Klima 2.0

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Autonomous Asset Manager, Liquidity and Bond Markets powered by a Dual Token structure designed for efficient and rational decentralised liquidity in the carbon offset markets.

Version 1.20

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1 Introduction

KlimaDAO was conceived to create market infrastructure driving seamless liquidity for Carbon monetisation and Carbon retirement. It has been constructed using decentralised architecture with a token system 'KLIMA' for dynamic economic governance. Whilst it has been successful in brand and customer acquisition, as well as acquiring real Carbon assets, the current token model and processes are unwieldy and will not allow the product to scale to its potential given the opportunity.

Hence we present **Klima 2.0** as a fundamental capital, liquidity and execution layer for wholesale Carbon trading.

1.1 Client base

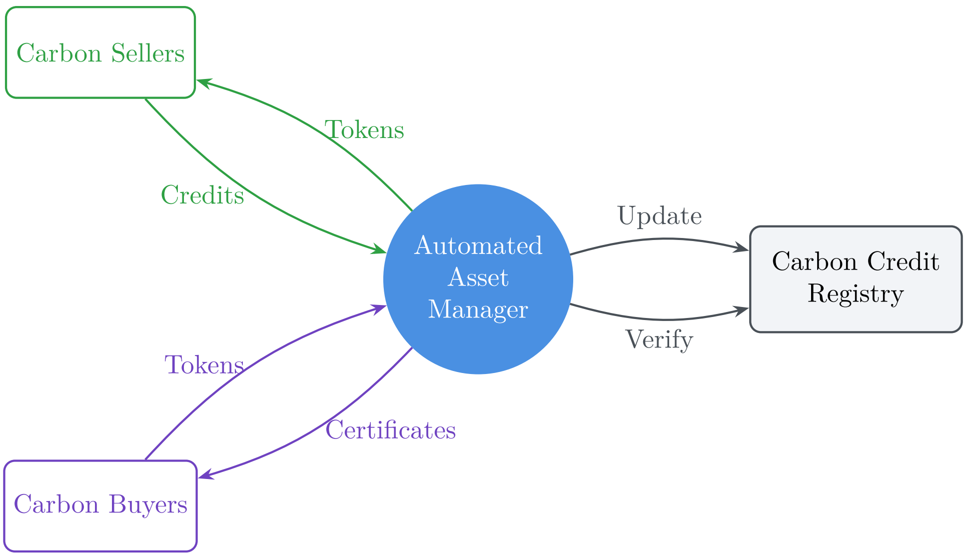
There are two end-users of the platform that create the supply and demand of Carbon assets.

1. **Sellers** wishing to capitalise liquid or forward delivery classes of Carbon. Forward-delivery trades at various discounts as a function of class and time.
2. **Buyers** who wish to retire Carbon in order to obtain the offset credit.

1.2 Automated Asset Manager

Both clients are facilitated through the Automated Asset Manager (**AAM**), a smart contract based system that continuously acquires (tokenised) Carbon, as well as selling offset certificates from its liquid Carbon portfolio, using the native **capital token** as a medium of exchange.

Figure 1: Automated Asset Manager (AAM) Transaction Flow



1.3 Dual tokens

The Klima economy shall be powered by two tokens:

1. Capital or **Asset token** as detailed above that determines Carbon class capital allocation by the AAM and the general forward (discount) curve for Carbon assets. These tokens are used to buy and sell Carbon as in Figure 1.
2. A **Risk Governance** token that combines with the capital token to shape the risk profile of the underlying Carbon portfolio.

The new tokens are named `KLIMA` and `KLIMAX` respectively, noting that the original token name carries through to the Asset Token reflecting the original utility. For the purposes of the document we shall refer to these tokens as `A` and `G` where brevity is required.

1.4 Core Economic Pillars

In addition to the AAM, there are two other tenets of Klima 2.0 that enable the model to find equilibrium through continous dynamic feedback loops. Importantly these are generated solely from token balances in the smart contracts and there is no oversight nor a centralised discretionary actor.

1. **AAM**: The AAM swaps its own token A for Carbon C (in) or Carbon offset certificates $\mathtt{C}^*$(out) to build a portfolio of Carbon.

   -Both A and G are also used as 'Staking' tokens in the AAM whereby A determines the weighting of any given Carbon class, and G determines the rate of acquisition (disposal).

   -Forward-delivery Carbon (for a set of fixed dates out to 10 years) is transacted simultaneously with liquid Carbon.

2. **Bond Market**: A token holders stake tokens until a set expiry to create floating yield bonds.

   -The collective temporal staking pattern produces a yield curve to reward bond-holders as well as price the forward curve for the AAM.

   -Only A tokens participate in the Bond Market which is responsible for pricing the cost of **illiquidity**.

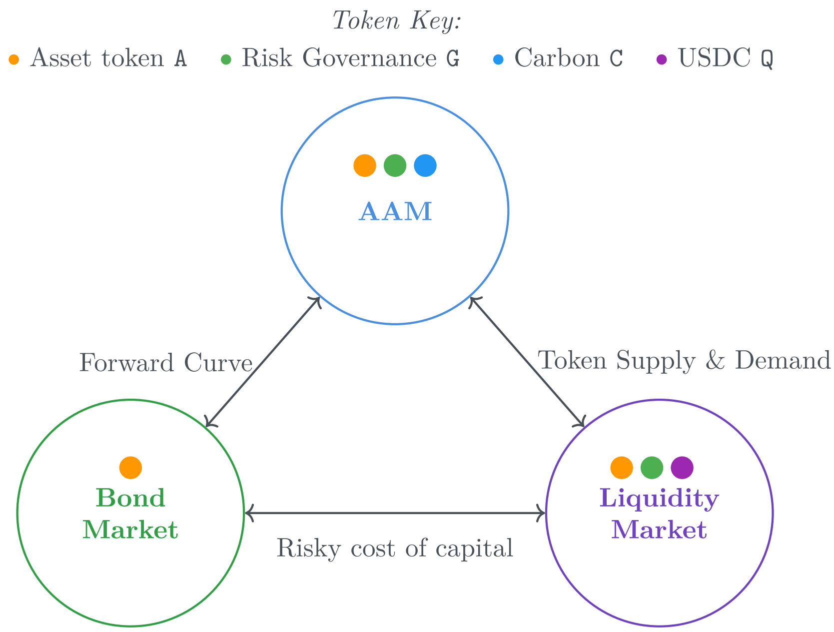
3. **Liquidity Market**: Here the tokens are traded in 2 core liquidity pairs with various incentives available to Liquidity Provider token holders (**LPs**), including a **risky-yield** generated by the Bond Market.

   (a) $\overline{\mathtt{AG}}$: Native token swap A and G.

   (b) $\overline{\mathtt{AQ}}$: The asset token A with USDC Q.

   The Liquidity Market provides the complementary facility to the Bond Market and the critical relationship between the native tokens and the hard currency of USDC.

Figure 2: Market Architecture, Token Utility



The Klima 2.0 system enables each participant in the various economic pillars to act in the (selfish) interests of their own capital and utility, which through the harmonic model, enables price discovery, liquidity and stability for Carbon trading which feeds back on itself as a catalyst for growth and scale.

1.5 Initialisation of the `KLIMA` Asset Token:

KlimaDAO has approximately 20 million tonnes of **Carbon** credits in its treasury as assets which will be used to create the initial issuance of `A` tokens upon launch of Klima 2.0.

1.6 User Experience

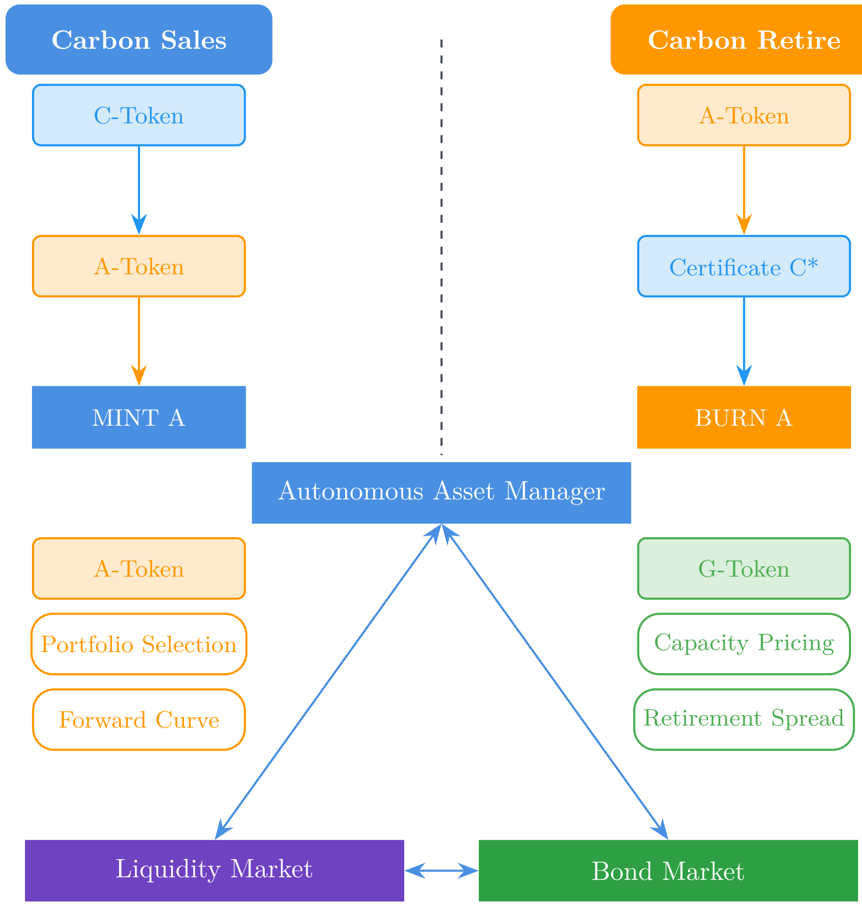
A summary of user functionality:

- AAM
  - Tokenise Carbon that is liquid or forward-delivery to create `C` tokens.
  - Swap Carbon `C` (liquid and forward) for `A` tokens.
  - Swap `A` tokens `A` for liquid Carbon offset certificate `C`*.
  - Stake `A` tokens for specific Carbon classes to contribute to the underlying portfolio weighting and pricing.
  - Stake `G` tokens for specific Carbon classes to contribute to the underlying portfolio pricing and capacity.
- Bond Market
  - Stake `A` tokens for set maturities to create Bonds and receive yield.
- Liquidity Market
  - Swap `A` tokens for `G` or USDC `Q` in the Liquidity Market.
  - Swap `G` tokens for `A` in the Liquidity Market.
  - Add `A` tokens, `G` tokens or USDC `Q` to liquidity pools and stake LP tokens to receive fees and a share of `G` incentives and `A` yield.

2 Economic System

The customer activity is managed through a smart contract asset manager driven by staking choices from the token system, the balances of assets held, and the discount curves generated by the bond market.

Figure 3: Autonomous Asset Manager - Detailed Architecture



The AAM is a smart contract exchange platform that facilitates:

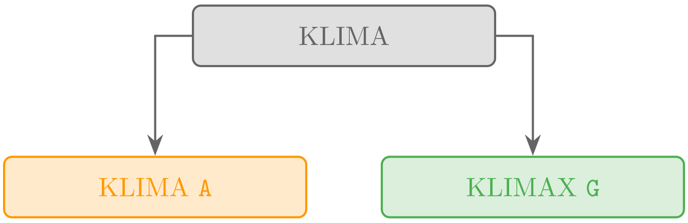
1. The sale of Carbon in return for newly issued `A` tokens.
2. The issuance of retirement certificates to burn `A` tokens.

The combined staking of `A` and `G` Tokens creates a dynamic pricing matrix by class of Carbon, and by time, enabling spot and forward trading of Carbon.

3 Two Token Model

The current token is deprecated and replaced with two new tokens:

Figure 4: Token Derivation Structure



A is issued autonomously to acquire Carbon and is a tokenised representation of the underlying Klima Carbon portfolio. It is also minted to pay Bond yields and Risky Yield for LPs, and is burnt when Carbon certificates are purchased.

The A token has 2 independent staking functions:

Figure 5: Asset Token Staking Dimensions

1. **Price:** Collective selection of Carbon classes by A staking determines the instantaneous price ratio for A token issuance. This stake can be amended and withdrawn at any time to allow price modulation for the platform of its Carbon assets.
2. **Time:** The A token is locked for a specific period of time representing a liquidity preference for the holder in return for yield. This part of the stake cannot be amended.

The G token has a single staking function that also selects Carbon classes. This determines the rate of issuance or price curve of A for the specified Carbon, as well as the retirement burning rate.

Both tokens facilitate the Klima Carbon market to function efficiently with the A token responsible for portfolio selection and pricing, and the G token modulating capacity and risk.

Table 1: Token Summary

Token	**Amount**	**Notes**
KLIMA A Token	20 million	Supply expands and contracts perpetually.
		87.5% of initial supply available to existing KLIMA holders.
		Initially created on 1:1 basis with Carbon Tonnes held.
		Issues on Carbon received, and Burns on Carbon retired.
		Sets portfolio weights for Carbon classes
		Sets discount curve for foward pricing
KLIMAX G Token	100 million	Fixed supply
		40% put into programmatic issuance as incentive yield over time.
		40% for existing KLIMA holders
		Sets capacity-price curve for Carbon classes
		Sets retirement spread for Carbon offsets.

4 Bond Market

Holders of `A` can stake (select) a bond maturity from the set of **standard maturities**. Bonds expire every 90 days on a rolling basis. There are always 40 maturities extending out to approximately 10 years for bond staking.

- Collective Bond staking detemines the shape of the discount curve of the `A` token with regards to its purchasing rate of forward Carbon
- Bondholders receive a floating yield of new `A` tokens on their stake following the shape of this discount curve. Yield is calculated daily and accumulates to the principal stake.
- There is no un-staking and all principal and accumulated yield is released at bond maturity.

G Tokens are not involved in the bond market and the forward curve is agnostic to Carbon class (as Carbon selection for portfolio weighting is an independent utility function of `A`).

4.1 Bond Market Calculations

Defining:

S: Total `A` tokens staked for Bonds expressed as a proportion of outstanding supply of `A`.

S_t: Total `A` tokens staked for Bond maturity bucket t, expressed as a proportion of outstanding supply of `A`, where $\sum S_t = S$, and t is the index of standard maturities $t \in \{1, 2, 3, \ldots, 40\}$.

E_t: Time to expiry expressed in years.

