Optimal Use of Forestland Under Future Bio-Energy Demand Scenarios

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The Future of Forest Products in a Changing Climate: Bioenergy from Forests, Yale Forest Forum

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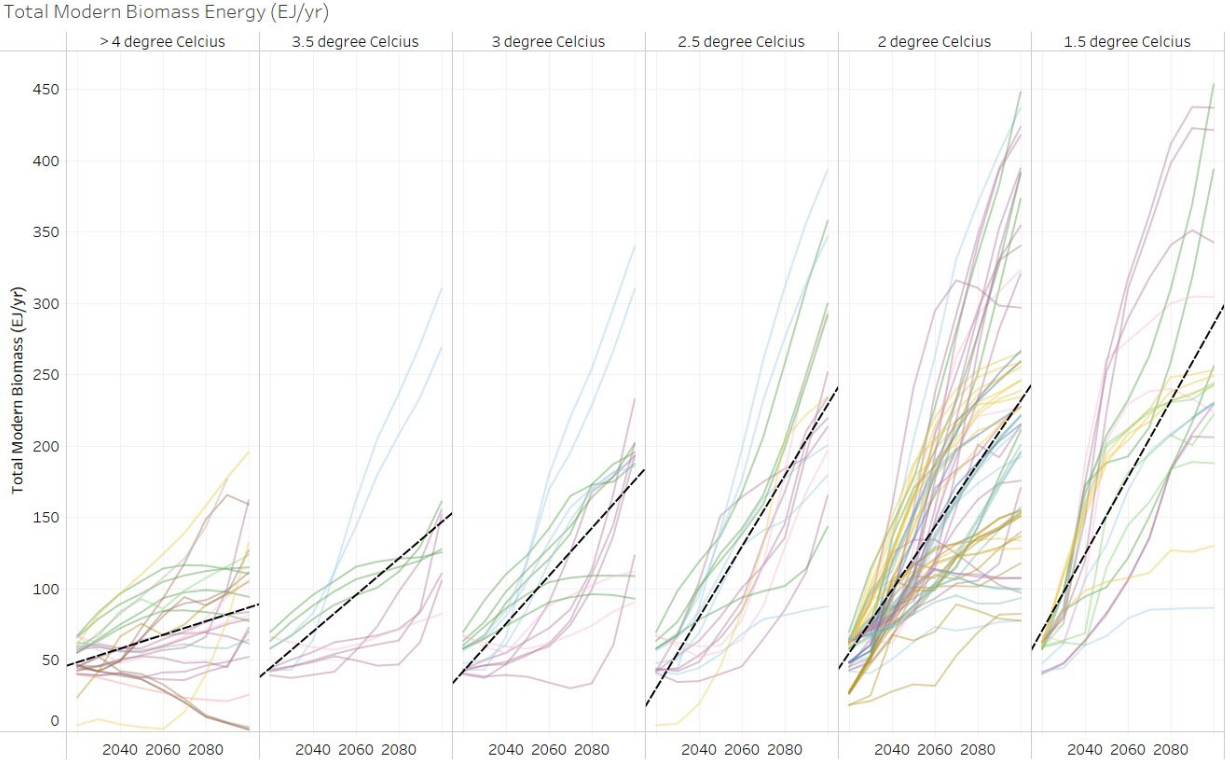
Outline

- Why are we talking about bio-energy?
  - Overview of IAMs results
- What is the bio-energy debate about?
  - Potential issues
- Assessment of the effects of woody biomass demand on the timber market, land use and forest carbon stock
- Discuss policy instruments to address potential externalities
- Open questions

Why are we talking about bio-energy?



