Chile sustainability-linked bond: Optionality analysis

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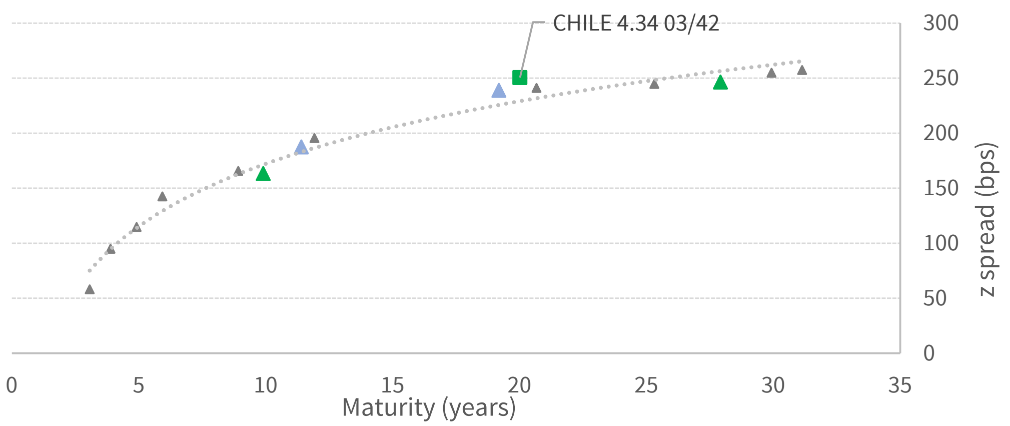
Chile's recent SLB issuance (CHILE 4.34 03/2042; ISIN US168863DY16) **was, in our view, constructed on a set of robust KPI's – in our terminology a step-up priceable SLB (SUP) – where the separation of the two KPIs to individual step-ups is** commended.[1] The structure accounts for the trajectory of GHG emissions rather than measuring a single point in time as Chile did with their carbon budget which seems an interesting and sensible way to go.

We price the option value of the two GHG emissions KPIs to around 0.5 and 0.3bps individually, or 0.7bps jointly. We discuss the renewable energy KPI and comment that it is not step-up priceable, as there simply are too few data points to produce probability forecasts[2], but that this should not be a material pricing issue given the high correlation between energy mix and GHG emissions KPIs.

The relatively small optionality value in the Chile SLB illustrates a general point in this space: with a low coupon-step up value, and relatively short maturities over which the step-up could crystallize, there is limited premium that could be harvested and convertible into lowered cost-of-capital for the issuer. Issuers with robust structures like Chile are likely to benefit cost-of-capital-wise from pushing bigger coupon step-ups.

Figure 1. New Chile SLB (green square) and past USD green (green), social bonds (blue) and standard issuances on an z-spread basis. 4 March 2022. Source: Bloomberg, AFII.



[1] Please refer to "An option pricing approach for sustainability-linked bonds", AFII, 18 Mar 2022, for a general overview on our approach to pricing SLBs.
[2] In that case, a fundamental approach based for example on an analysis of public policies sounds more appropriate than a statistical one to infer probabilities.

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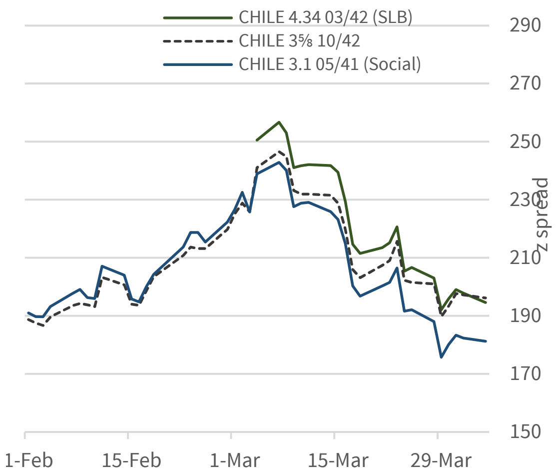
Issuance parameters

Chile is a relatively frequent issuer in the labelled debt market having issued a series of green, social and sustainability bonds since 2019.[4] With the recent SLB, Chile became the first sovereign to issue a sustainability-linked bond, raising USD2bn at 200 basis points over the current 20-year US Treasury (see Figure 1, ISIN US168863DY16).[5] The new SLB is associated with targets on both GHG emissions and share of renewable energies:

1. *a)* reducing annual absolute GHG emissions to 95 MtCO2e by 2030, from 112 MtCO2e in 2018; and *b)* limiting its GHG budget to 1,100 MtCO2e or less between 2020 and 2030 (10 years or equivalent to 110MtCO2e on average). This would be in line with Chile's NDCs.
2. Increasing the share of renewables in national electricity generation to 50% by 2028 and 60% by 2032.

