces slightly higher projected market risk premiums when using world and US GDP as the market benchmark.

6 The estimated growth premiums may change over time to the extent that GDP-linked bonds reduce the probability of a crisis, and hence the potential relationship between domestic growth and the market portfolio.

Graph 1
Growth Premium Estimates – Different Market Portfolios*
Based on CAPM



* The graph range represents the minimum and maximum estimates of the growth risk premium using world GDP, US GDP, world equities and US equities as the benchmark portfolio

** Restricted sample beginning in 1993; estimates for all other countries use the full sample from 1989 to 2015

Sources: Bloomberg; IMF; RBA

used as the market portfolio and was, on average, 350 percentage points higher than the average of the three alternatives.[7] This is because GDP growth rates for most countries tend to be more closely correlated with world GDP than with US GDP, world equities or US equities. For almost half of the countries examined, the highest estimated cost would be large enough to make the issuance of GDP-linked bonds undesirable, based on the aforementioned finding that the benefits would outweigh the cost if the growth risk premium is less than 350 basis points. If, instead, the lower threshold value of 200 basis points is used, then issuance would be too costly for 16 of the 19 countries in the sample. For each country, any assessment of the costs of issuing GDP-linked bonds would need to be carefully weighed against the benefits, which may also vary by country and are not considered in this article.

7 Four of the countries sampled were estimated to have negative growth risk premiums (at the lower end of the range). Negative growth risk premiums occur when there is a negative correlation between a country's GDP growth and the returns on the market portfolio. Financial products that have a negative correlation with the market portfolio provide investors with a measure of insurance against a decline in the value of the market portfolio. This means that they should be willing to pay rather than receive a premium in exchange for investing in these products.

The D-CAPM framework

One of the criticisms of the CAPM is that it assumes that investors place equal weight on above-average and below-average returns when assessing the riskiness of an asset. However, in practice, investors may care more about below-average returns. Furthermore, the CAPM assumes that the distribution of expected returns is symmetrical, which means that above-average outcomes are assumed to be just as likely as below-average outcomes. There is evidence that this is often not the case, with many financial assets subject to much more downside risk than upside risk (Bakshi, Kapadia and Madan 2003). This phenomenon is particularly relevant for GDP-linked bonds, since economic growth tends to be slightly above average for extended periods of time whereas downturns tend to be deep but shorter in duration (Morley and Piger 2012).

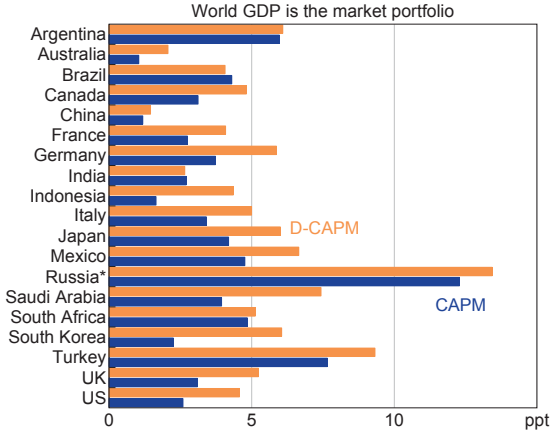
In contrast to the standard CAPM, the D-CAPM focuses on the variation of below-average returns. As such, the D-CAPM framework may be better suited to capturing risk aversion and asymmetric returns. Specifically, the D-CAPM framework uses an alternative beta, which, following Estrada (2007), is expressed below.

$$\beta^{D} = \frac{\text{cov}\left(r_i, r_m \middle| \left[r_m < \overline{r}_m; r_i < \overline{r}_i\right]\right)}{\text{var}\left(r_m \middle| r_m < \overline{r}_m\right)} \tag{3}$$

Where, in the context of GDP-linked bonds β^{D} is the downside beta, r_i is the GDP-linked bond's return (country *i's* real GDP growth), r_m is the market return on the benchmark portfolio, $\overline{r}_i$ is the mean historical return on the GDP-linked bond (country *i's* average real GDP growth), and $\overline{r}_m$ is the mean historical return on the benchmark portfolio. The D-CAPM therefore estimates beta in a similar way to the CAPM, but only includes observations when returns on *both* the benchmark portfolio and the GDP-linked bond are below their historical average.

The D-CAPM has been found to reflect prices of emerging market debt securities more accurately compared with the CAPM (Estrada 2007), which suggests it may also be a useful framework for gauging how GDP-linked bonds could be priced.[8] Our results show that the D-CAPM leads to slightly higher estimates of the growth risk premium for 17 countries in our sample of 19.[9] Graph 2 demonstrates this difference when world GDP is used as the market portfolio.[10]

Graph 2
Growth Premium Estimates – CAPM and D-CAPM
World GDP is the market portfolio



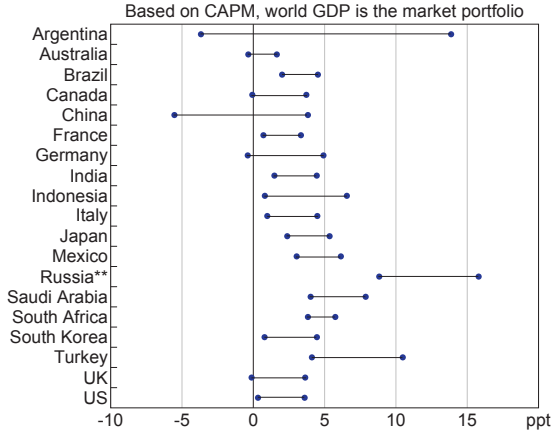
* Restricted sample beginning in 1993; estimates for all other countries use the full sample from 1989 to 2015

