Deferred tax valuation

A market based approach

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Motivation

- Solvency 2 harmonizes EU insurance regulation and provide guidelines on capital requirements
- Deferred taxes are important. Under Solvency 2 can be used to mitigate capital requirements
- Pillar of Solvency 2 is market based accounting
- However, extant valuation methods are not market based. Extant valuation based on all or nothing scenarios.
- In practice, this means that DTA's are *overestimated* and insurers hold too little capital.

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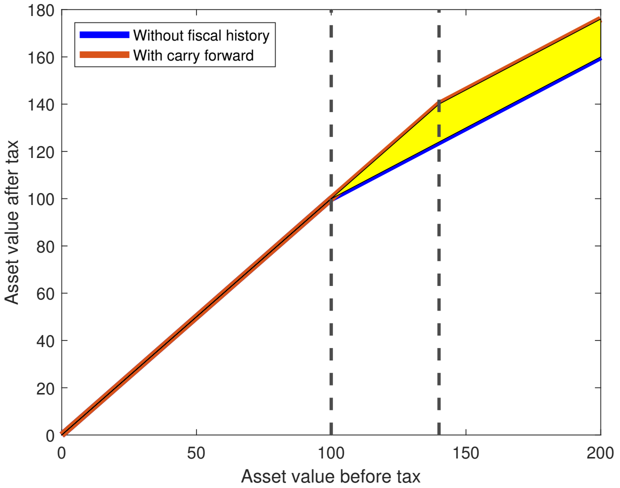
A new valuation approach

- Each type of deferred tax is contingent on future profits, with a payoff structure depending on the type of deferral.
- The firm has an "option" on the IRS, which can be exercised if the company is profitable enough (or unprofitable).
- In this presentation I focus on loss carryforward.
- Loss carryforward is the allowance to use current losses to offset *future* tax payments (tax on corporate profit).

Loss carryforward

- I assume that taxable profit consists of the difference in asset value in two consecutive periods (if positive) and is zero otherwise.
- Similar to counter factual framework
- The post-tax value of a company without fiscal history is given by
$$\widetilde{A}_1 = A_1 - \tau \underbrace{\max(A_1 - A_0, 0)}_{\text{taxable profit}}.$$
- Suppose an otherwise identical company has carryforward (CF) available. The value of the company after paying tax equals
$$\widetilde{A}_1^{(cf)} = A_1 - \tau \max(A_1 - A_0 - CF, 0).$$
- Use the difference, $\widetilde{A}_1^{(cf)} - \widetilde{A}_1$, as the added value of the DTA.

Carryforward value



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Risk neutral pricing

- Assume the following asset price dynamics

$$\frac{dA_t}{A_t} = \mu dt + \sigma dB_t$$

- I also assume the *idealized market assumptions*, as in the seminal Merton (1974) paper on pricing of corporate debt.
- The valuation of deferred taxes becomes isomorphic to an option valuation problem.
- This allows to apply risk-neutral pricing and renders the following firm value accounting for taxes

$$V^{BS} = e^{-r}\mathbb{E}^{Q}(\widetilde{A}_1 | \mathcal{F}_0), \ \mathcal{F}_t = \sigma(B_s : s \leq t).$$

- For ease of exposition I focus on 1-year time horizon.
- Multiple period model is done in the paper with Monte Carlo simulation.
- Use the notation $C^{BS}(K) \triangleq C^{\text{BS}}(K, \underbrace{T, A_t, \sigma, r, t}_{\text{fixed}})$. for price of a Black-Scholes call option. Similarly define $P^{BS}(K)$.

- The market based value of carryforward then becomes

$$\xi_{cf}^{BS} = \tau e^{-r}\mathbb{E}^Q\left(\underbrace{\max(A_1 - A_0, 0)}_{\text{Counterfactual}} - \underbrace{\max(A_1 - A_0 - CF, 0)}_{\text{Firm with DTA}} |\mathcal{F}_0 \right)$$

$$= \tau(C^{BS}(A_0) - C^{BS}(A_0 + CF)).$$

$$\overset{\text{Put-Call parity}}{=} e^{-r}\tau CF - \underbrace{\tau\left(P^{BS}(A_0 + CF) - P^{BS}(A_0)\right)}_{\text{Settlement risk}}$$

(In)variance of capital structures

- Previous analysis ignores the capital structure of a company (debt/equity financing). This is in line with the first Modigliani-Miller theorem.
- However, capital markets are not perfect due to taxation.
- If we take capital structures into account, then the carryforward value changes due to debt financing.
- First deduct interest payment from taxable income, then DT's can be used.