The coupon step-ups commence in 2034 as the GHG emissions are observed with a two-year lag. This means that step-ups would be paid out over 8 years. Sustainalytics provided the second opinion on these KPIs.[6] Further to the structure, each KPI has an individual, independent coupon step-up of 12.5bp. As structural comment on this we note that it is more common to have several KPIs adding up to pricing SLBs where the coupon step-up is linked to more than one KPIs. We discuss the implications of this further below.

Figure 2.CHILE 4.34 SLB secondary market performance vs comparables. Source: Bloomberg.



In terms of market pricing, the bond appears to have priced just slightly wider than secondary curve (see Figure 1). However, as shown in the addendum of our option pricing paper, several other factors should be counted in, where we think in this case the general market new issue premium (NIP) should play a big role. We estimate that the bond priced at around 8.5bp (negative) premium to the secondary curve. At the time of issuance, both geopolitical concerns as well as yield volatility would have driven NIPs in the market in general higher. As illustrated in Figure 2, secondary market performance has been strong versus the slightly longer 3.625 42s which is a standard bond, but flat versus the 3.1 41s that have been issued in social bond format. We would caution against drawing to definitive conclusions of the relative performance versus the standard 2042 bonds as those are quite an old and today a relatively small issue.

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[4] CHILE 3.5 01/50 (US168863DL94, USD2.3bn, green bond), CHILE 0.83 07/31 (XS1843433639, EUR1.9bn, sustainability bond), CHILE 2.55 01/32 (US168863DN50, USD1.5bn, sustainability bond), CHILE 1.25 01/40 (XS2108987517, EUR1.3bn, green bond)

[5] For some broader discussions around the Chile SLB issuance, see "Chile prices first sovereign sustainability-linked bond", IPE, 3 Mar 2022; "Chile has revealed the next big thing in sovereign debt", GlobalCapital, 2 Mar 2022; "After SLB, Chile to continue to test ESG boundaries", IFR, 4 Mar 2022.

[6] "Government of Chile Sustainability-Linked Bond Framework Second Party Opinion", Sustainalytics, Feb 2022.

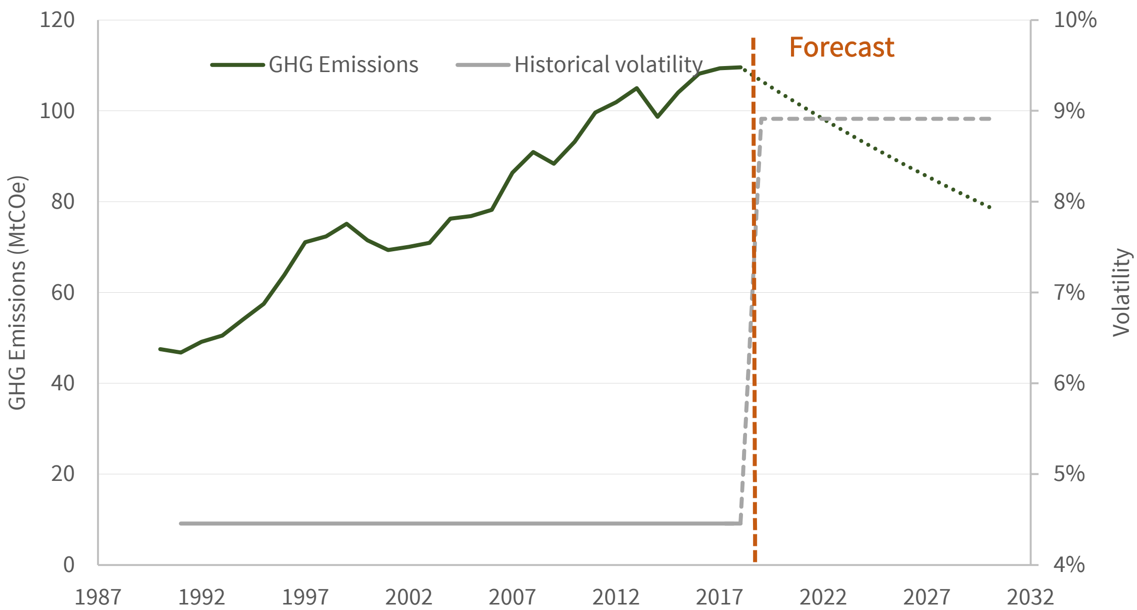
Optionality valuation of KPI 1

We now look at the combined effect of both the carbon budget and the emissions target conditions on pricing. Pricing separately both conditions, we evaluate that adding a carbon budget target brings a 36% gain on the premium compared to an SPT linked only to a GHG emissions target.