Calculating curve parameters D, C:

$$D = \frac{1}{S}\sum_{t=1}^{40} S_t \cdot E_t \tag{1}$$

$$C = \frac{1}{S}\sum_{t=1}^{40} S_t \cdot E_t^2 \tag{2}$$

The shape of the yield curve is produced:

$$\gamma_t = \max\left(\frac{E_t}{D} - \frac{E_t^2}{2 \cdot C}, 0\right) \tag{3}$$

Normalising γ_t to $\hat{\gamma}_t$:

$$\hat{\gamma}_t = \frac{\gamma_t}{\sum_{t=1}^{40} \gamma_t} \tag{4}$$

With the cumulative sum of the normalised values be expressed as Γ_t:

$$\Gamma_t = \sum_{i=1}^{t} \hat{\gamma}_i \quad \text{for } t = 1, \ldots, 40 \tag{5}$$

The zero coupon yield curve Z_t is solved:

$$Z_t = (1 - S) \cdot \frac{\Gamma_t}{E_t} \tag{6}$$

Finally, the Bond discount rate B_t is derived:

$$B_t = e^{-Z_t \cdot E_t} \tag{7}$$

The yield due on `A` bonds is calculated daily and added to staked principal, hence the daily yield for each time bucket is calculated as Y_t:

$$Y_t = \exp\left(\frac{Z_t}{365}\right) - 1 \tag{8}$$

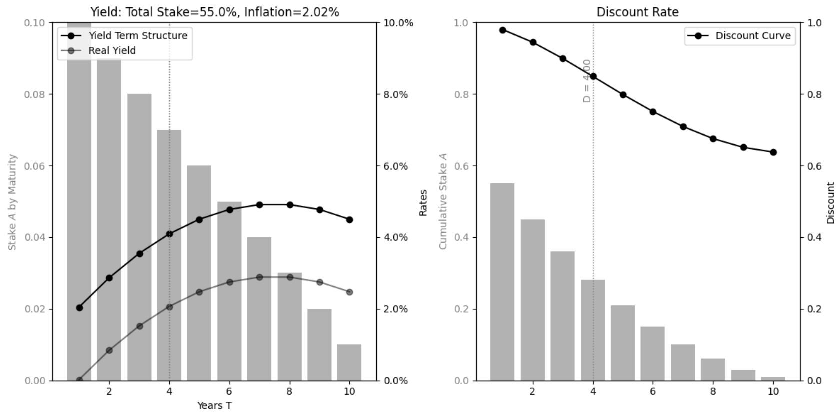
Hence, any bond stake A_t will increase by ΔA_t:

$$\Delta A_t = A_t \cdot Y_t \tag{9}$$

The total tokens created on a daily basis for Bond inflation R:

$$R = \sum_{t=1}^{40} \Delta A_t \tag{10}$$

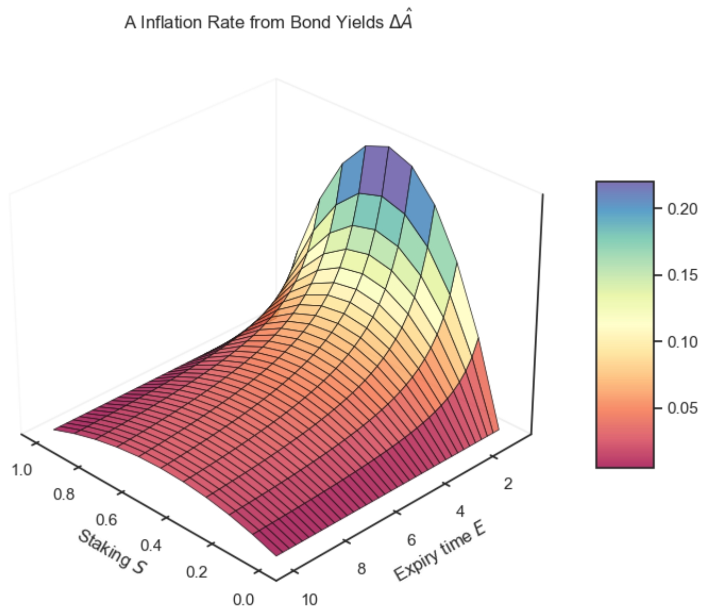
Figure 6: Example of Bond Market State



See Appendix A for further outputs.

For visualising the sensitivity of A overall inflation rates with respect to staking and duration, Figure 7 assumes a single maturity over the staking range to provide an approximation of inflation $\Delta A \approx Z \cdot S$.

Figure 7: Range of A Inflation



5 Governance

Governance rights, for example the whitelisting (blacklisting) of Carbon classes, and any other matter requiring token stakeholder voting, are allocated to two cohorts:

1. Bond staking: S_t
2. Locked liquidity in the A - G pair $\overline{AG}$ (see Section 7) defined here as A_{Gt} representing the quantity of A tokens held in the liquidity pool expressed as a proportion of circulating supply.

Voting power is allocated by time and applied to the respective balance of A:

1. Initial voting weights for Bonds v_t:

$$v_t = Z_t \cdot S_t \cdot B_t \tag{11}$$

2. Initial voting weights for LPs w_t:

$$w_t = Z_t \cdot A_{Gt} \cdot B_t \tag{12}$$

1. Final voting weights Bonds V_t:

$$V_t = \frac{v_t}{\sum_{j=1}^{40}(v_j + 2w_j)} \tag{13}$$

2. Final voting weights LPs W_t

$$W_t = \frac{w_t}{\sum_{j=1}^{40}(\frac{1}{2}v_j + w_j)} \tag{14}$$

6 Automated Asset Manager

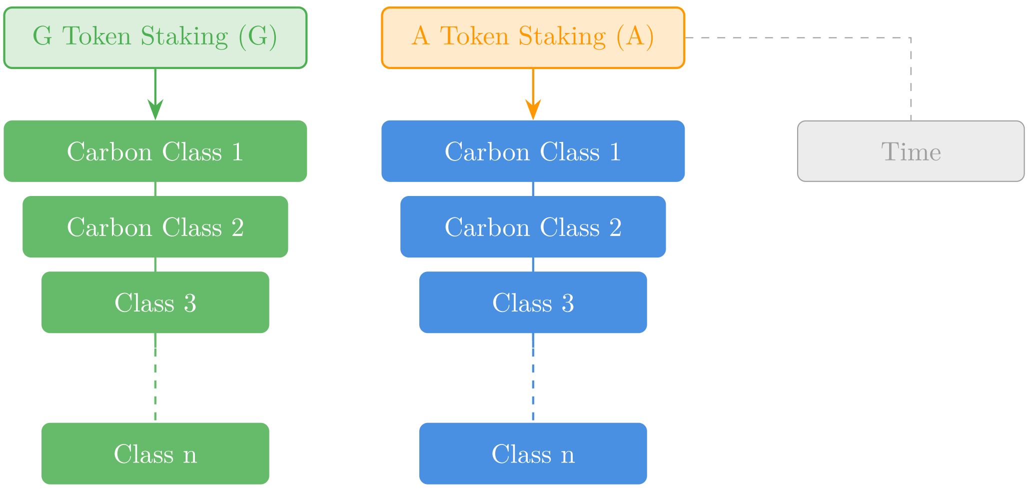
6.1 Carbon Sales (AAM Purchase)

6.1.1 Existing Carbon in the Portfolio

Carbon classes $i \in \{1, 2, 3, ..., n\}$ are whitelisted through governance by the A token and the $\overline{\texttt{AG}}$ LP holders (see Section 5).

For Carbon pricing, both the A tokens and the G tokens may stake for specific Carbon classes C_i and these are independent stakes between the two token systems.

Figure 8: Token Staking Class Structure



For a Carbon class quantity to be sold to the AAM, it must have a strictly positive quantity of A tokens staked for that Carbon class, otherwise there is no price, and the Carbon cannot be sold.

Defining:

A: Total A tokens staked for pricing of Carbon classes, expressed as a proportion of outstanding supply of A Tokens.

C_i: Total tonnes of Carbon class i currently held in the portfolio.

A_i: A tokens staked for Carbon class i expressed as a proportion of outstanding supply of A Tokens where $\sum A_i = A$.

G_i: G tokens staked for class i expressed as a proportion of outstanding supply of G Tokens.

C_{it}: The quantity of Carbon class i held in the AAM deliverable per maturity t where C_{i0} reflects the liquid quantity.

In order to determine the present-value quantity of Carbon, $\bar{C}_i$ we apply the discount curve from Equation (7) to the liquidity schedule and sum the discounted holdings:

$$\bar{C}_i = C_{i0} + \sum_{t=1}^{40} B_t \cdot C_{it} \tag{15}$$

Similarly, taking ΔC_{it} as the quantity of Carbon i to be sold with a specific maturity index t.

$$\Delta\bar{C}_i = \Delta C_{i0} + \sum_{t=1}^{40} B_t \cdot \Delta C_{it} \tag{16}$$

Once standardised by the discount curve, trades can be agglomerated in the same class for the defined trade or auction period.

Where $\Delta\bar{C}_i)$ is expressed as the relative increment to its respective pool balance, the amount of `A` tokens issued to pay for Carbon, ΔA, expressed as a proportion of current supply, is determined as:

$$\ln(1 + \Delta A) = \left(A_i - \frac{A_i^2(1 - G_i)^2}{2}\right)\ln(1 + \Delta\bar{C}_i) \tag{17}$$

For completeness, denoting the expression on the right hand side of Equation (17) as RHS:

$$\Delta A = e^{\text{RHS}} - 1 \tag{18}$$

Finally, ΔA is applied to the outstanding supply of A to solve for token quantities.

Figure 9 illustrates the G token capacity to maintain the initial portfolio pricing of the A token. The data has been normalised in Figure 10 to $\Delta\bar{C}_i A_i$

Figure 9: A Price Curves (ΔA) when $\Delta\bar{C}_i = 1$

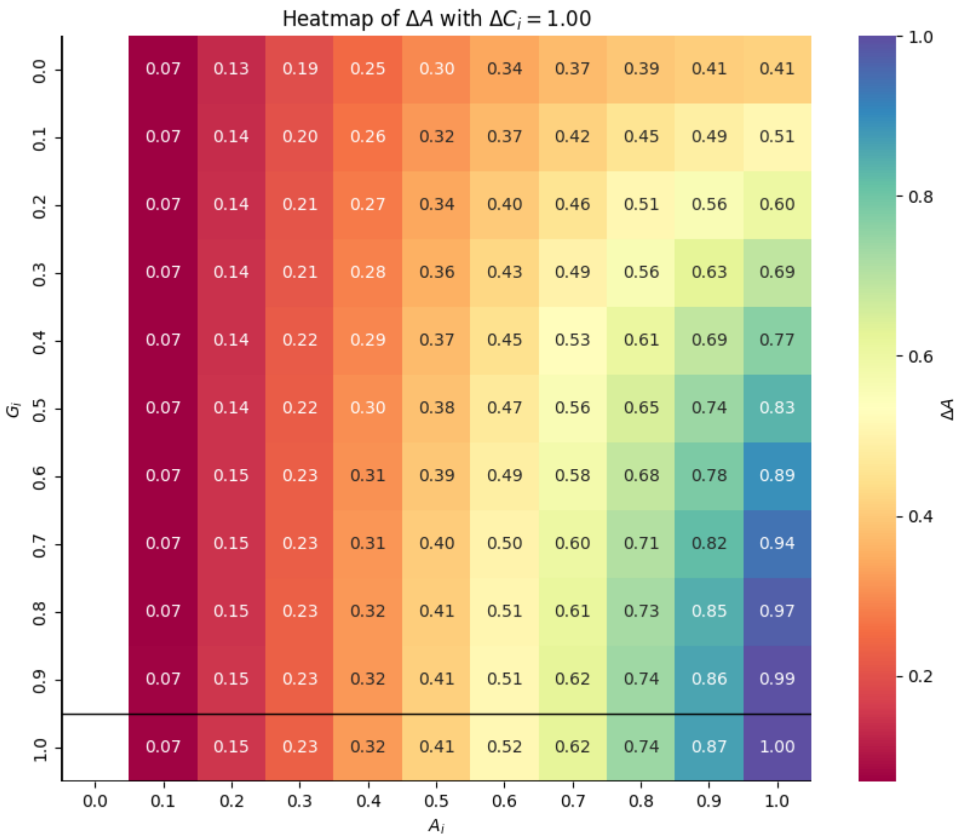
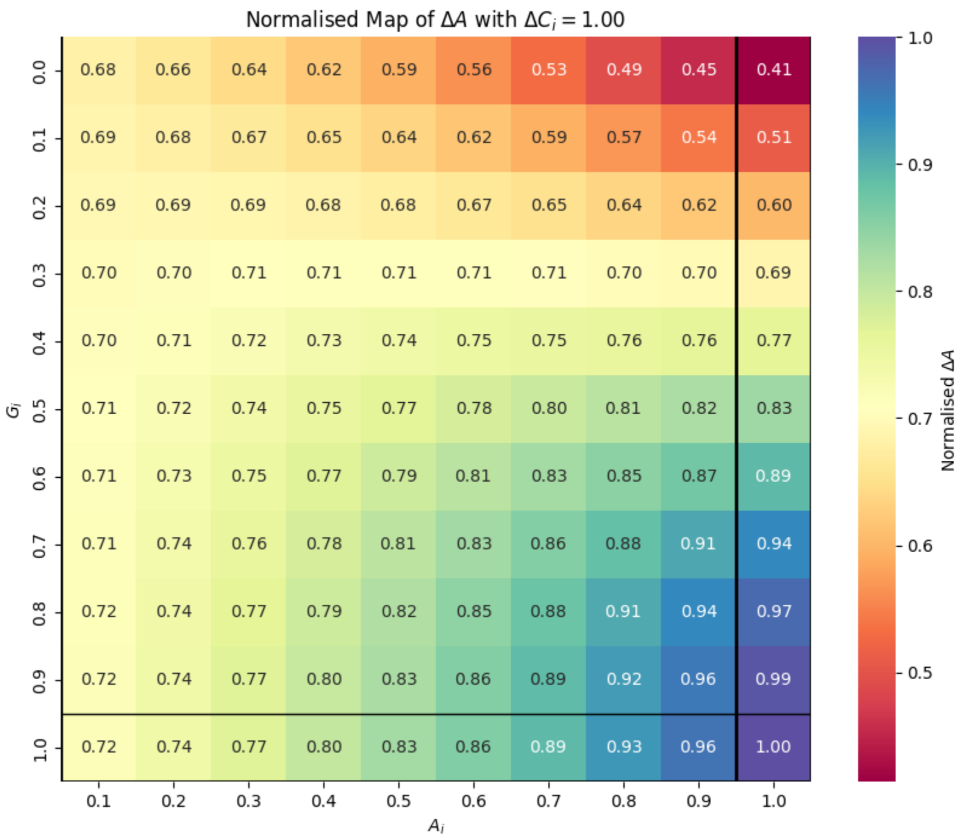


Figure 10: Normalised A Price Curves (ΔA) when $\Delta\bar{C}_i = 1$



Noting that the sensitivity to G increases as A increases and the effects become more pronounced as $\delta\bar{C}_i$ increases.

Examples can be seen in Appendix B.

6.1.2 Zero Carbon scenario

There is the circumstance when there is zero Carbon held in the portfolio for a particular class, i.e. $C_i = 0$ which invalidates the calculation of $\Delta\bar{C}_i$. This is dealt with by computing an *implied* portfolio balance $\tilde{C}_i$.

Defining $\bar{C}_j$ as the Carbon balances under Equation (15) for the whole portfolio of J Carbon classes with strictly positive Carbon balances and A_j as the respective price stakes expressed as the proportion of outstanding `A` tokens; and with $C_\emptyset$ as any Carbon class with a zero Carbon balances with a strictly positive `A` price stake.

The implied balance for any zero carbon asset is given as:

$$\tilde{C}_\emptyset = \left(\prod_{j=1}^{J} \bar{C}_j^{A_j}\right)^{\dfrac{1}{\sum_1^J A_j}} \tag{19}$$

Hence $\hat{C}_\emptyset$ can be substituted in Equation (16) for $\bar{C}_i$ and the process can compute.