- This renders a more general formula for loss carryforward

$$\xi_{\text{cf}}^{\text{BS}} = \tau \underbrace{\left(C^{\text{BS}}(A_0 + r^* D) - C^{\text{BS}}(A_0 + CF_1 + r^* D) \right)}_{\text{Decreases in } r^*}.$$

- Formula shows that CF value diminishes trough debt financing.
- Intuitively, the value deduction for CF arises as there is less profit after interest is paid.

Back to Modigliani-Miller (MM)

- MM value of interest tax shield (adapted to continuous time setting)

$$\tau e^{-r} r^* D$$

- MM tacitly assume that the tax shield is completely realized.
- In reality, the tax shield is also an option and its value can be analyzed by the exact same methods introduced for DTA's.

$$R^{BS} \triangleq \mathcal{V}^{BS} - V^{BS} = \tau \Big(C^{BS}(A_0) - C^{BS}(A_0 + r^* D) \Big). \quad (1)$$

- Special case of general formula (1) when $\lim \sigma \downarrow 0$, provided

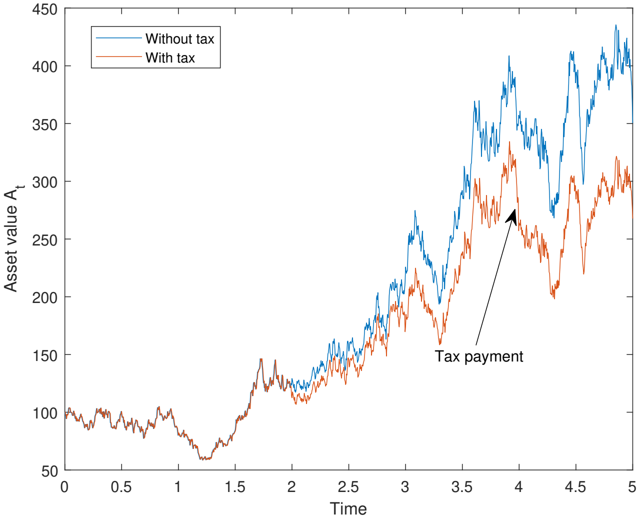
$$\underbrace{(e^r - 1)A_0}_{\text{Taxable income}} > r^* D$$

Multi year model

- "Payoff structure" becomes more complicated. Assuming no fiscal history , we get

$$\widetilde{A}_2 = A_2 - \tau(A_2 - \widetilde{A}_1 - 1_{A_1 < A_0}(A_0 - A_1))^+.$$

- This is a variant of the *compound option*; an option on an option. Analytical expressions are much more involved, but can be found in the paper.
- Have to make assumptions about the time losses can be carried forward/backward
- Can easily be estimated by Monte Carlo simulation


Without tax
With tax
Tax payment
Asset value A_t
Time
450
400
350
300
250
200
150
100
50
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

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Loss absorbing capacity of deferred taxes

- Data on 2851 European insurance companies. Information on EOF, Assets (A_0), Debt (D), Average debt duration, Forward rates $r(t)$, net DTA position, SCR, EIOPA Lac DT estimate, applicable tax rate (τ), Dummy carryback, duration carryforward
- I assume that debt is *risk-free*

Solvency ratio

- Recall

$$\text{Solvency ratio} = \frac{\text{Eligible own funds}}{\text{Solvency capital requirements} - \text{LAC DT}}$$

- Solvency 2 dictates ratio should be larger than 1
- SCR is 99.5% Value-at-risk of assets (withstand shock bound to occur every 200 years)
- LAC DT := post shock net DTA - ex-ante net DTA
- LAC DT is at most $\tau \times$ Loss in assets. In reality its worth less

Market based approach

- Recalculate **net DTA** from EIOPA, in market consistent framework. Simulate with

$$\tilde{A}_{T,i} \sim \underbrace{(A_0, T, r_{\text{forward},T}, \hat{\sigma}, D, \mathcal{C}, \tau)}_{\text{counterfactual}}$$

$$\tilde{A}^{cf}_{T,i} \sim \underbrace{(A_0, T, r_{\text{forward},T}, \hat{\sigma}, D, \mathcal{C}, \tau, CF_1)}_{\text{Firm with DT}}$$