Sources: Bloomberg; IMF; RBA

Rolling estimation window

Finally, a large body of work finds that risk premiums in financial markets vary considerably over time (see, for example, Engle, Lilien and Robins (1987)). This raises additional uncertainty about the time frame that investors would use to price GDP-linked bonds, which in turn has implications for both the β_i and $\left[E(r_m)-r_f\right]$ components of the estimated GDP risk premium in Equation (1). To examine this, we estimate the CAPM over 15-year rolling windows, generating a wide range of growth risk premiums. Focusing on the minimum and maximum estimates across the rolling windows, our results highlight the substantial effect that the choice of the sample period can have on the estimated size of the growth risk premiums (Graph 3).[11]

Graph 3
Growth Premium Estimates – Different Time Periods*
Based on CAPM, world GDP is the market portfolio



* Based on 15-year rolling window

** Restricted sample beginning in 1993; estimates for all other countries use the full sample from 1989 to 2015

Sources: Bloomberg; IMF; RBA

Conclusion

In principle, GDP-linked bonds have features that appeal to both issuers and investors. If used widely, GDP-linked bonds also have the potential to improve the sustainability of sovereign debt and reduce the likelihood of default, thereby enhancing the resilience of the international financial system. In practice, however, there are many factors that may discourage governments from issuing

8 The study focused on emerging markets as they are likely to be susceptible to much larger downside shocks than advanced economies.

9 We use annual data from 1989 to 2015 to estimate $\overline{r_m}$ and $\overline{r_f}$. The estimated premiums can be less under the D-CAPM relative to the CAPM. This can occur when the covariance between the financial asset and market portfolio returns are greater when both experience above average returns relative to below average returns.

10 This finding is not sensitive to the choice of the market portfolio. Under the D-CAPM, the average estimated premium is 1.5 percentage points higher than the CAPM when world GDP is used as the market portfolio, compared to 0.8, 0.2 and 0.3 percentage points for US GDP, world equities and US equities, respectively.

11 The average difference between the minimum and maximum estimates when world GDP is used as the market portfolio is 4.8 percentage points compared to 2.6, 0.6 and 0.5 percentage points for US GDP, world equities and US equities, respectively.

GDP-linked bonds and/or investors from purchasing them. The estimated cost of borrowing is also critical in assessing the practicality of GDP-linked bond issuance from a government's perspective. This article highlights that the cost of borrowing using GDP-linked bonds is highly uncertain, largely due to the wide range of estimates for the growth risk premium. Given this, further investigation into GDP-linked bonds could draw on liaison with private market participants, particularly potential investors, to better understand how GDP-linked bonds are likely to be priced in practice.

References

Bakshi G, N Kapadia and D Madan (2003), 'Stock Return Characteristics, Skew Laws, and the Differential Pricing of Individual Equity Options', *The Review of Financial Studies*, 16(1), pp 101–143.

Barr D, O Bush and A Pienkowski (2014), 'GDP-Linked Bonds and Sovereign Default', Bank of England Working Paper No 484.

Blanchard O, P Mauro and J Acalin (2016), 'The Case for Growth-Indexed Bonds in Advanced Economies Today', Peterson Institute for International Economics, Policy Brief No PB16–2.

BoE (Bank of England) (2015), *Bank of England Workshop on GDP Linked Bonds: Making It Happen*, Proceedings of a Conference, Bank of England, London. Available at < http://www.bankofengland.co.uk/research/Pages/conferences/301115.aspx>.

Borensztein E and P Mauro (2004), 'The Case for GDP-Indexed Bonds', *Economic Policy*, 19(38), pp 165–216.

Brooke M, R Mendes, A Pienkowski, and E Santor (2013), 'Sovereign Default and State-Contingent Debt', vox, 12 December. Available at <http://voxeu.org/article/sovereign-default-and-state-contingent-debt>.

Chamon M and P Mauro (2005), 'Pricing Growth-Index Bonds', IMF Working Paper No WP/05/216.

Costa A, M Chamon and L Ricci (2008), 'Is there a Novelty Premium on New Financial Instruments? The Argentine Experience with GDP-Indexed Warrants', IMF Working Paper No WP/08/109.

De Paoli B, G Hoggarth and V Saporta (2009), 'Output Costs of Sovereign Crises: Some Empirical Estimates', Bank of England Working Paper No 362.

Engle R, D Lilien and R Robins (1987), 'Estimating Time Varying Risk Premia in the Term Structure: The Arch-M Model', *Econometrica*, 55(2), pp 391–407.

Estrada J (2007), 'Mean-Semivariance Behavior: Downside Risk and Capital Asset Pricing', *International Review of Economics & Finance*, 16(2), pp 169–185.

Fama E and K French (2004), 'The Capital Asset Pricing Model: Theory and Evidence', *The Journal of Economic Perspectives*, 18(3), pp 25–46.

Griffith-Jones S and K Sharma (2006), 'GDP-Indexed Bonds: Making It Happen', UN DESA Working Paper ST/ESA/2006/DWO/21.

Kamstra M and R Shiller (2009), 'The Case for Trills: Giving the People and Their Pension Funds a Stake in the Wealth of the Nation', Cowles Foundation Discussion Paper No 1717.

Miyajima K (2006), 'How to Evaluate GDP-Linked Warrants: Price and Repayment Capacity', IMF Working Paper No WP/06/85.

Morley J and J Piger (2012), 'The Asymmetric Business Cycle', *The Review of Economics and Statistics,* 94(1), pp 208–221.

Roll R (1977), 'A Critique of the Asset Pricing Theory's Tests Part 1: On Past and Potential Testability of the Theory', *Journal of Financial Economics*, 4(2), pp 129–176.

Siegel J (2014), *Stocks for the Long Run*, 5th edition, McGraw Hill Education, United States of America.