6.2 Carbon Retirement (AAM Sells)

6.2.1 Weighted Carbon Class

For retiring Carbon that is *weighted*, that is there is a strictly positive `A` token stake for that class, an `A` token holder can extract the Carbon class offset of their choice C_i but the available pool is only the liquid balance, namely the element C_{i0}

$$\ln(1 + \Delta C_i) = \frac{\ln(1 - \Delta A)}{A_i + \frac{1}{2}A_i^2(1 - G_i)^2} \quad \Delta A \neq 1 \tag{20}$$

As before denoting the expression on the right hand side of Equation (20) as RHS:

$$\Delta C_i = e^{\text{RHS}} - 1 \tag{21}$$

Figure 11: Proportion of Carbon Retired when $\Delta A = 0.10$

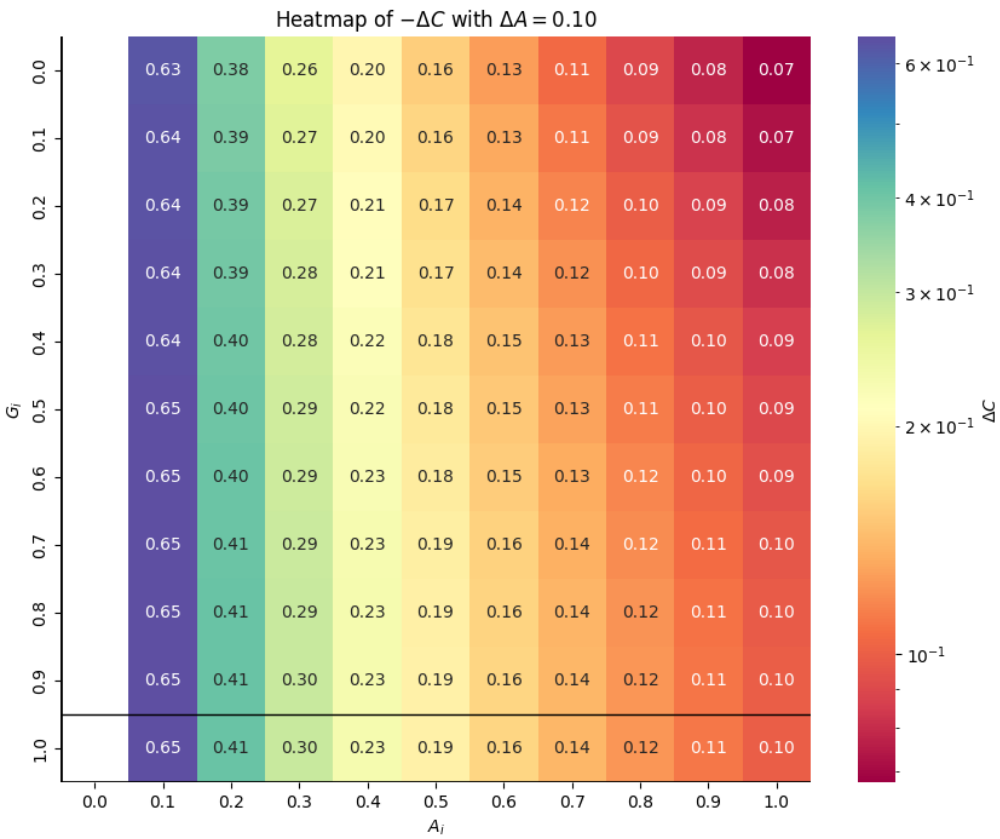


Figure 11 shows the cost of Carbon increasing with A_i and G_i increasing.

More examples are in Appendix C.

6.2.2 Unweighted Carbon Class

When a Carbon class is included in the portfolio but currently has no weighting ($A_i = 0$) some modifications are required. An important distinction is the retirement of zero-weighted Carbon is as a portfolio and not for specified Carbon classes. The A token burnt will receive a portion of the underlying residual portfolio weighted by tons of liquid Carbon.

Assuming $A \neq 1$:

A_i is replaced in Equation (20) for the residual portfolio of unweighted Carbon, $C_\emptyset$. with an implied weighting $\tilde{A}_\emptyset$ derived from the total liquid Carbon assets

$$\tilde{A}_\emptyset = (1 - A)^2 \tag{22}$$

With K classes of Carbon existing in the residual portfolio, noting that $C_{\emptyset 0} = \sum_{k=1}^{K} C_{k0}$, with G_k similarly defined, we can determine a residual average for $G_\emptyset$:

$$G_\emptyset = \frac{1}{C_{\emptyset 0}} \sum_{k=1}^{K} G_k \cdot C_{k0} \tag{23}$$

Substituting in Equation (20)

$$\ln(1 + \Delta C_\emptyset) = \frac{\ln(1 - \Delta A)}{\tilde{A}_\emptyset + \frac{1}{2}\tilde{A}_\emptyset^{\,2}(1 - G_\emptyset)^2} \quad \Delta A \neq 1 \tag{24}$$

The result $\Delta C_\emptyset$ is applied to the liquid elements of the residual portfolio to determine the delivery quantities.

If $A = 1$:

In the event that there is 100% `A` staking for price, and the portfolio consists of zero-staked Carbon classes with liquid balances, the portfolio begins to issue these balances to <u>all A Bond holders</u> as a daily liquid yield using the governance based weightings W in Section 5, Equation (13).

With S as previously defined as the total A tokens staked as bonds (Time staking):

$$\Delta C_\emptyset = \frac{1}{365} \cdot \frac{S}{1 - \frac{1}{2}(1 - G_\emptyset)^2} \tag{25}$$

6.2.3 Liquidation: $\Delta A = 1$

In the event that 100% of `A` tokens are placed into the burn mechanism for Carbon offsets, the following occurs:

- The portfolio of liquid tokens is distributed to the `A` token sellers pro-rata to `A` contribution
- A new set of nominal `A` tokens are issued to locked `G` token holders on a pro-rata basis

Figure 12 below shows the spread captured on a 'round trip' by the system where ϵ is the proportion retained:

Figure 12: Carbon 'Spread'

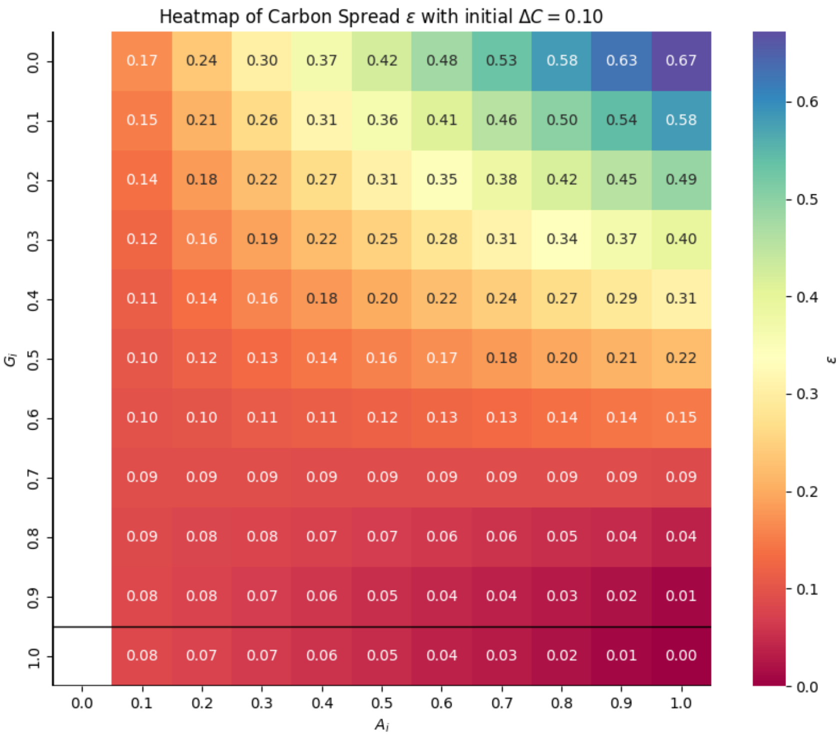
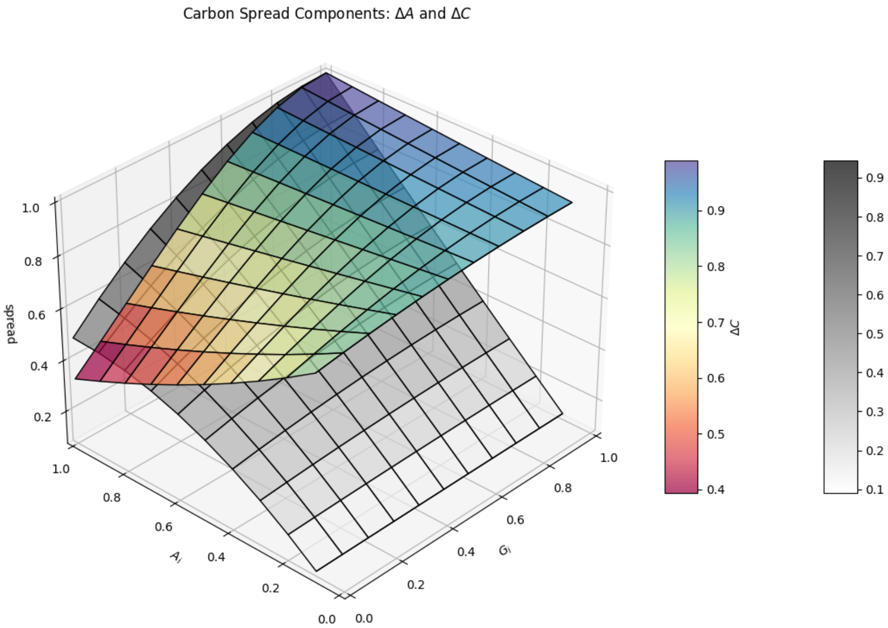


Figure 13 shows the component spread parts on a Carbon sale and purchase converging to 1 (no spread) as A_i and G_i tend to 100%.

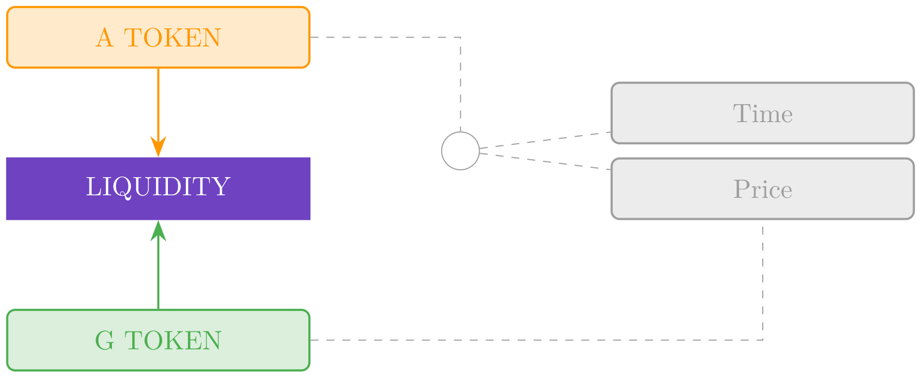
Figure 13: Carbon 'Spread' Components



7 Liquidity

Both A and G tokens can be used independently of price (and time) staking for providing liquidity.

Figure 14: Token Liquidity and Pricing Structure



There are two core liquidity pools:

1. An AMM 50:50 pairing of `A` and `G` tokens; pool $\overline{\texttt{AG}}$.
2. A hard currency USDC denoted as `Q` paired with `A`; pool $\overline{\texttt{AQ}}$.

7.1 Liquidity Fees

The $\overline{\texttt{AQ}}$ pool will have its own set of fees in the normal way[1].

The $\overline{\texttt{AG}}$ pool has different economics as the assets are highly correlated since they represent the same economy. For this reason, the fees are extremely low.

By locking liquidity (LP tokens) to the **standard maturities**, both pools may receive a distribution of `A` tokens determined from the Risky Yield calculation below. This is an <u>additional</u> primary issuance to the Bond yields already discussed.

[1] Note the development of LP pricing functionality may be applicable

8 Risky Yield

8.1 Beta Determination

We can consider the Bond market yield as the system *risk-free* rate. In addition to this mechanism, a *risky* spread is determined that is ultimately paid to the liquidity providers of the `A` and `G` tokens as compensation for the risk levels assumed.

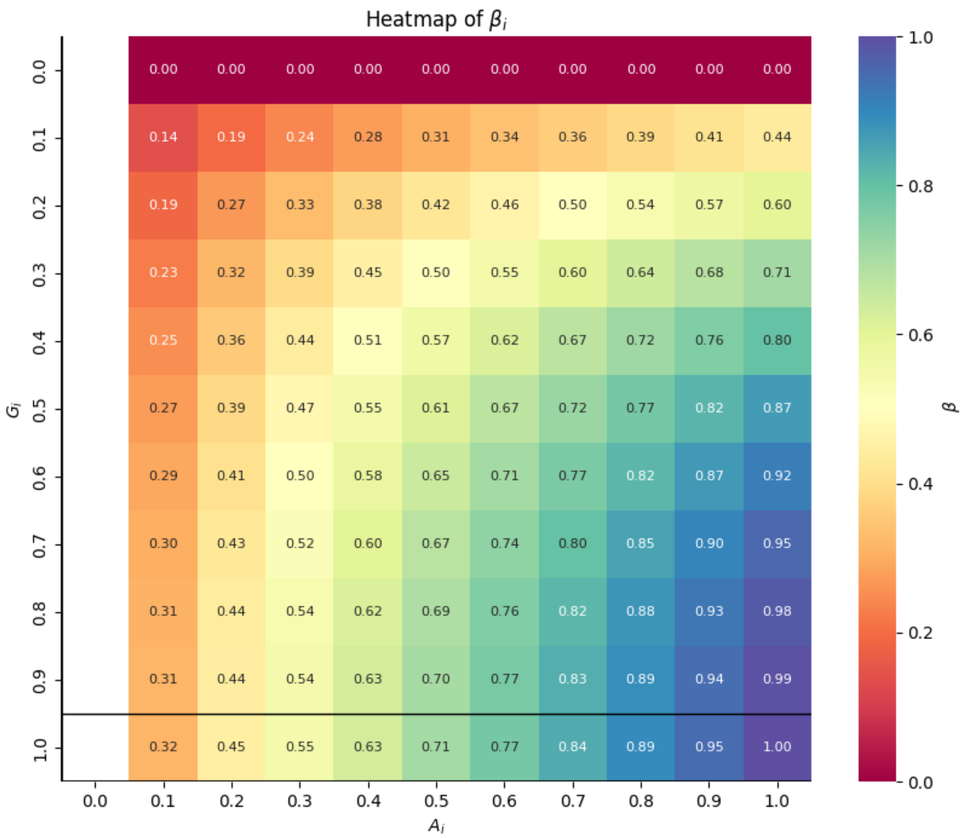
As we have seen, the `G` token has an impact on risk-pricing of `A`. As `G`staking increases, the relationship between the Carbon class selected under G_i and the portfolio token `A` strengthens. We can consider G_i staking as an estimate of residual or idiosyncratic risk in the carbon-class and this allows us to calculate a portfolio beta β from the implied betas of each carbon class i.

$$\beta = \sqrt{\sum_{i=1}^{n} A_i - A_i(1 - G_i)^2} \tag{26}$$

The portfolio β determines a yield factor for the liquidity pools of A to compensate for the implied risk levels.

For intuition, the map in Figure 15 shows the various outputs of the function per Class where Figure **??** assumes an equally distributed allocation of A tokens per class for overall portfolio β.

Figure 15: Range of β_i



The table and figure below shows an example of the effects on β on allocating large G values to small A values where the shift in G results in a lower β (0.11 from 0.37) with no change to total G and A staking.

