Discovery Exercises

Module 4, Lesson 3: Scenario Analysis and Climate Modeling

Foundation level. Two pre-class and two in-class activities. Full worked solutions are at the back: try each activity before you check.

Four activities open the ideas of Lesson 4.3 before, and during, the lecture. The two pre-class tasks take 15 to 20 minutes each and you do them alone. The two in-class tasks take 5 to 10 minutes and you do them with others. Nothing here is graded; think first, then compare your thinking with the worked solution. The lesson answers the board's hardest question: *what if* the future turns out this way?

PRE-CLASS Read the seven climate futures like a map

15 to 20 min, work on your own, pen and paper

Based on: guided discovery (Mayer 2004)

The **Network for Greening the Financial System (NGFS)**, a network of central banks and financial supervisors, publishes the standard climate **scenarios** (structured "what if" stories, not predictions) used for stress testing. The set below is results version 5.0 of November 2024: seven scenarios in four categories. Check which release any scenario table comes from, because the set is revised roughly every year. *Divergent Net Zero*, which belonged to the 2022 vintage and still turns up on slides in circulation, has been retired. The four categories are *Orderly*: the world acts early and smoothly. *Disorderly*: the world acts late, then suddenly and harshly. *Hot House World*: the world barely acts, so warming runs high. *Too little, too late*: the world acts late *and* unevenly, so it pays for a transition and still gets the warming. Here are the seven, with the warming each reaches by 2100 and the kind of policy action each assumes:

Scenario	Category	Policy action assumed	Warming (2100)
Net Zero 2050	Orderly	early, steady, ambitious	1.5 deg C
Below 2 deg C	Orderly	early, steady, less ambitious	1.7 deg C
Low Demand	Orderly	early, plus lower energy demand	1.5 deg C
Delayed Transition	Disorderly	nothing yet, then sudden	below 2 deg C
Fragmented World	Too little, too late	late, and uneven across countries	2.1 to 2.4 deg C
NDCs	Hot House World	only the pledges already made	2.3 deg C
Current Policies	Hot House World	today's policies, nothing more	2.75 to 3 deg C

1. Read the policy column against the warming column. As the assumed action gets later and weaker, what happens to the year-2100 warming? State the trade-off you have just found in one sentence.
2. "Transition risk" is the cost of *acting* on climate (carbon prices, stranded assets). "Physical risk" is the cost of *warming* (floods, storms, heat). Which category has the highest *transition* risk, and which the highest *physical* risk? Then look at *Too little, too late*: what is unusual about where it falls on those two channels?
3. Which single scenario looks the most financially disruptive in the short term, and why? (Hint: look for the word "sudden".)
4. No carbon-price column appears, and the omission is deliberate. Write down one reason a carbon price might be harder to tabulate than a warming level. (Hint: the warming is part

of the story the scenario tells. The carbon price is something a model computes from that story.)

Your attempt (before you check the solution at the back):

PRE-CLASS Turn a scenario into a loss, before you see the formula

15 to 20 min, work on your own, pen and paper (optional spreadsheet stretch)

Based on: productive failure (Kapur 2008)

Try this *before* the lecture gives you the calibration rules. A scenario gives you an economy-wide number, such as a fall in **GDP** (Gross Domestic Product, the size of the economy). You have to turn it into a bank number, a change in default risk. Two ideas, stated plainly:

- Some sectors feel a GDP fall more than others. A "sensitivity" of 1.5 means the sector's default rate moves 1.5 times as much as GDP.
- **Probability of default** (PD) is the chance a borrower fails to repay; **loss given default** (LGD) is the fraction of a loan lost when they do.

Philippine agriculture faces a Hot House World: GDP falls 8 percent, and agriculture has a sensitivity of 1.5.

1. Work out the rise in the agriculture default probability (PD). You have the two numbers you need; combine them and write your reasoning, even if unsure.
2. Now the LGD. An agricultural loan starts at LGD = 45%. A flood causes a 25 percent damage rate to the land, but only 30 percent of the loss is insured, so the bank eats the uninsured 70 percent of that damage. Work out how many percentage points the flood adds to the LGD, and the new LGD. (Hint: uninsured share times damage rate.)
3. Which of your two numbers (the PD rise or the LGD rise) is larger for this ASEAN farm loan? In one sentence, say why the insurance gap makes physical damage bite so hard here.