Table 1. Chile SLB carbon emissions KPI targets and impact in terms of option premium valuation.

CONDITION ON THE COUPON STEP-UP	SPREAD IMPACT (BPS)
CARBON BUDGET & GHG EMISSIONS TARGET 1. A) + 1. B)	0.67
CARBON BUDGET 1. A)	0.49
GHG EMISSIONS TARGET 1. B)	0.28

Figure 3. Chile GHG emissions since 1990, projected emissions according to NDC and expected volatility. Source: Climate Change, AFII.



How do we arrive at these numbers?

The first step for evaluating the coupon step-up optionality associated with GHG Emissions (KPI1a) is to calibrate pricing parameters i.e. drift and volatility. Although there is a substantial lag in data, recent studies suggest carbon data exhibit a high level of persistence.[7] Governments having generally tracked their GHG emissions for longer than corporates, we are provided with 22 data points (see), giving us a reasonable level of confidence on historical statistical estimations.

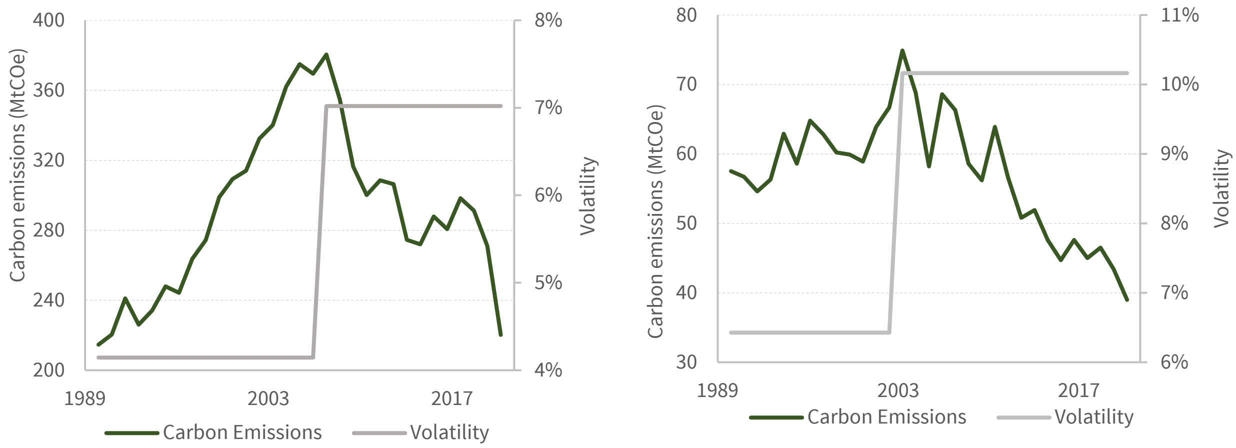
The straightforward approach for calibrating drift and volatility is to apply historical data to the model. A more sophisticated approach is to use forward-looking data and account for the change of emissions "regime" that is likely to arise from Chile's ambitious sustainability agenda. In its

[7] "Looking forward with historical carbon data", AQR, 14 Mar 2022

National Defined Contribution,[8] Chile estimates a 30% reduction in its GHG Emissions by 2030, as per 2016 figures (-2.71% p.a.) which sounds an acceptable drift assumption.

We also believe that a change of emissions “regime” should result in an increased emissions volatility for Chile. Emissions volatility grew strikingly for countries that have embarked on their transition journey after decades of upward emissions trajectory when emissions started decreasing (see). Based on our observations, we set the “implied” GHG emissions volatility at 8.9% (i.e. twice the historical volatility).

Figure 4. Spain (LHS) and Finland (RHS) carbon emissions and volatility regimes. Source: Bloomberg, AFII.



Another feature in the Chile SLB is the usage of a cumulative emissions target (KPI 1b). Effectively, this means that not only do emissions be reduced as per KPI 1a (to 95MtCO2e) but the trajectory to go there also needs to be aligned. Consider an example where emissions rise a lot in the short term, such that there is a significant carbon budget overshoot. Then Chile would need to compensate this with increased back-loaded measures versus baseline. This puts the structure as an interesting contrast to many net-zero year 2030/40/50 commitments, where the trajectories of going forward to the net-zero point are not being considered.

Clearly, the GHG emissions budget condition adds optionality value to the structure. From a pricing standpoint, this adds some computational complexity as we need to simulate all possible trajectories over time up until the coupon step-up condition measurement. However, the underlying dynamics of the process will be the same in terms of volatility and drift. We conduct a small Monte Carlo simulation to this end, with the valuation result that the budget condition should be worth 0.49bps.