Table 2: Effect on β from outsized G Staking

Class	1	2	3	4	β
A_i	0.50	0.20	0.10	0.05	
G_i	0.30	0.10	0.05	0.01	
β_i^2	0.2550	0.0380	0.0098	0.0010	0.5511
New G_i	0.01	0.05	0.10	0.30	
ΔG_i	(0.29)	(0.05)	0.05	0.29	
β_i^2	0.0100	0.0195	0.0190	0.0255	0.2719
$\Delta\beta_i^2$	(0.2451)	(0.0185)	0.0092	0.0245	

Figure 16: Example of G Stake on β

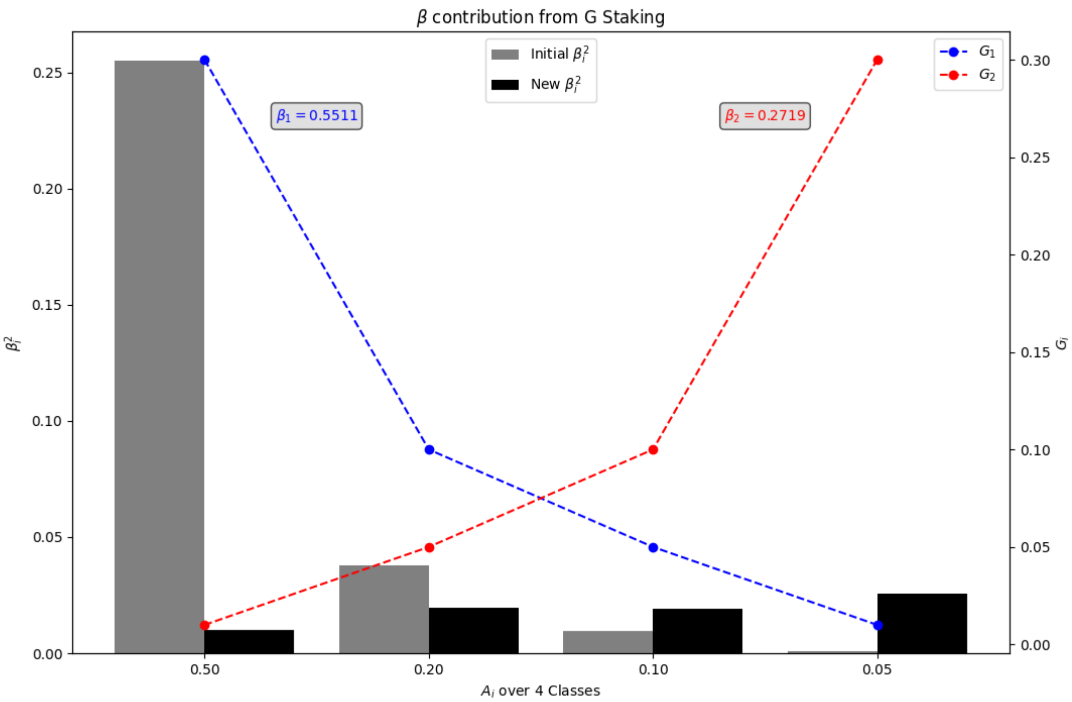
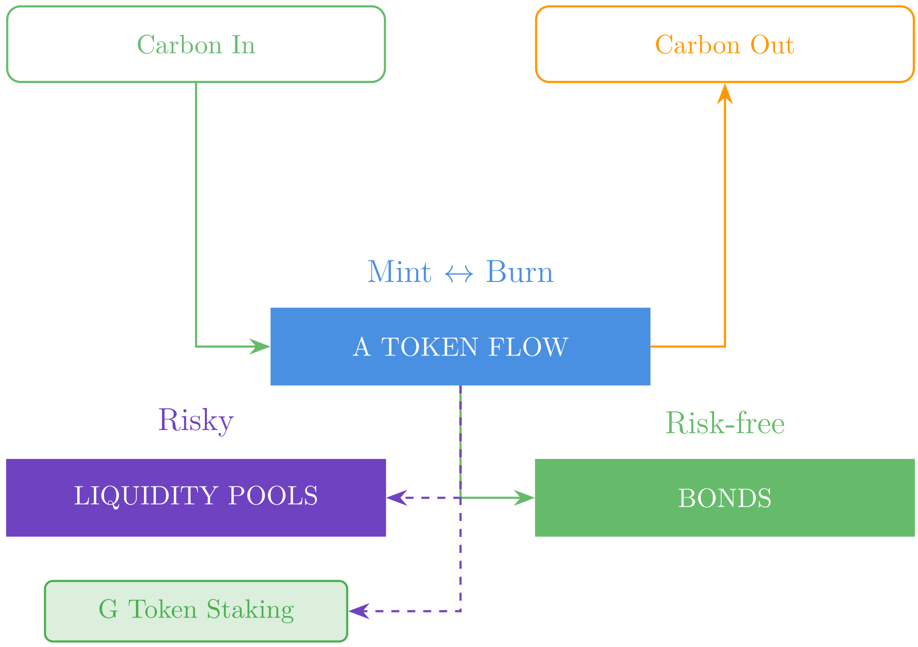


Figure 16 shows the β sensitivity to G staking as a function of A stake; that is to say that a large G stake on a small A stake has limited effects (notwithstanding other consequential factors).

8.2 Allocation of Risk Premium

The full issuance of `A` tokens is depicted below including now the risky premium for the liquidity pools accordingly.

Figure 17: A Token Flow Structure



8.3 Share of Risky Premium

The risky premium allocation is shared between G staking, $\overline{\texttt{AG}}$ and $\overline{\texttt{AQ}}$ pools with shares λ_{GG}, λ_G and λ_Q respectively.

Defining:

G_G: Total `G` tokens in the $\overline{\texttt{AG}}$ pool, expressed as a proportion of outstanding supply of `G`.

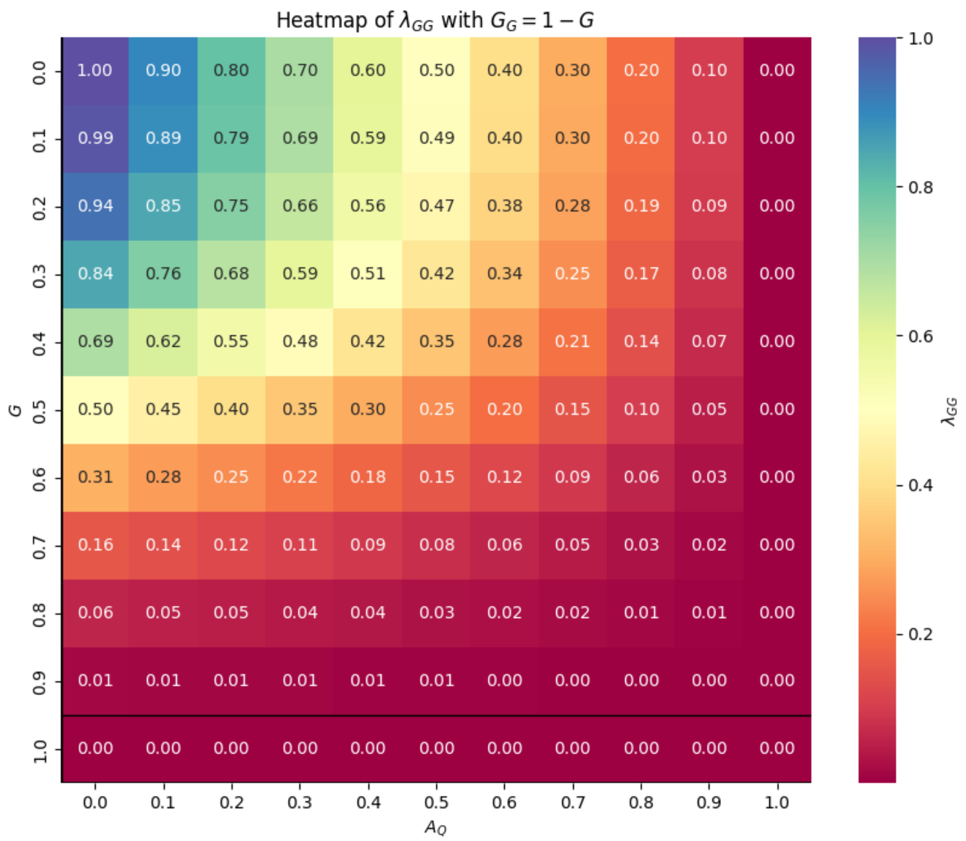
A_G: Total `A` tokens in the $\overline{\texttt{AG}}$ pool, expressed as a proportion of outstanding supply of `A`.

A_Q: Total `A` tokens in the $\overline{\texttt{AQ}}$ pool, expressed as a proportion of outstanding supply of `A`.

The allocation to `G` token staking, λ_{GG}:

$$\lambda_{GG} = \frac{1 - A_Q}{1 + \left(\frac{G_i}{G_G}\right)^2} \tag{27}$$

Figure 18: G Stake Allocation (assuming $G_G = 1 - G_i$)



Noting the relationship between G and β, and particularly if $G = 0$, $\beta = 0$.

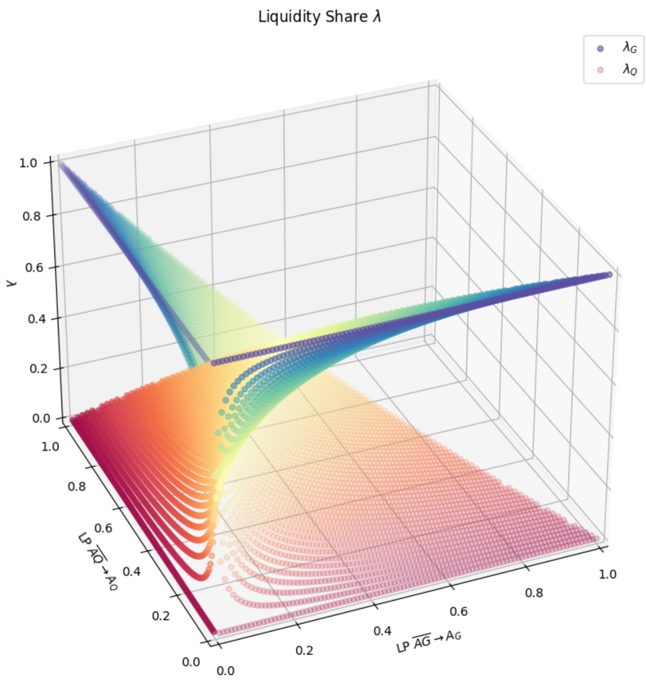
The residual share, $1 - \lambda_{GG}$, is split between the liquidity pools:

$$\lambda_G = \frac{2A_G}{2A_G + A_Q\sqrt{2}} \tag{28}$$

For completeness:

$$\lambda_Q = 1 - \lambda_G \tag{29}$$

Figure 19: Liquidity Pool Split λ_G, λ_Q



8.4 Risky Premium Distribution

For $\lambda_{GG}, \lambda_G, \lambda_Q$ we apply β:

$$\Lambda_X = \lambda_X \cdot \beta, \quad \text{for } X \in \{GG, G, Q\} \tag{30}$$

Taking b as a discount parameter:

$$b = \frac{\sum_1^{40} Z_t \cdot S_t \cdot B_t}{\sum_1^{40} Z_t \cdot S_t} \tag{31}$$

The total Risky Yield tokens R_λ:

$$R_\lambda = b \cdot R \cdot (\Lambda_3 + \Lambda_4 + \Lambda_5) \tag{32}$$

The allocations of R_λ are pro-rata to $\Lambda_3, \Lambda_4, \Lambda_5$ and thereafter:

1. Locked `G`: Λ_3 in proportion to `G`.
2. Locked $\overline{\texttt{AG}}$, $\overline{\texttt{AQ}}$ tokens are allocated a weighting G_t, Q_t depending on their time bucket t:

$$G_t = \frac{Z_t \cdot L_{Gt} \cdot B_t}{\sum Z_t \cdot L_{Gt} \cdot B_t} \tag{33}$$

$$Q_t = \frac{Z_t \cdot L_{Qt} \cdot B_t}{\sum Z_t \cdot L_{Gt} \cdot B_t} \tag{34}$$

Where L_{Gt}, L_{Qt} are the proportion of all liquidity locked in each time bucket for $\overline{\texttt{AG}}$ and $\overline{\texttt{AQ}}$ respectively.

Thereafter each time bucket allocation is proportionate to LP holdings.

9 Distribution

9.1 Planned Allocations

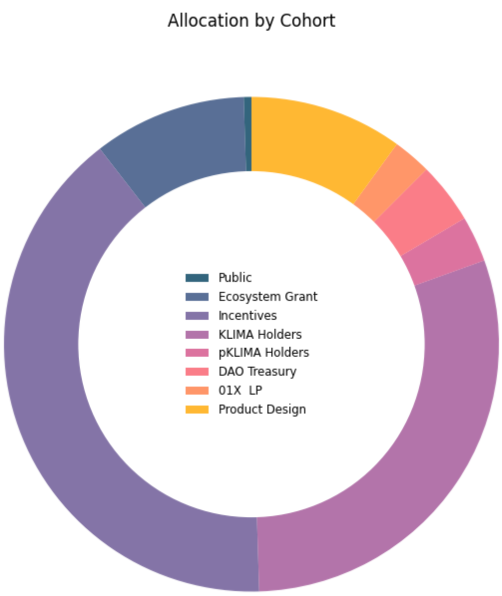
Table 3: KLIMA Token

Cohort	Proportion	Quantity (m)
Klima Holders	87.5%	17.5
DAO / Treasury	10%	2.0
01X	2.5%	0.5
Total		20

Table 4: KLIMAX Token

Cohort	Proportion	Quantity (m)	Liquidity
Klima Holders	40%	40	Logistic Vesting 48 months
Ecosystem Grant	5%	5	Logistic Vesting 48 months
Programmatic Incentives	40%	40	Incentive Curve
pKlima Holders	3.0%	3	Logistic Vesting 48 months
DAO / Treasury	4.5%	4.5	24 month locked LP of $\overline{AG}$
01X	2.5%	2.5	24 month locked LP of $\overline{AG}$
Product design and development	5%	5	Logistic Vesting 48 months
Total		100	

Figure 20: Allocations: KLIMAX Token



9.2 Programmatic Incentive Curve

The incentive issuance is built on a sigmoid curve, P to generate total proportion of supply in issue. It is calibrated from the initial issuance at TGE, $\mathrm{P_0}$ and the inflection point time T where 50% of G token incentives have been released.

Initiating $\mathbf{x_0}$ from the initial issuance parameter:

$$\mathrm{x_0} = \ln\left[\frac{\mathrm{P_0}}{1-\mathrm{P_0}}\right] \tag{35}$$

with $_t$ at time point t, $(t \in (0, \infty))$:

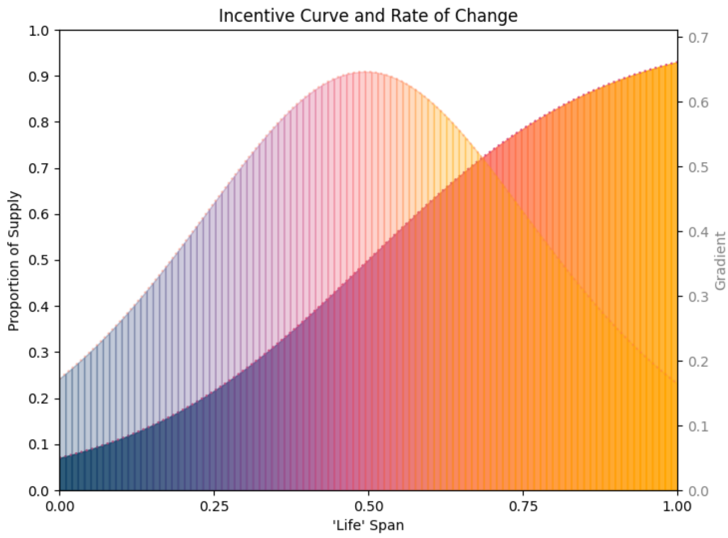
$$\mathrm{x_t} = \mathrm{x_0} \cdot \left[1 - \frac{t}{\mathrm{T}}\right] \tag{36}$$

Giving supply function $\mathrm{P_t}$ as:

$$\mathrm{P_t} = \frac{e^{\mathrm{x_t}}}{e^{\mathrm{x_t}} + 1} \tag{37}$$

Setting $\mathrm{P_0}$ set at 7.0%:

Figure 21: Incentive Issuance



The inflection point (T) is set at 24 months.