Your attempt (before you check the solution at the back):

Optional stretch

In a spreadsheet, make a column for insurance coverage running 0%, 30%, 60%, 90%. For each, compute the LGD add-on as (1 minus coverage) times the 25% damage rate, and add it to the 45% base LGD. Plot LGD against coverage. How much insurance would you need before the flood stops mattering to the bank?

IN-CLASS Which climate future hurts ASEAN most?

5 to 10 min, think-pair-share

Based on: predict then reveal, testing effect (Roediger and Karpicke 2006)

For *developed* markets, heavy in fossil assets, the worst NGFS category is usually Disorderly: a late, sudden transition strands their assets. ASEAN is different. These are tropical, coastal,

farming-based economies with very low insurance penetration. This activity asks you to predict the ASEAN answer before your instructor reveals it.

1. **Predict (1 minute, on your own).** For a typical ASEAN bank, rank the four categories from *most* to *least* damaging. If you think two of them tie for worst, write both on the first blank:

   most damaging on the left, least damaging on the right

   _____ > _____ > _____ > _____

   and circle whether you think ASEAN's worst case is the *same as* or the *opposite of* developed markets.

2. **Pair (2 minutes).** Compare with a neighbour. Agree on one sentence explaining *why* a hot, coastal, under-insured region might fear a world that barely acts more than a sudden carbon-price shock.

3. **Share and reveal.** Your instructor reveals the ASEAN ranking. Were you right? State the "ASEAN inversion" rule in one sentence. Then name the category you would run alongside the worst case in a stress test, and say why.

IN-CLASS Financing a coal utility's exit under two scenarios

5 to 10 min, small groups of 3 to 5

Based on: data and case interrogation, active learning (Freeman et al. 2014)

Scenarios are not just about physical weather; a *transition* scenario changes what a fossil asset is worth. Here you apply that to a real transition problem. Use these lesson facts: an Orderly (early) transition means high transition cost now but low physical damage later, while a Delayed Transition means a *sudden* carbon-price jump around the 2030s, the most financially disruptive path.

From the case study: Thailand EGAT energy transition financing (case study 6)

The Electricity Generating Authority of Thailand (EGAT) runs a coal-heavy fleet: coal is about 30 percent of Thailand's electricity, its coal plants average about 25 years old, and roughly 12 to 15 gigawatts of coal capacity are slated to retire by 2030. Thailand's plan targets about 51 percent renewable electricity by 2037. Coal plants with long remaining debt risk becoming stranded assets, and as banks pull back, the cost of capital rises.

1. **Vote first (no arithmetic).** Under which NGFS category does EGAT's ageing coal fleet lose value *fastest*: Orderly, Disorderly (Delayed Transition), Too little, too late, or Hot House World? Agree on one answer as a group.

2. **Now reason it through.** In a Delayed Transition the carbon price jumps suddenly in the 2030s, exactly when many of EGAT's plants still have debt outstanding. List two reasons a *sudden* jump is worse for EGAT's lenders than the *same* carbon price arriving gradually from today.

3. A Hot House World assumes minimal climate policy, so carbon stays cheap and EGAT's coal looks "safe" on paper. Give one sentence explaining why a Thai bank should still not prefer the Hot House World, even for its coal borrower. (Think about the rest of the bank's book: floods, drought, the 2011 event.)

Full Solutions

Try each exercise on your own before you read its solution.

Solution: Read the seven climate futures like a map

1. As the assumed action gets later and weaker, the year-2100 warming *rises*. It runs from 1.5 deg C under early, ambitious action to 2.75 to 3 deg C under today's policies alone. The trade-off: acting earlier and harder costs more now and buys a cooler, safer climate later. There is no zero-cost option.
2. Highest *transition* risk is the **Disorderly** category. A late, then sudden, tightening is what strands assets, because the owners get no time to adjust. Highest *physical* risk is **Hot House World**, which reaches the most warming: 2.3 deg C on today's pledges, and 2.75 to 3 deg C on today's policies. More warming means more floods, storms, and heat. What is unusual about **Too little, too late** is that it is high on *both* channels. That world pays for a late transition and still gets 2.1 to 2.4 deg C of warming. That is why it is a category of its own.
3. **Delayed Transition** is the most disruptive in the short term. Its tightening arrives *suddenly*, so banks and firms get no time to adjust. Note where it lands: below 2 deg C. The damage is in the timing, not in the destination.
4. A warming pathway is part of what defines the scenario. A carbon price is a model *output*: run the same scenario through a different integrated assessment model and the price changes. For Net Zero 2050 the modelled global carbon price reaches 500 to 1,250 US$2010 per tonne by 2050, a two-and-a-half-fold spread across models for one scenario in one year. So quote a range together with the model that produced it, or pull the pathway live from the NGFS Scenario Explorer. Never take a carbon price off a slide, and never use a scenario table that does not name its version.