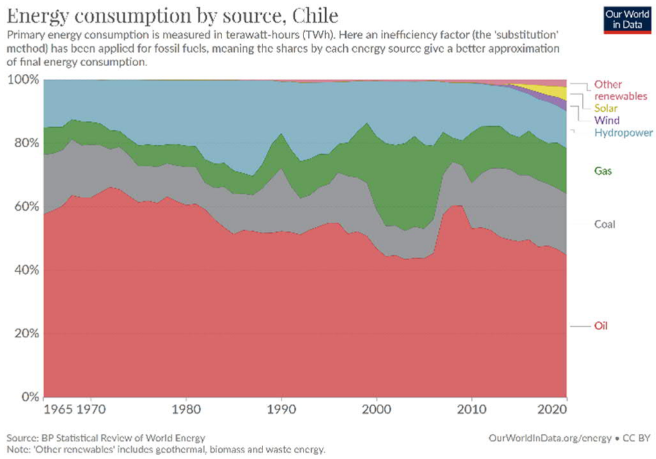
Using the combination of NDC-based drift and inflated volatility, we calculate the value of the coupon step-up optionality at 0.67bps.

[8] “Chile’s Nationally Determined Contribution - update 2020”, Gobierno de Chile, 2020.

The energy mix component of the Chile SLB: KPI 2

Whereas the first KPI targets emissions, the second KPI targets the build-out of renewable energy as part of the total energy mix. This is an important evolution, considering Chile's current high dependency on fossil sources (see Figure 5). For example, coal currently is the energy source for around 20-25% of total energy consumption.

Figure 5. Chile power mix. Source: Our World in Data.

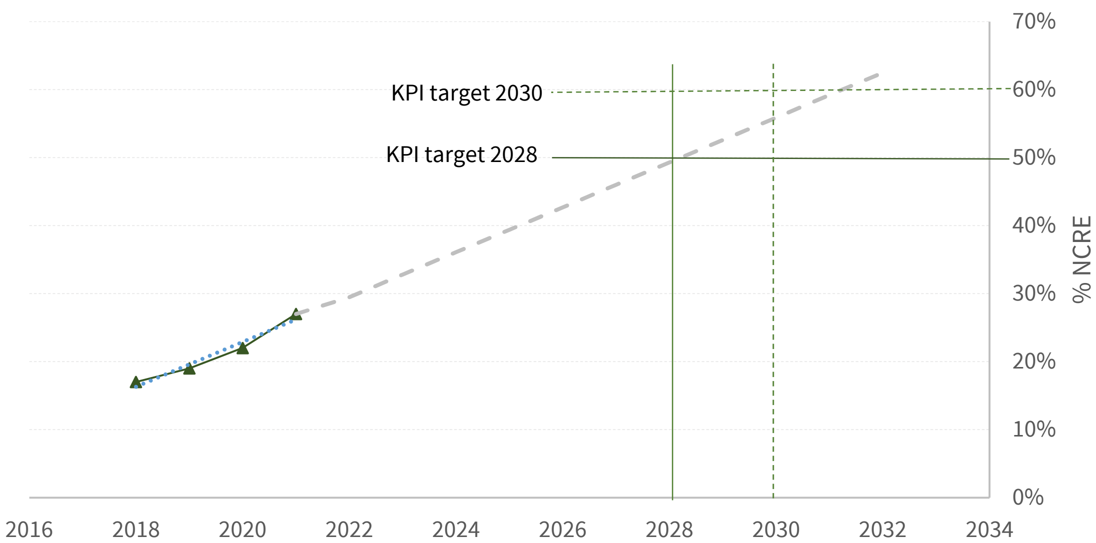


From a pricing perspective, it is hard to derive strong probabilistic inference on the evolution of the renewable energy proportion variable. First, there are only a few data points to extrapolate from, as the increase will likely come from wind and solar rather than expanded hydro. Of course, the build out is also a quite deterministic process which makes traditional statistical inference difficult. Lastly, on the statistical/pricing side, handling variables that are bounded (capped at 100%) can theoretically be difficult.

To illustrate the type of inference needed for KPI2 to be priceable, we illustrate the data provided and the conditions in Figure 6. We have extrapolated the linear trend from the four current data points illustrating that if that trend continues, Chile will fairly exactly be able to meet the KPI target for 2028 (50%) and have some headroom for the 2030 target (60%).

However, given these uncertainties, we would hold KPI 2 for "non-priceable" in our terminology. This does not mean that it is unimportant or irrelevant – it is not – but simply that trying to price the optionality in that KPI leaves too much uncertainty in the numbers. However, it should be noted that there should be a very high correlation between energy mix and total CO_2 emissions, such that one should consider KPI 2 being almost fully built into KPI 1.

Figure 6. Data points on Chile renewable energy generation proportion with extrapolated linear trend. Source: AFII, Ministerio de Hacienda.



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