Figure 22: KLIMAX Token Supply Over Time

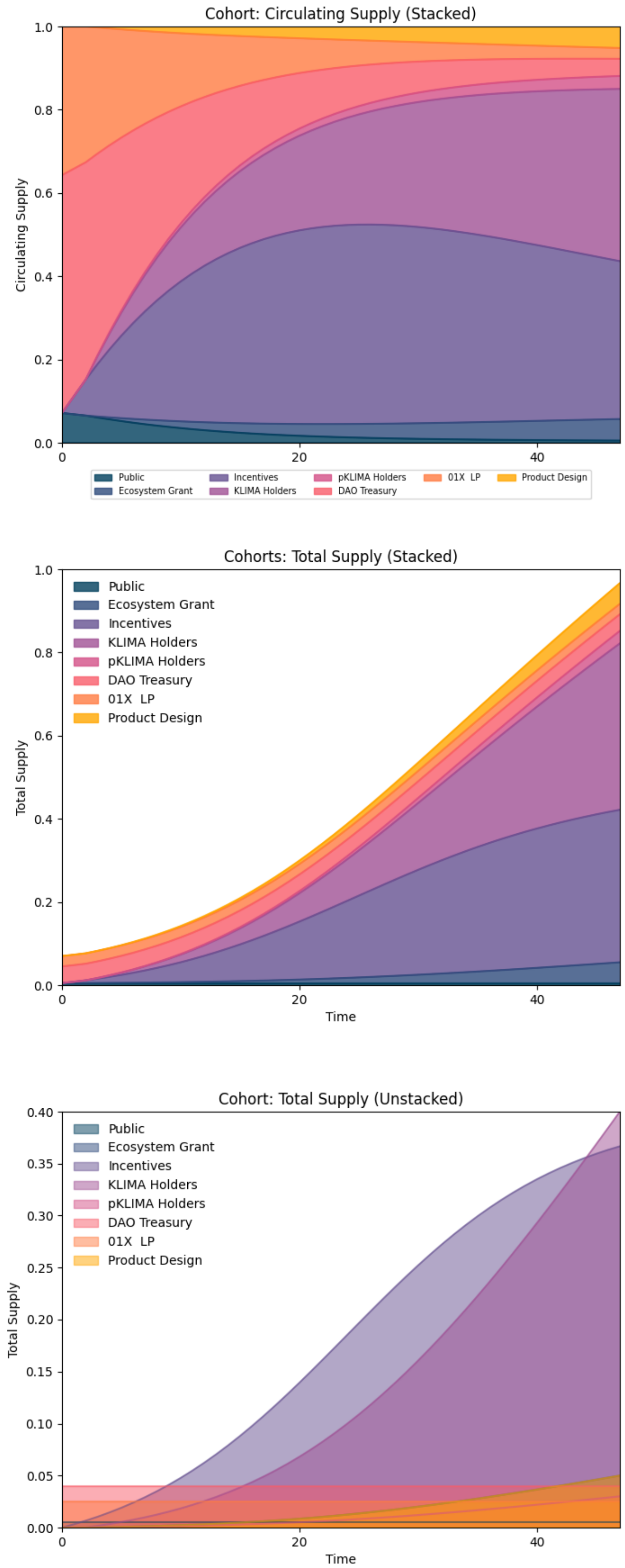
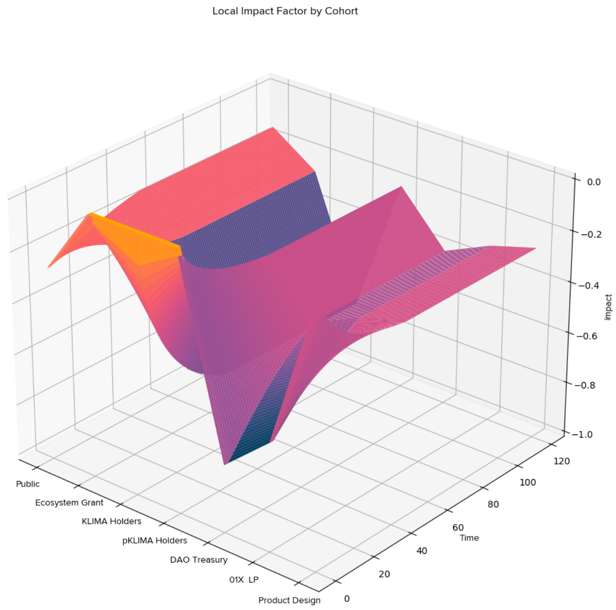
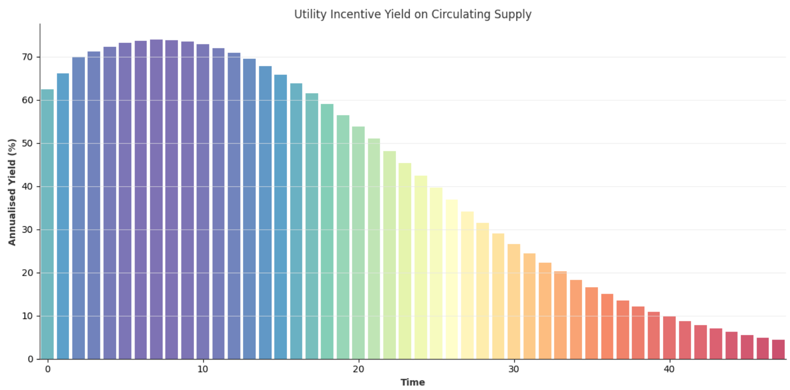


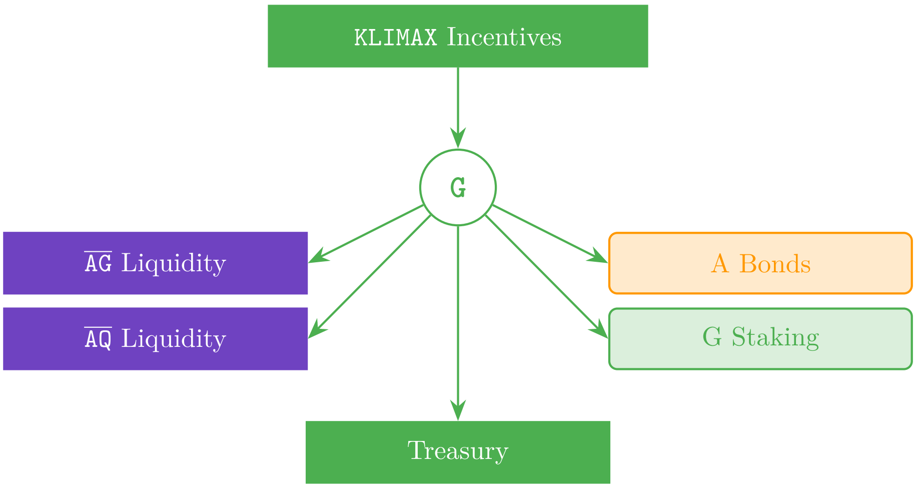
Figure 23: KLIMAX Token Supply Risk Metrics





9.3 Incentive Allocations

Figure 24: G Token Incentive Distribution Structure



The **relative utilisation** measurement factor υ is calculated as follows:

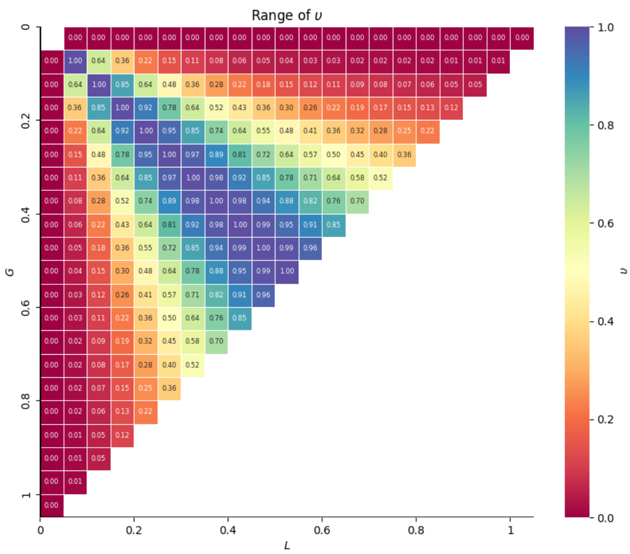
Defining initially:

G: Total G tokens staked expressed as a proportion of circulating supply, $G \in [0, 1]$.
L: Total G tokens held in the $\overline{\texttt{AG}}$ pool expressed as a proportion of circulating supply, $L \in (0, 1]$.

Where $\upsilon = 0$ if $G + L = 0$ otherwise:

$$\upsilon = \left[\frac{2GL}{G^2 + L^2}\right]^2 \tag{38}$$

Figure 25: Upsilon υ range of values



The **absolute utilisation** parameter η is defined as:

$$\eta = \frac{1}{1 - \ln(G + L)}, \quad G + L \neq 0 \tag{39}$$

Where $\eta = 0$ if $G + L = 0$.

Incentives **I** are allocated as follows:

Treasury

The allocation to the Treasury I_T is the imbalance generated from υ:

$$I_T = 1 - \upsilon \cdot \eta \tag{40}$$

The residual post Treasury allocation is shared four ways within 2 buckets:

(1) A Bonds & G Staking

Where S is the proportion of A tokens that are staked for Bonds (as defined previously in Section 4):

i. A Bonds, I_S:

$$I_S = S \cdot \frac{L^2}{G^2 + L^2} \tag{41}$$

ii. G Staking, I_G:

$$I_G = (1 - S) \cdot \frac{L^2}{G^2 + L^2} \tag{42}$$

(2) Liquidity

With λ_G, λ_Q,$\lambda_G G$ as defined in Section 8.3:

iii. $\overline{\texttt{AG}}$ Pool I_{AG}

$$I_{AG} = \frac{\lambda_G}{1 - \lambda_{GG}} \cdot \frac{G^2}{G^2 + L^2} \tag{43}$$

iv. $\overline{\texttt{AQ}}$ Pool, I_{AQ}:

$$I_{AQ} = \frac{\lambda_Q}{1 - \lambda_{GG}} \cdot \frac{G^2}{G^2 + L^2} \tag{44}$$

Figure 26: Share of Non-Treasury Incentives (1)(2)

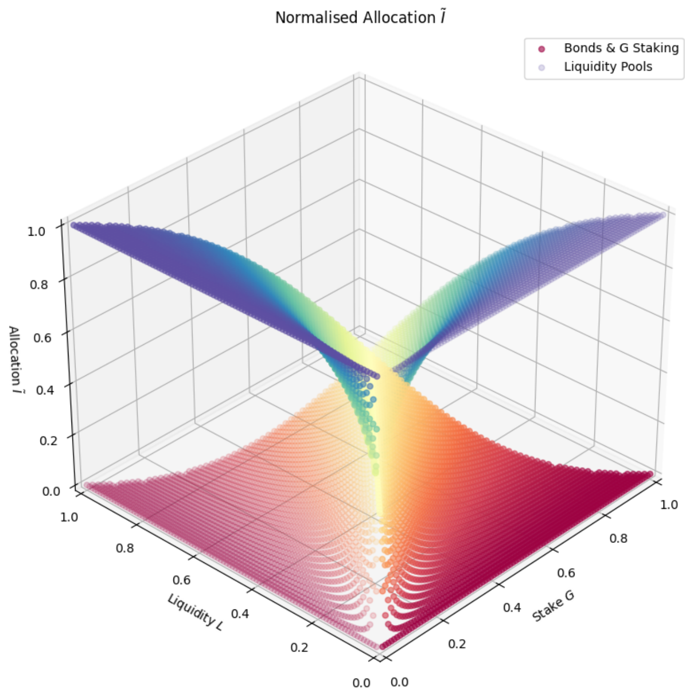
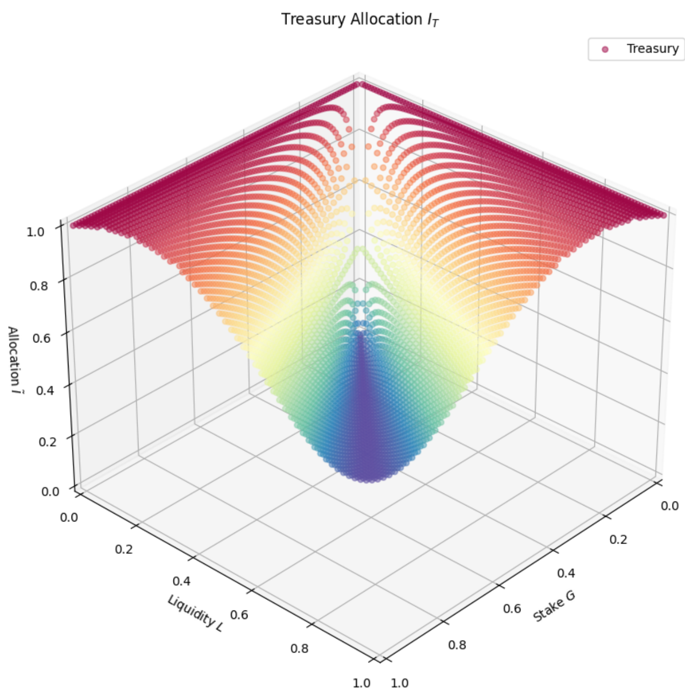
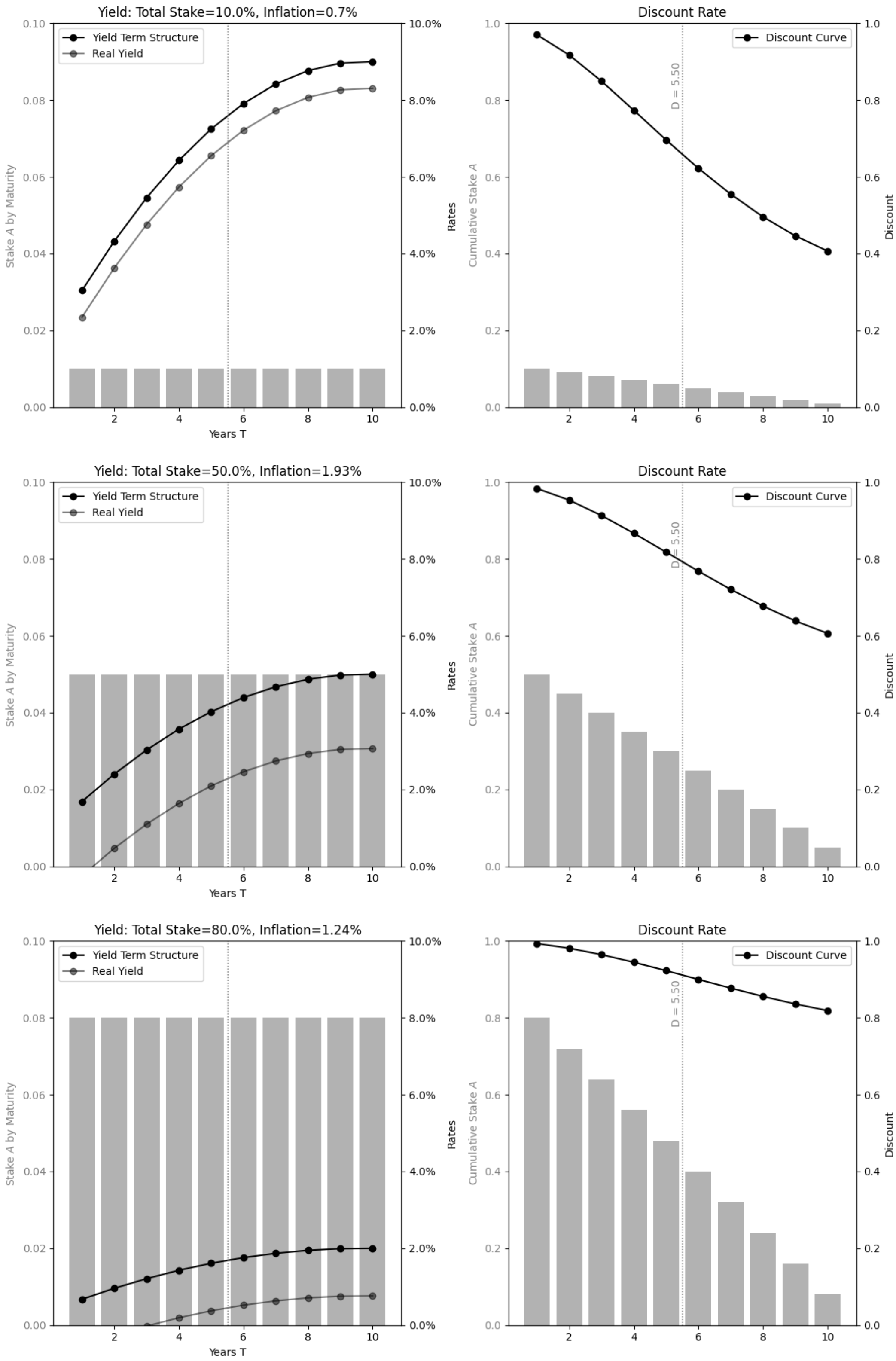