- Calculate DTA value as

$$mcf = e^{-rT}\frac{1}{I}\sum_{i}^{I}\widetilde{A}^{(cf)}_{T,i} - e^{-rT}\frac{1}{I}\sum_{i}^{I}\widetilde{A}_{T,i}$$

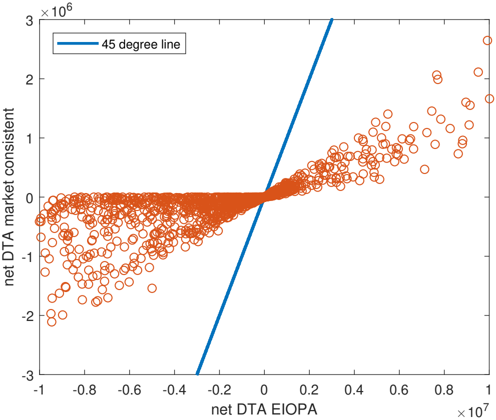

Figure: Scatter diagram of market consistent calculations of **net DTA** vs. **net DTA** calculated by EIOPA

LAC DT calculations

- Assume 1-in 200 year shock, equal to SCR. Simulate asset paths of

$$\widetilde{A}_{T,i} \sim \underbrace{(A_0 - \mathbf{SCR}, T, r_{\text{forward},T}, \hat{\sigma}, D, \mathcal{C}, \tau, CF_1 = SCR)}_{\text{counterfactual}}$$

$$\widetilde{A}^{(cf)}_{T,i} \sim \underbrace{(A_0 - SCR, T, r_{\text{forward},T}, \hat{\sigma}, D, \mathcal{C}, \tau, CF_1 + SCR)}_{\text{Firm with DT}}$$

- Calculate post shock DTA value as

$$mcf_{\text{post-shock}} = e^{-rT}\frac{1}{I}\sum_{i}^{I}\widetilde{A}^{(cf)}_{T,i} - e^{-rT}\frac{1}{I}\sum_{i}^{I}\widetilde{A}_{T,i}$$

- LAC DT* $:= mcf_{\text{post-shock}} - mcf$

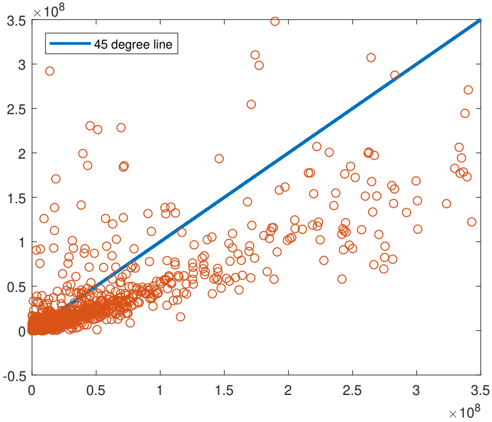

Figure: Estimated LAC DT EIOPA (x-axis) vs. LAC DT market consistent (y-axis)

Solvency 2 ratio

- Recalculate Solvency ratio

$$\text{Solvency ratio}^* = \frac{\text{Eligible own funds}^*}{\text{Solvency capital requirements} - \text{LAC DT}^*}$$

- Eligible own funds* =

$$\begin{aligned}\text{Eligible own funds}\\ &- \min(\max(\textbf{net DTA}, 0), 0.15 \cdot (SCR - \text{LAC DT}))\\ &- \min(\textbf{net DTA}, 0)\\ &+ \min(\max(\textbf{net DTA}^*, 0), 0.15 \cdot (SCR - \text{LAC DT}^*))\\ &+ \min(\textbf{net DTA}^*, 0).\end{aligned}$$

Result

- We find a total of 29 insurance companies that have Solvency ratio < 1, under market consistent approach.
- Implication for policymakers: recapitalize (increase EOF), or de-risk (sell risky assets to reduce $\hat{\sigma}$).
- My approach shows that decrease in $\hat{\sigma}$ might negatively influence DTA value (not taken into account by current methods). Hence, de-risking might even lead to further decrease in Solvency ratio!

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Conclusion

- Provide a new way to value tax deferrals by recognizing the option component and contingent nature of the claim.
- Resulting valuation formulas are smooth and take into account that future profit/losses are uncertain
- Similar reasoning can be applied to obtain a more general version of the Modigliani-Miller result.
- Empirical application shows the importance of this new valuation, recognizing 29 insurance companies that cannot meet the Solvency capital requirement.