Common misconception. That a scenario is a prediction of what will happen. Scenarios are internally consistent "what if" stories used to stress test against several plausible futures; the point is to find vulnerabilities that show up across all of them, not to forecast one.

Solution: Turn a scenario into a loss, before you see the formula

The calibrations the lecture will give you are $\Delta\text{PD} = -\beta \times \Delta\text{GDP}$, in percentage points, and $\text{LGD}_{climate} = \text{LGD}_{base} + (1 - \text{insurance}) \times \text{damage rate}$. The minus sign is what makes a fall in output come out as a rise in defaults.

1. PD rise $= -1.5 \times (-8\%) = +\mathbf{12}$ percentage points (the sensitivity times the GDP fall). Agricultural default probability rises by 12 percentage points.
2. LGD add-on $= (1 - 0.30) \times 25\% = 0.70 \times 25\% = 17.5$ percentage points. New LGD $= 45\% + 17.5\% = \mathbf{62.5}\%$.
3. The LGD rise is the larger of the two: a 17.5 pp add-on against a 12 pp rise in PD. That ordering is typical of an ASEAN farm loan, where the recovery side takes the bigger climate impact. The insurance gap is what decides it. Only 30 percent is insured, so the bank absorbs 70 percent of every dollar of flood damage straight onto its recovery value.

Common misconception. That buying a little crop insurance removes the climate risk. With only 30 percent coverage the bank still eats 70 percent of the damage, so the LGD barely improves; the uninsured share, not the insured share, drives the loss.

Solution: Which climate future hurts ASEAN most?

For ASEAN the ranking is **Hot House World and Too little, too late** > **Disorderly** > **Orderly**. The worst case is the *opposite* of developed markets, whose worst case is Disorderly. For ASEAN portfolios the Hot House World typically produces losses well above those of a Disorderly transition.

Why: ASEAN economies are tropical, coastal, and farming-heavy, with very low insurance penetration. The extra warming of a Hot House World, 2.3 to 3 deg C, means far more flood, storm, and drought damage, and it flows straight onto bank books. Developed markets hold more fossil assets, so they fear the sudden carbon-price shock of a Disorderly transition instead. The rule: for ASEAN, physical risk dominates, so a low-action future is the worst case, inverting the developed-market picture.

The category to run alongside it is **Too little, too late** (Fragmented World). It is late *and* regionally uneven, so it has high physical *and* high transition risk at once. That is exactly an ASEAN bank's position: physically exposed at home, and trade-exposed to carbon policy set elsewhere. Which of the two bites harder depends on the model and on the portfolio, so both belong in the stress test.

Common misconception. That the future with the most policy action must be the worst for everyone. A sudden, steep carbon price is worst for fossil-heavy developed markets, but for physically exposed ASEAN it is the low-action futures that do the most damage.

Solution: Financing a coal utility's exit under two scenarios

1. EGAT's coal fleet loses value fastest under the **Disorderly (Delayed Transition)** category: a sudden carbon-price jump in the 2030s hits plants that still have debt outstanding, stranding them abruptly. Too little, too late strands the same plants, but later and less abruptly, and it adds the physical damage on top. Disorderly is the fastest write-down; Too little, too late is the worse combination.

2. Two reasons a sudden jump is worse than a gradual one: (i) EGAT and its lenders have no time to refinance, rebuild reserves, or build replacement renewables before the shock, so the loss lands all at once; (ii) many plants still have unpaid debt in the 2030s, so a sudden write-down turns them into stranded assets while the loans are live, raising the loss given default. A gradual price from today would let the fleet retire and refinance in an orderly way.

3. Even though a Hot House World keeps coal "cheap", a Thai bank should not prefer it, because the rest of its book (agriculture, property, industry along the Chao Phraya) is highly exposed to the floods and droughts that a hotter world worsens; the 2011 floods alone caused roughly $46.5 billion in damage. Saving the coal borrower is not worth wrecking the whole portfolio.

Common misconception. That low carbon prices are always good news for a bank with fossil borrowers. Low carbon prices come bundled with a hotter climate, and for a physically exposed ASEAN bank the physical losses across the rest of the book outweigh the relief on the coal loan.

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