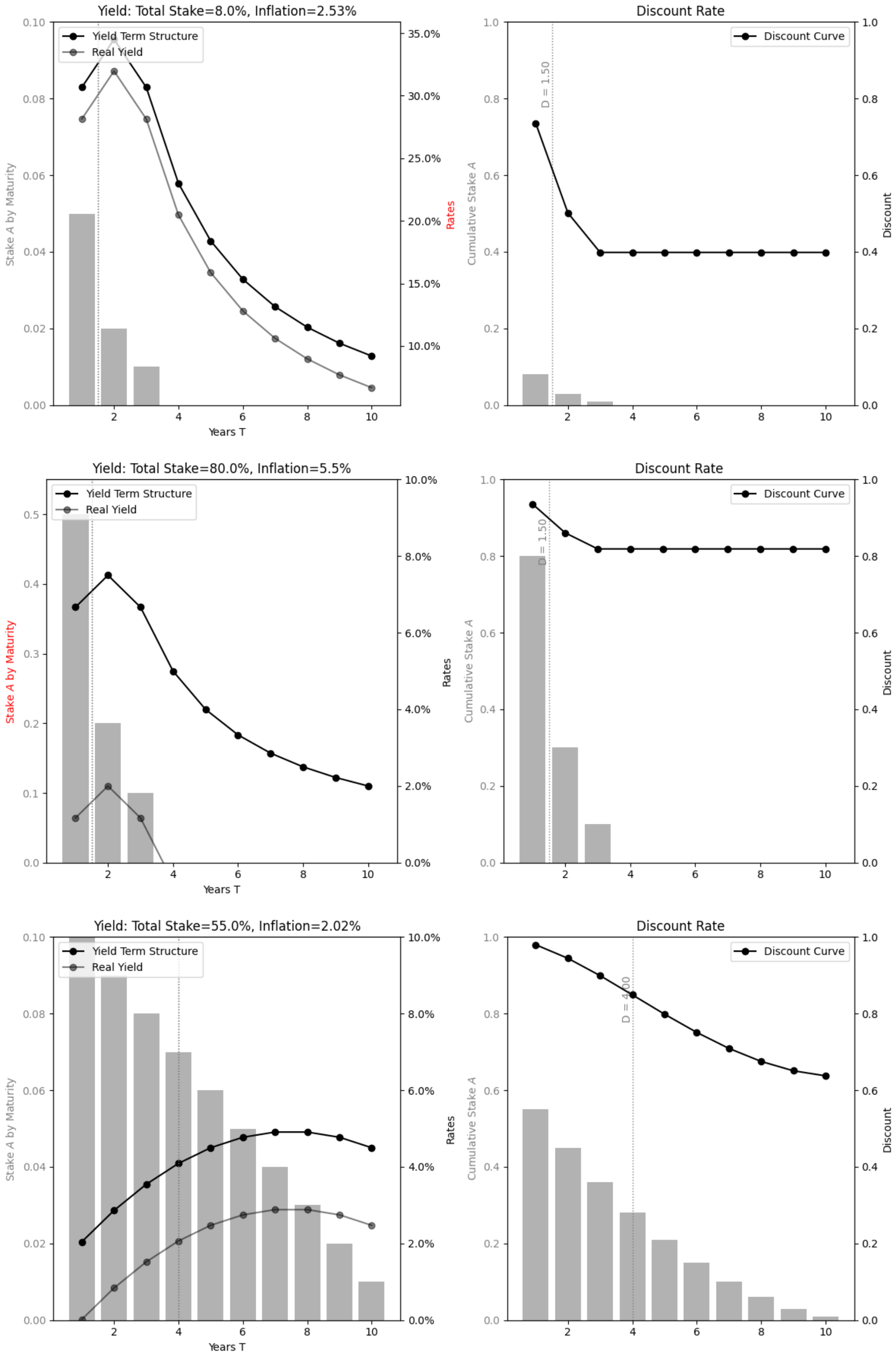
Figure 27: Treasury Incentives I_T

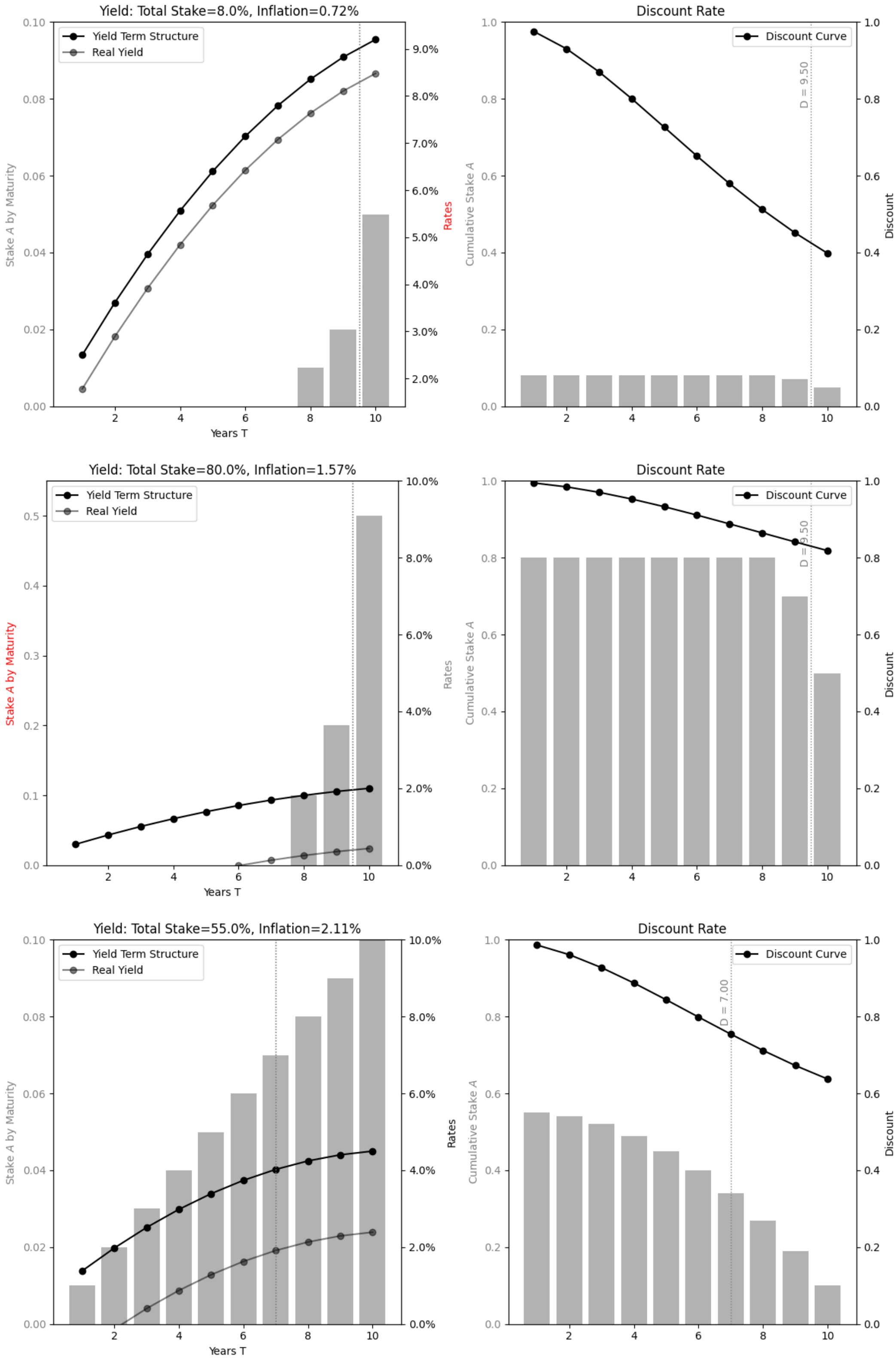


APPENDIX

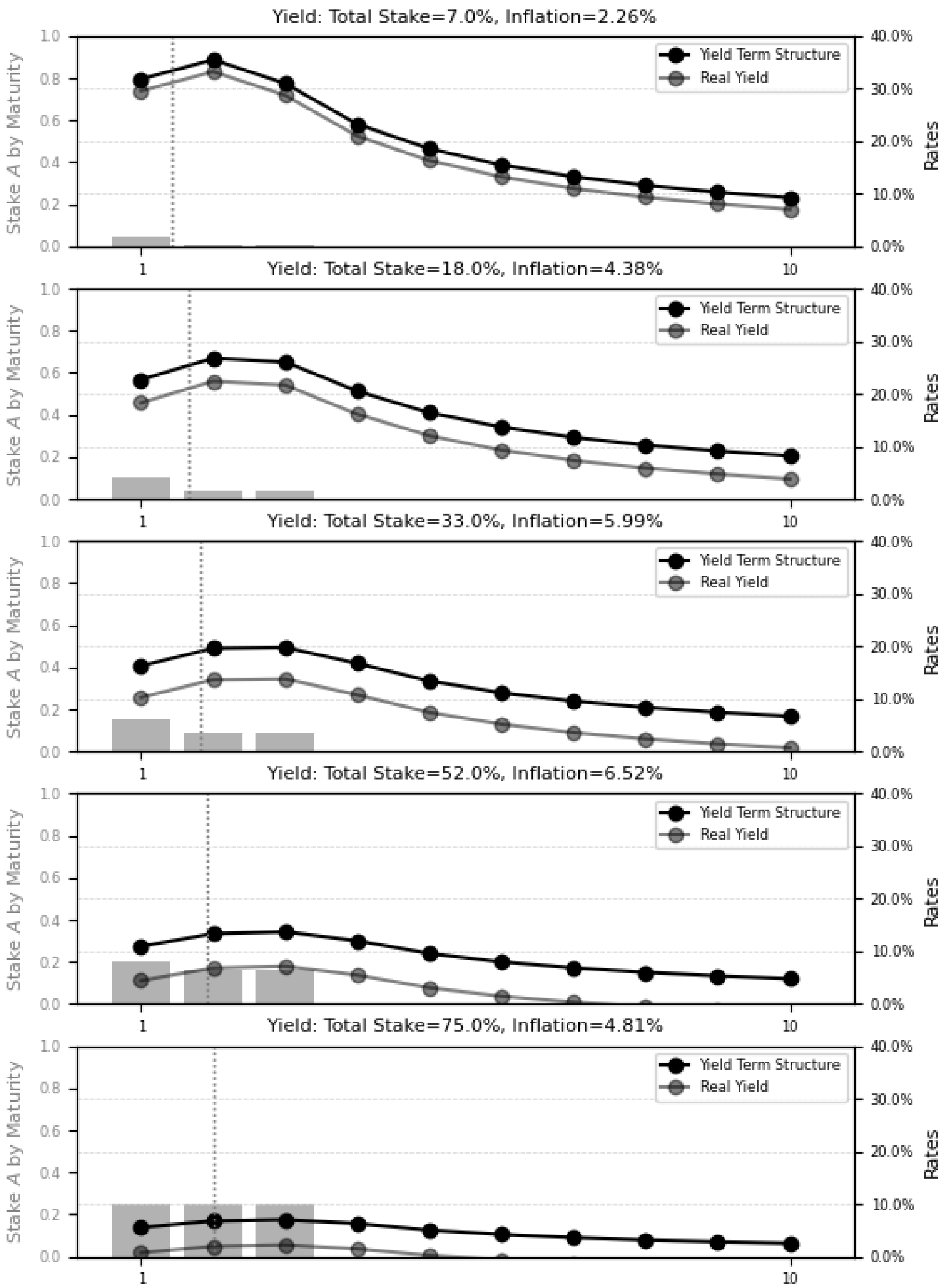
A Bond Market Outputs

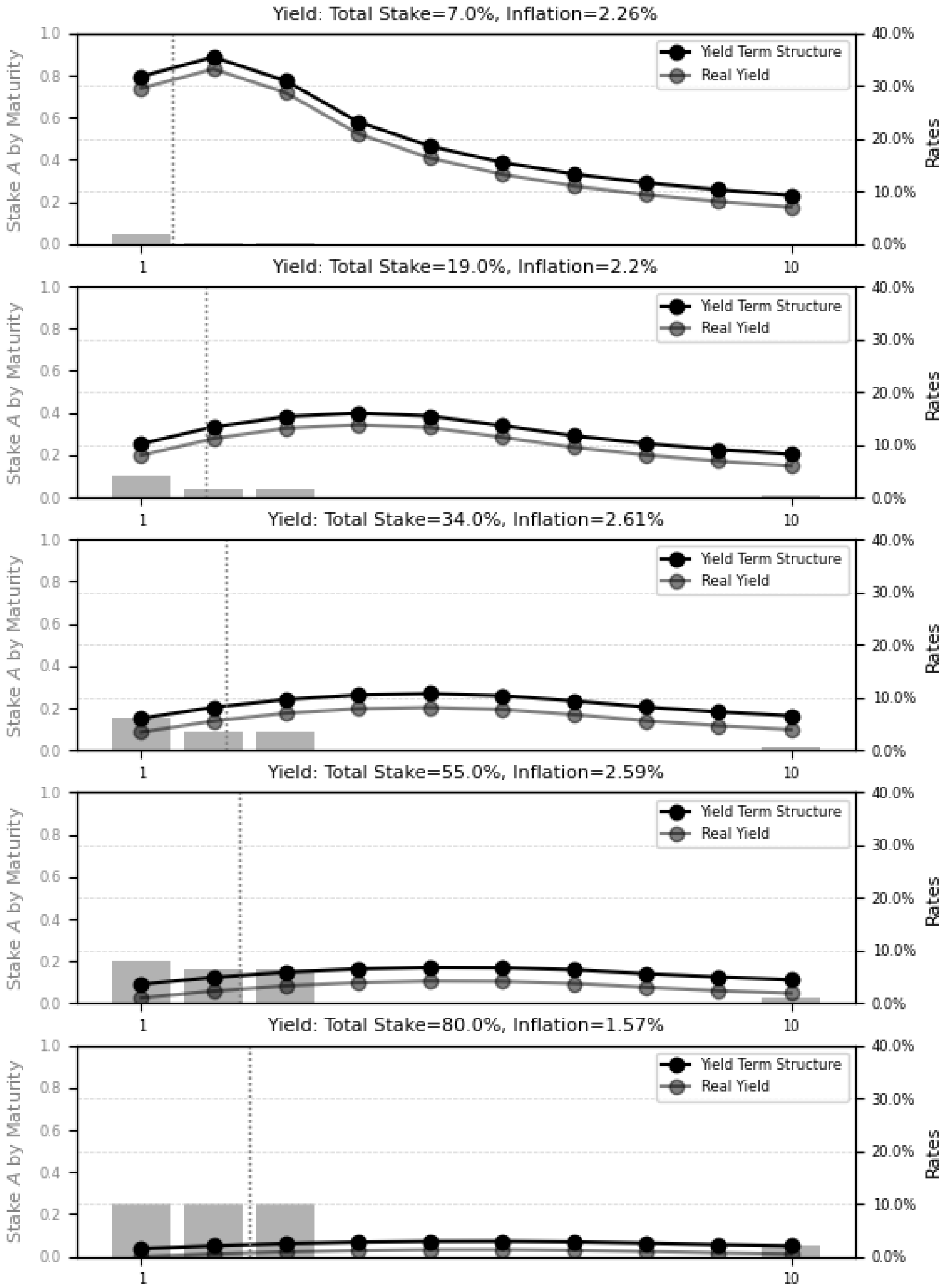



Yield: Total Stake=8.0%, Inflation=2.53%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
Years T
Discount Rate
Discount Curve
D = 1.50
Cumulative Stake A
Discount
Yield: Total Stake=80.0%, Inflation=5.5%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
Years T
Discount Rate
Discount Curve
D = 1.50
Cumulative Stake A
Discount
Yield: Total Stake=55.0%, Inflation=2.02%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
Years T
Discount Rate
Discount Curve
D = 4.00
Cumulative Stake A
Discount



Yield: Total Stake=8.0%, Inflation=0.72%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
Years T
Discount Rate
Discount Curve
D = 9.50
Cumulative Stake A
Discount
Yield: Total Stake=80.0%, Inflation=1.57%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
Years T
Discount Rate
Discount Curve
D = 9.50
Cumulative Stake A
Discount
Yield: Total Stake=55.0%, Inflation=2.11%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
Years T
Discount Rate
Discount Curve
D = 7.00
Cumulative Stake A
Discount

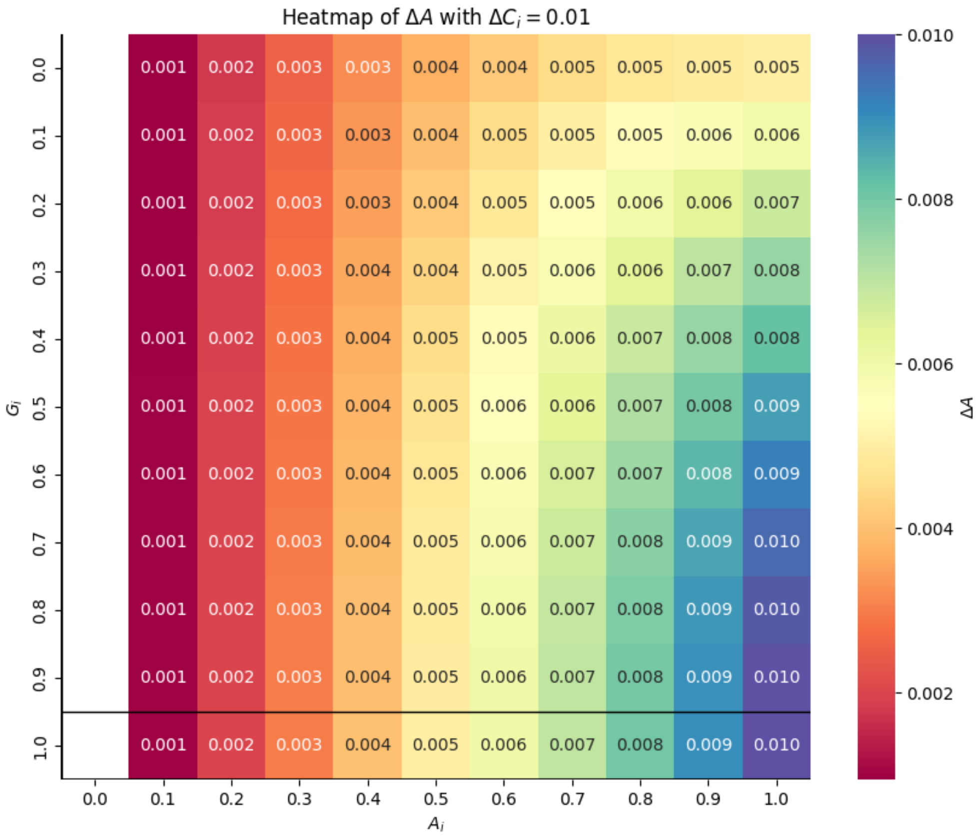

Yield: Total Stake=7.0%, Inflation=2.26%
Yield: Total Stake=18.0%, Inflation=4.38%
Yield: Total Stake=33.0%, Inflation=5.99%
Yield: Total Stake=52.0%, Inflation=6.52%
Yield: Total Stake=75.0%, Inflation=4.81%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
1.0
0.8
0.6
0.4
0.2
0.0
40.0%
30.0%
20.0%
10.0%
0.0%
1
10

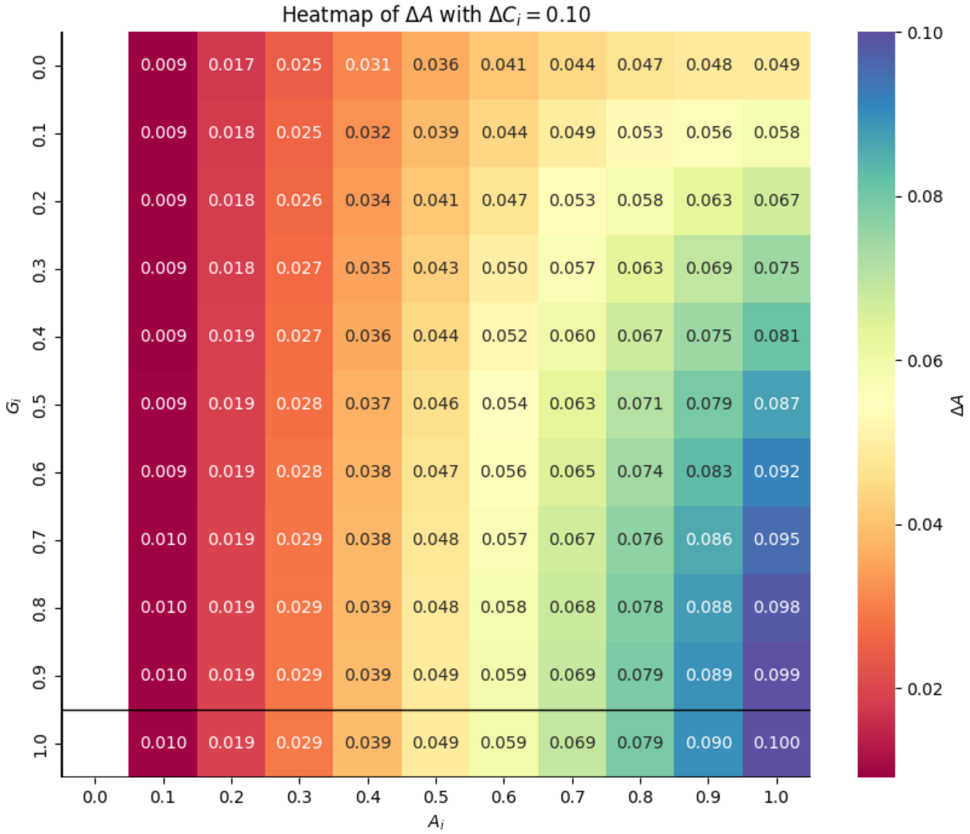

Yield: Total Stake=7.0%, Inflation=2.26%
Yield: Total Stake=19.0%, Inflation=2.2%
Yield: Total Stake=34.0%, Inflation=2.61%
Yield: Total Stake=55.0%, Inflation=2.59%
Yield: Total Stake=80.0%, Inflation=1.57%
Yield Term Structure
Real Yield
Stake A by Maturity
Rates
1.0
0.8
0.6
0.4
0.2
0.0
40.0%
30.0%
20.0%
10.0%
0.0%
1
10

B Carbon Purchase Rates

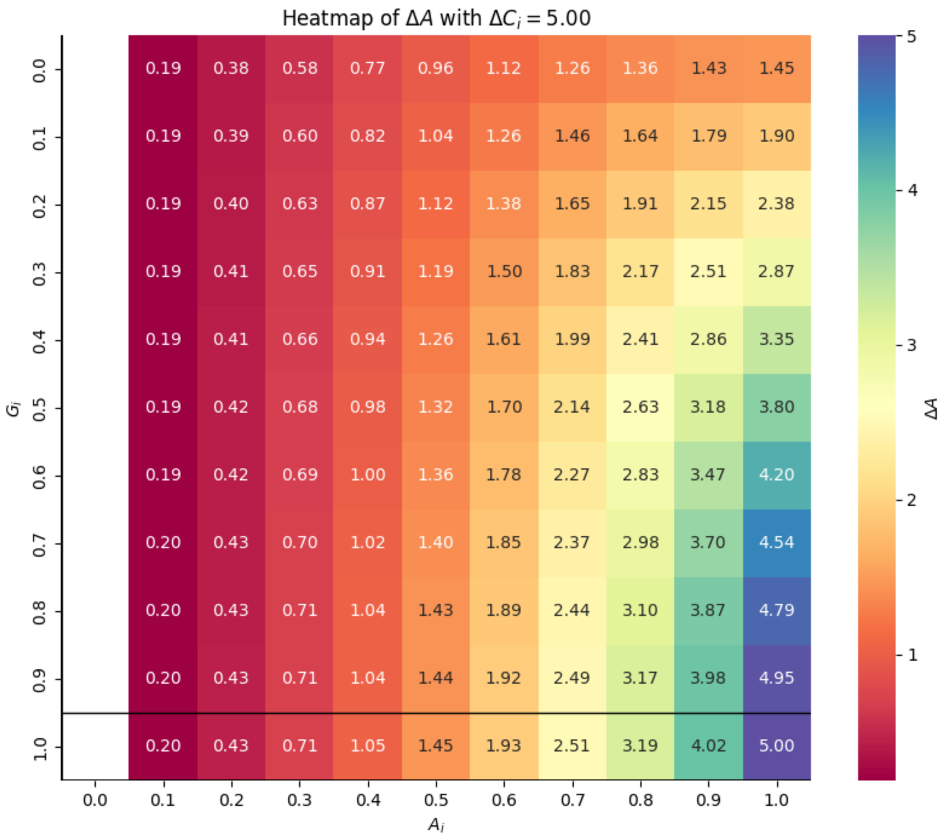
B.1 Price Curves (ΔA)

Figure 28: A Price Curves (ΔA) when $\Delta C \in \{0.01, 0.10, 5.0\}$



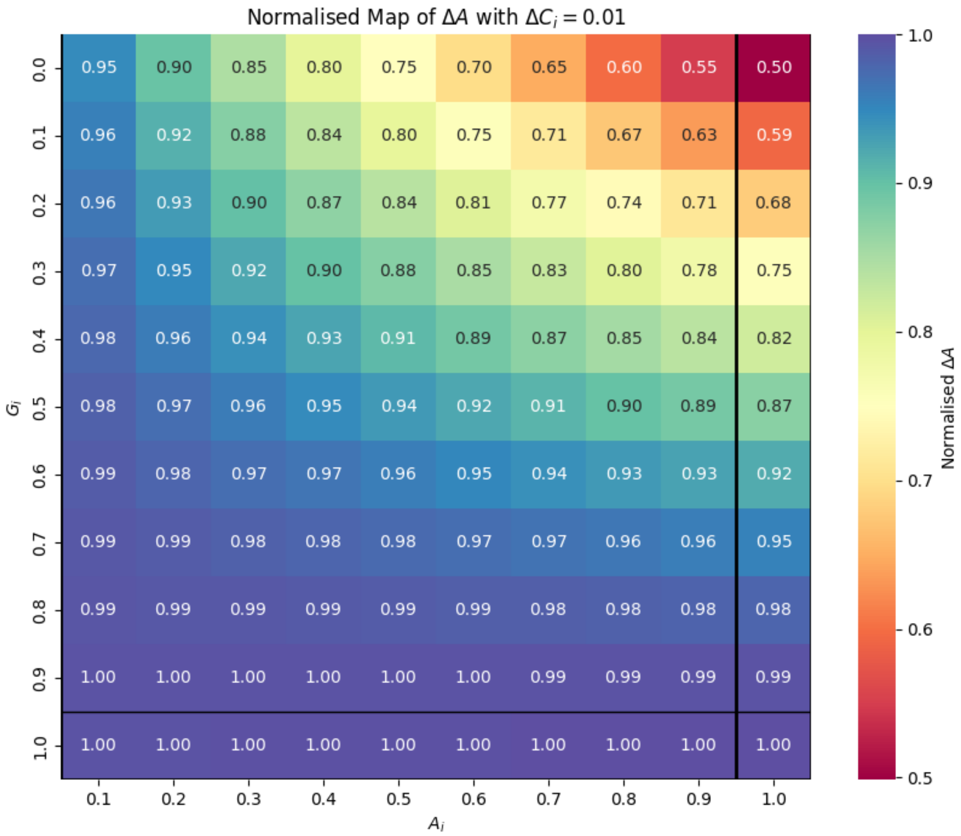


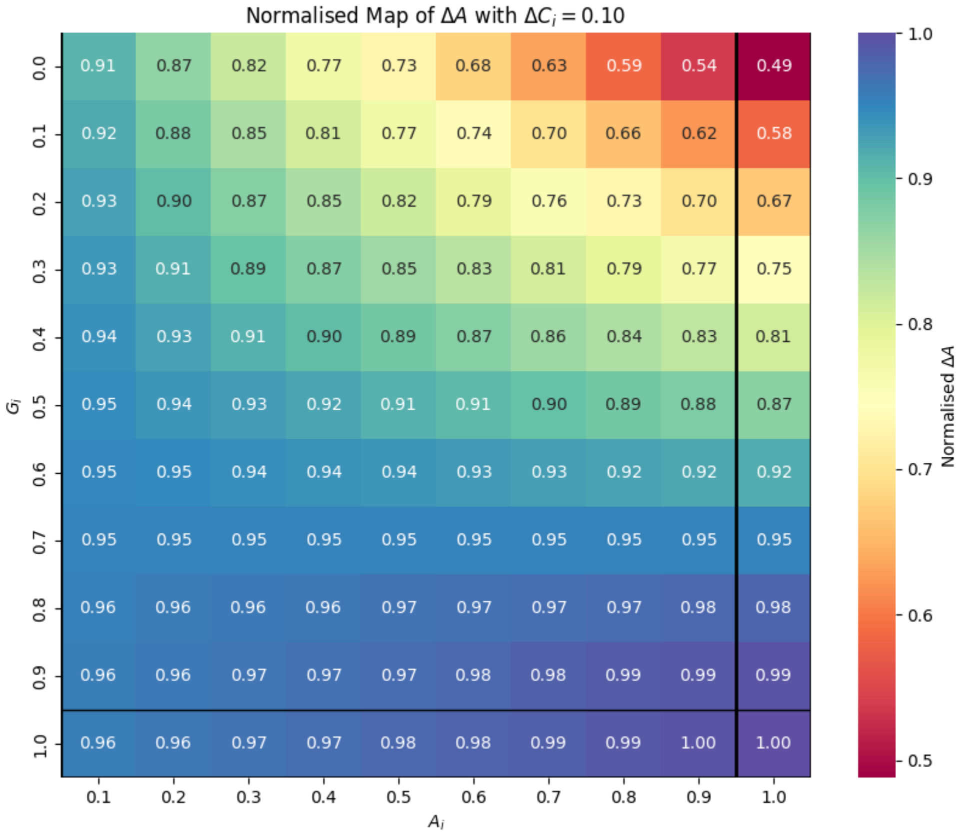
Heatmap of ΔA with $\Delta C_i = 0.10$
0.009 0.017 0.025 0.031 0.036 0.041 0.044 0.047 0.048 0.049
0.009 0.018 0.025 0.032 0.039 0.044 0.049 0.053 0.056 0.058
0.009 0.018 0.026 0.034 0.041 0.047 0.053 0.058 0.063 0.067
0.009 0.018 0.027 0.035 0.043 0.050 0.057 0.063 0.069 0.075
0.009 0.019 0.027 0.036 0.044 0.052 0.060 0.067 0.075 0.081
0.009 0.019 0.028 0.037 0.046 0.054 0.063 0.071 0.079 0.087
0.009 0.019 0.028 0.038 0.047 0.056 0.065 0.074 0.083 0.092
0.010 0.019 0.029 0.038 0.048 0.057 0.067 0.076 0.086 0.095
0.010 0.019 0.029 0.039 0.048 0.058 0.068 0.078 0.088 0.098
0.010 0.019 0.029 0.039 0.049 0.059 0.069 0.079 0.089 0.099
0.010 0.019 0.029 0.039 0.049 0.059 0.069 0.079 0.090 0.100
G_i
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
A_i
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
ΔA
0.10 0.08 0.06 0.04 0.02

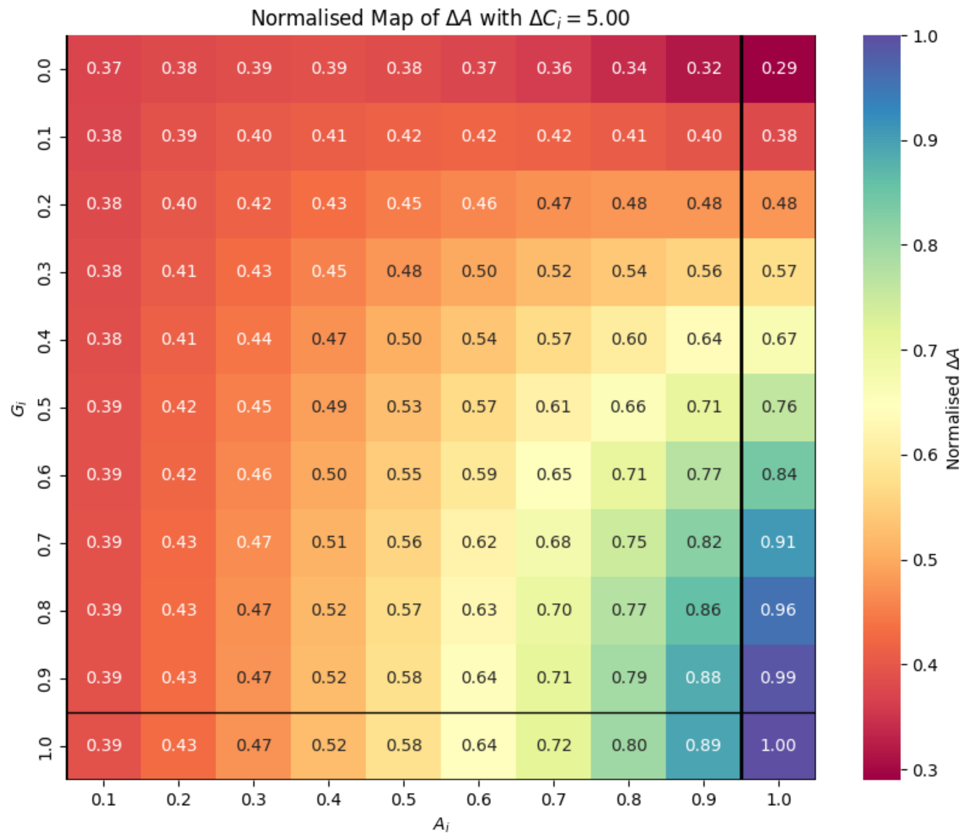

Heatmap of ΔA with $\Delta C_i = 5.00$
0.19 0.38 0.58 0.77 0.96 1.12 1.26 1.36 1.43 1.45
0.19 0.39 0.60 0.82 1.04 1.26 1.46 1.64 1.79 1.90
0.19 0.40 0.63 0.87 1.12 1.38 1.65 1.91 2.15 2.38
0.19 0.41 0.65 0.91 1.19 1.50 1.83 2.17 2.51 2.87
0.19 0.41 0.66 0.94 1.26 1.61 1.99 2.41 2.86 3.35
0.19 0.42 0.68 0.98 1.32 1.70 2.14 2.63 3.18 3.80
0.19 0.42 0.69 1.00 1.36 1.78 2.27 2.83 3.47 4.20
0.20 0.43 0.70 1.02 1.40 1.85 2.37 2.98 3.70 4.54
0.20 0.43 0.71 1.04 1.43 1.89 2.44 3.10 3.87 4.79
0.20 0.43 0.71 1.04 1.44 1.92 2.49 3.17 3.98 4.95
0.20 0.43 0.71 1.05 1.45 1.93 2.51 3.19 4.02 5.00
G_i
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
A_i
ΔA
1 2 3 4 5

B.2 Normalised Price Curves (ΔA)

Figure 29: Normalised A Price Curves (ΔA) when $\Delta C = \{0.01, 0.10, 5.0\}$

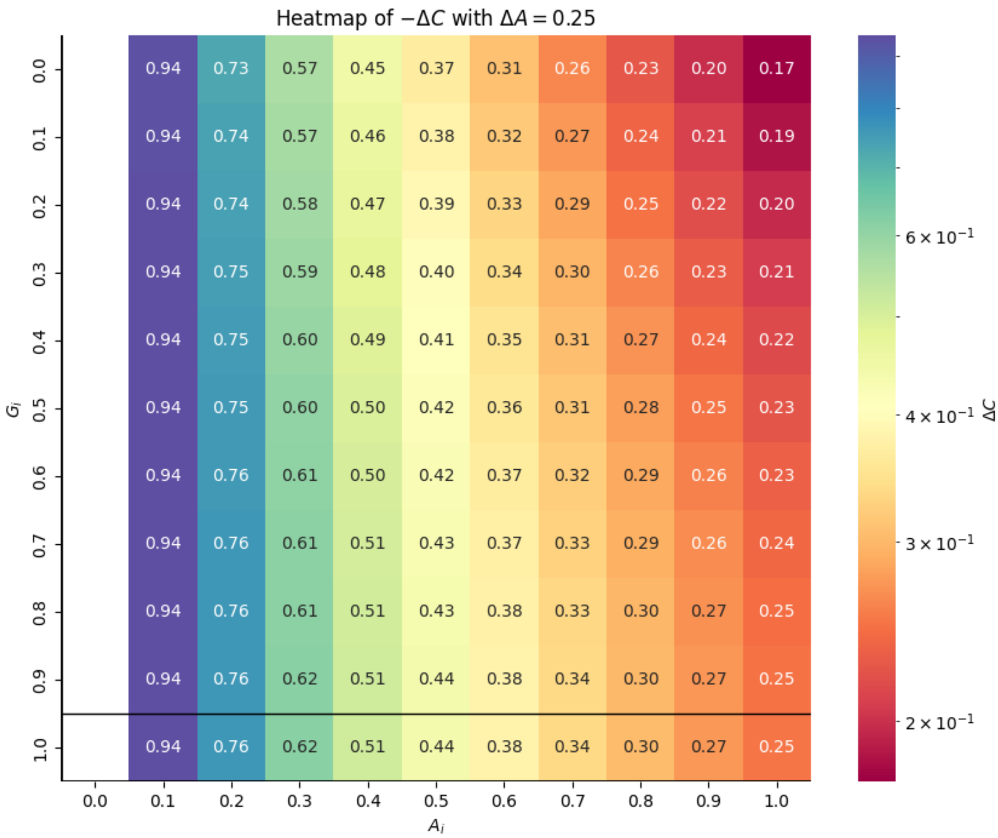


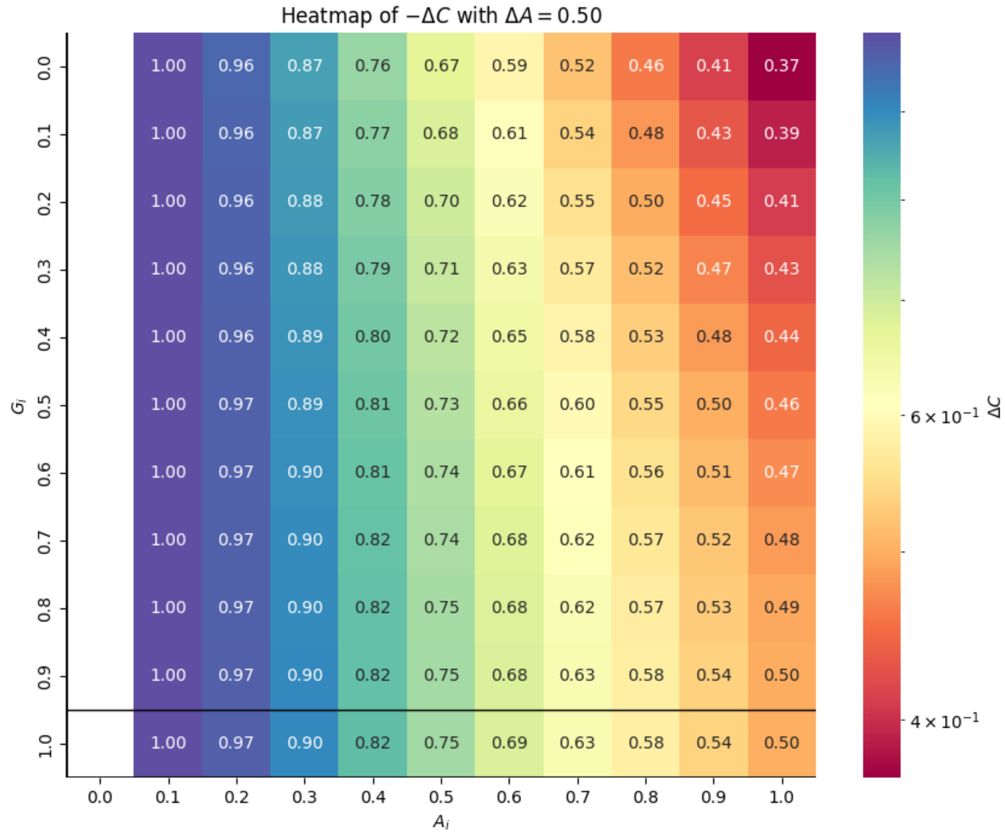

Normalised Map of ΔA with $\Delta C_i = 0.10$
0.0 0.91 0.87 0.82 0.77 0.73 0.68 0.63 0.59 0.54 0.49
0.1 0.92 0.88 0.85 0.81 0.77 0.74 0.70 0.66 0.62 0.58
0.2 0.93 0.90 0.87 0.85 0.82 0.79 0.76 0.73 0.70 0.67
0.3 0.93 0.91 0.89 0.87 0.85 0.83 0.81 0.79 0.77 0.75
0.4 0.94 0.93 0.91 0.90 0.89 0.87 0.86 0.84 0.83 0.81
0.5 0.95 0.94 0.93 0.92 0.91 0.91 0.90 0.89 0.88 0.87
0.6 0.95 0.95 0.94 0.94 0.94 0.93 0.93 0.92 0.92 0.92
0.7 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95
0.8 0.96 0.96 0.96 0.96 0.97 0.97 0.97 0.97 0.98 0.98
0.9 0.96 0.96 0.97 0.97 0.97 0.98 0.98 0.99 0.99 0.99
1.0 0.96 0.96 0.97 0.97 0.98 0.98 0.99 0.99 1.00 1.00
G_i
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
A_i
1.0 0.9 0.8 0.7 0.6 0.5
Normalised ΔA

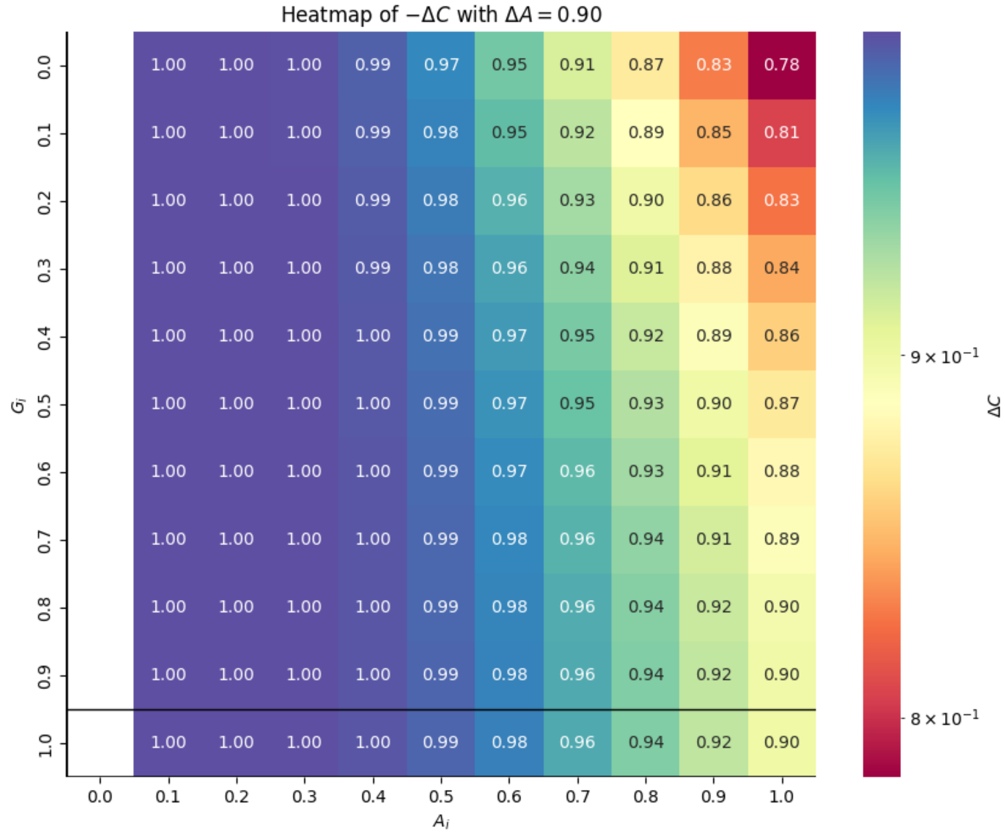

Normalised Map of ΔA with $\Delta C_i = 5.00$
G_i
A_i
Normalised ΔA
0.0 0.37 0.38 0.39 0.39 0.38 0.37 0.36 0.34 0.32 0.29
0.1 0.38 0.39 0.40 0.41 0.42 0.42 0.42 0.41 0.40 0.38
0.2 0.38 0.40 0.42 0.43 0.45 0.46 0.47 0.48 0.48 0.48
0.3 0.38 0.41 0.43 0.45 0.48 0.50 0.52 0.54 0.56 0.57
0.4 0.38 0.41 0.44 0.47 0.50 0.54 0.57 0.60 0.64 0.67
0.5 0.39 0.42 0.45 0.49 0.53 0.57 0.61 0.66 0.71 0.76
0.6 0.39 0.42 0.46 0.50 0.55 0.59 0.65 0.71 0.77 0.84
0.7 0.39 0.43 0.47 0.51 0.56 0.62 0.68 0.75 0.82 0.91
0.8 0.39 0.43 0.47 0.52 0.57 0.63 0.70 0.77 0.86 0.96
0.9 0.39 0.43 0.47 0.52 0.58 0.64 0.71 0.79 0.88 0.99
1.0 0.39 0.43 0.47 0.52 0.58 0.64 0.72 0.80 0.89 1.00
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3

C Carbon Retirement Rates

Figure 30: C Price Curves ($-\Delta C$) when $\Delta A = \{0.25, 0.50, 0.90\}$




Heatmap of $-\Delta C$ with $\Delta A = 0.50$
G_i
A_i
ΔC
6×10^{-1}
4×10^{-1}
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.00 0.96 0.87 0.76 0.67 0.59 0.52 0.46 0.41 0.37
1.00 0.96 0.87 0.77 0.68 0.61 0.54 0.48 0.43 0.39
1.00 0.96 0.88 0.78 0.70 0.62 0.55 0.50 0.45 0.41
1.00 0.96 0.88 0.79 0.71 0.63 0.57 0.52 0.47 0.43
1.00 0.96 0.89 0.80 0.72 0.65 0.58 0.53 0.48 0.44
1.00 0.97 0.89 0.81 0.73 0.66 0.60 0.55 0.50 0.46
1.00 0.97 0.90 0.81 0.74 0.67 0.61 0.56 0.51 0.47
1.00 0.97 0.90 0.82 0.74 0.68 0.62 0.57 0.52 0.48
1.00 0.97 0.90 0.82 0.75 0.68 0.62 0.57 0.53 0.49
1.00 0.97 0.90 0.82 0.75 0.68 0.63 0.58 0.54 0.50
1.00 0.97 0.90 0.82 0.75 0.69 0.63 0.58 0.54 0.50


Heatmap of $-\Delta C$ with $\Delta A = 0.90$
G_i
A_i
ΔC
9×10^{-1}
8×10^{-1}