- Its consumption is likely to increase as the stringency of the temperature targets increases
- Increasing role of bio-energy in the energy mix (e.g. 27% energy in 2050 under 1.5C target)

Source: [IIASA IAMC 1.5°C Scenario Explorer]()

The debate

Risks of using bio-energy from forests:

1. Decrease forest carbon sequestration (e.g. carbon debt) (Buchholz, et al. 2016; Birdsey, et al. 2018)
2. Reduce ecosystem services provided by primary forests (Searchinger et al. 2018; DeCicco et al. 2018)

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- Use the Global Timber Model (GTM) under different biomass demand pathways to assess these risks

  Results based on:

  - Alice Favero, Adam Daigneault and Brent Sohngen (2020) "*Forests: Carbon Sequestration, Biomass Energy, or Both?*", *Science Advances,* 25 Mar 2020
  - Alice Favero, Adam Daigneault, Brent Sohngen and Justin Baker (2022) "A system-wide assessment of forest biomass sustainability" Working Paper

Why GTM?

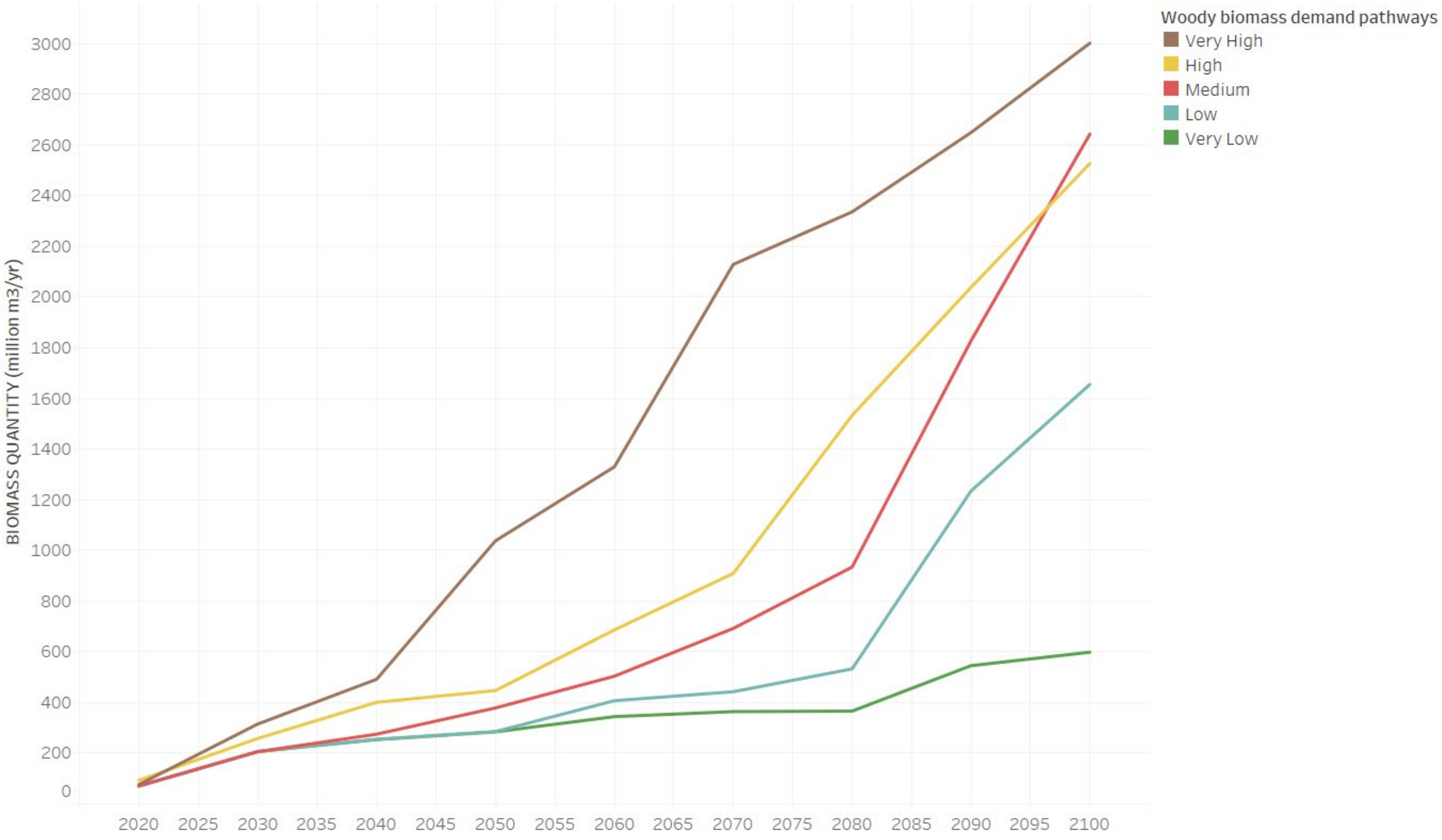
GTM is a forward-looking model:

- It maximizes the net present value of consumers' and producers' surplus in the forestry sector by selecting the age of harvesting timber and land conversion and management decisions

- System-wide approach: multiple ecosystem services / goods are considered simultaneously
- Intertemporal and spatial assessment: forests within and across regions are linked through markets
    - Today's demand for woody biomass will affect future investments decisions
    - Today's supply of woody biomass in one region will affect investment and land use decision in all the other regions

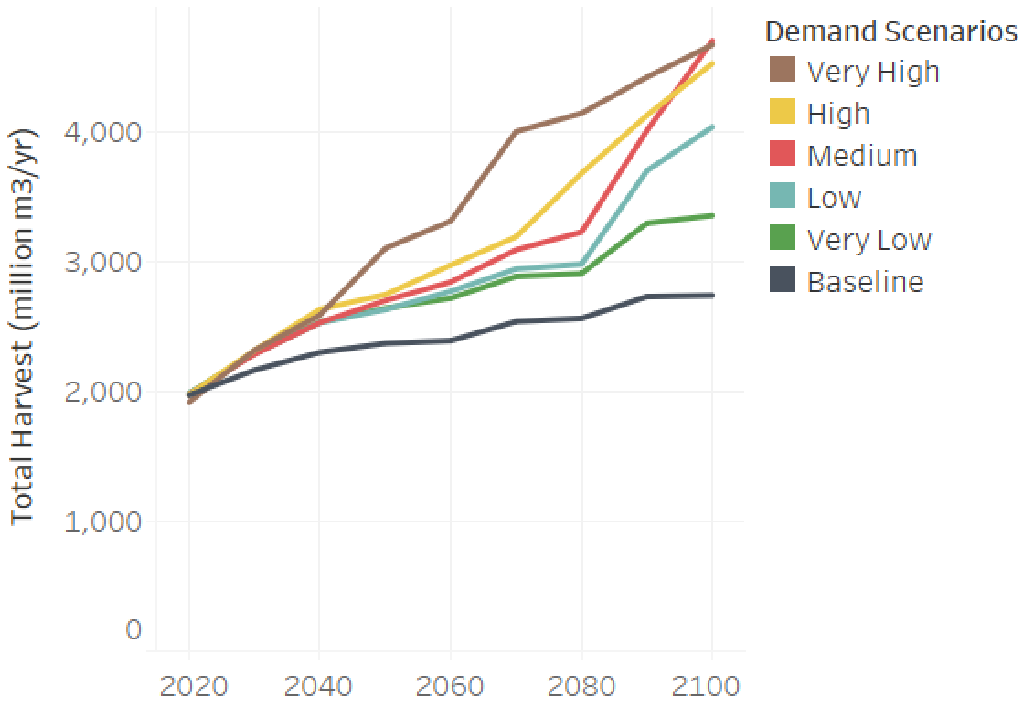
Baseline scenario

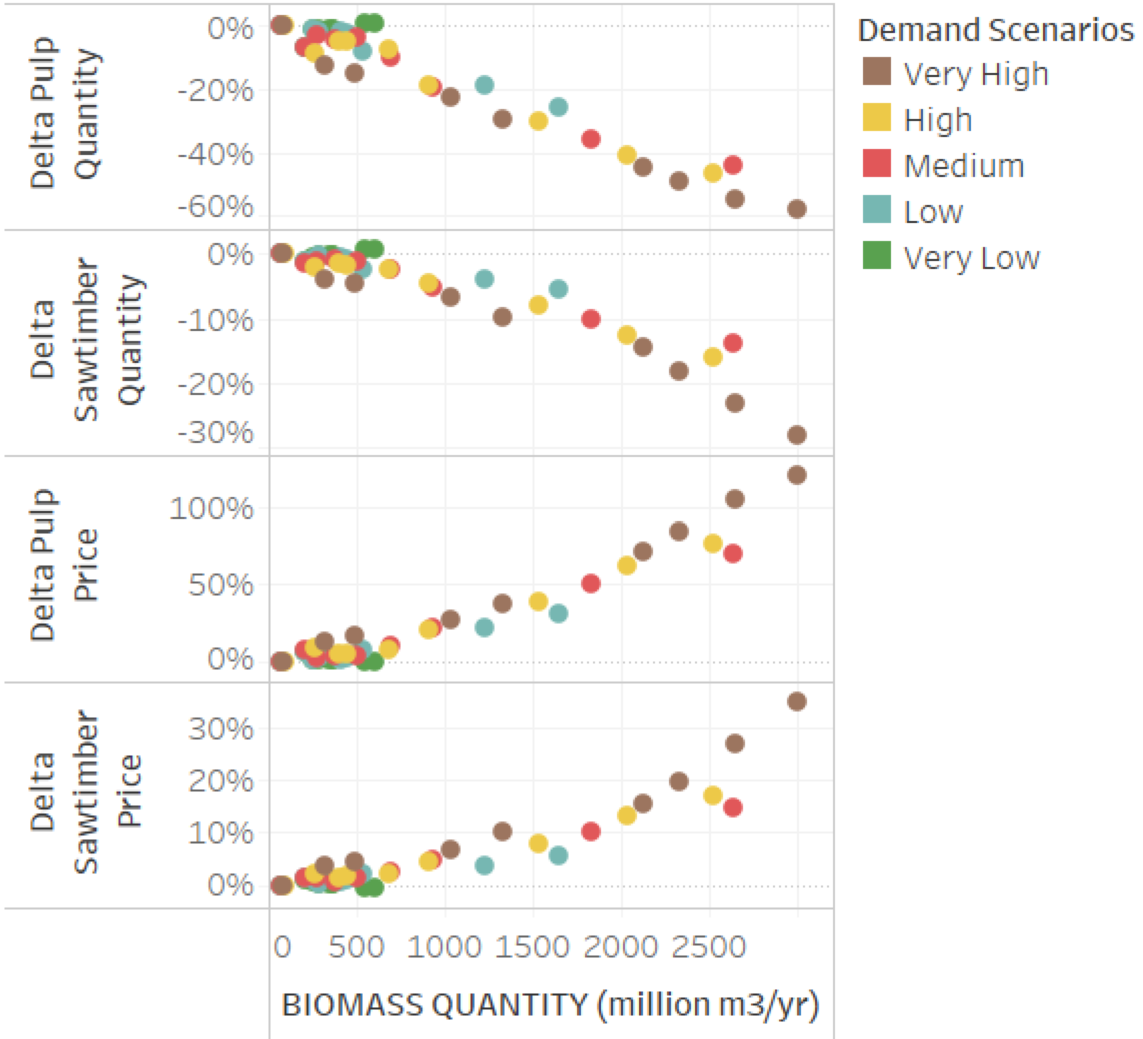
Input: bio-energy demand pathways



Source: Favero et al. 2022

Market effects



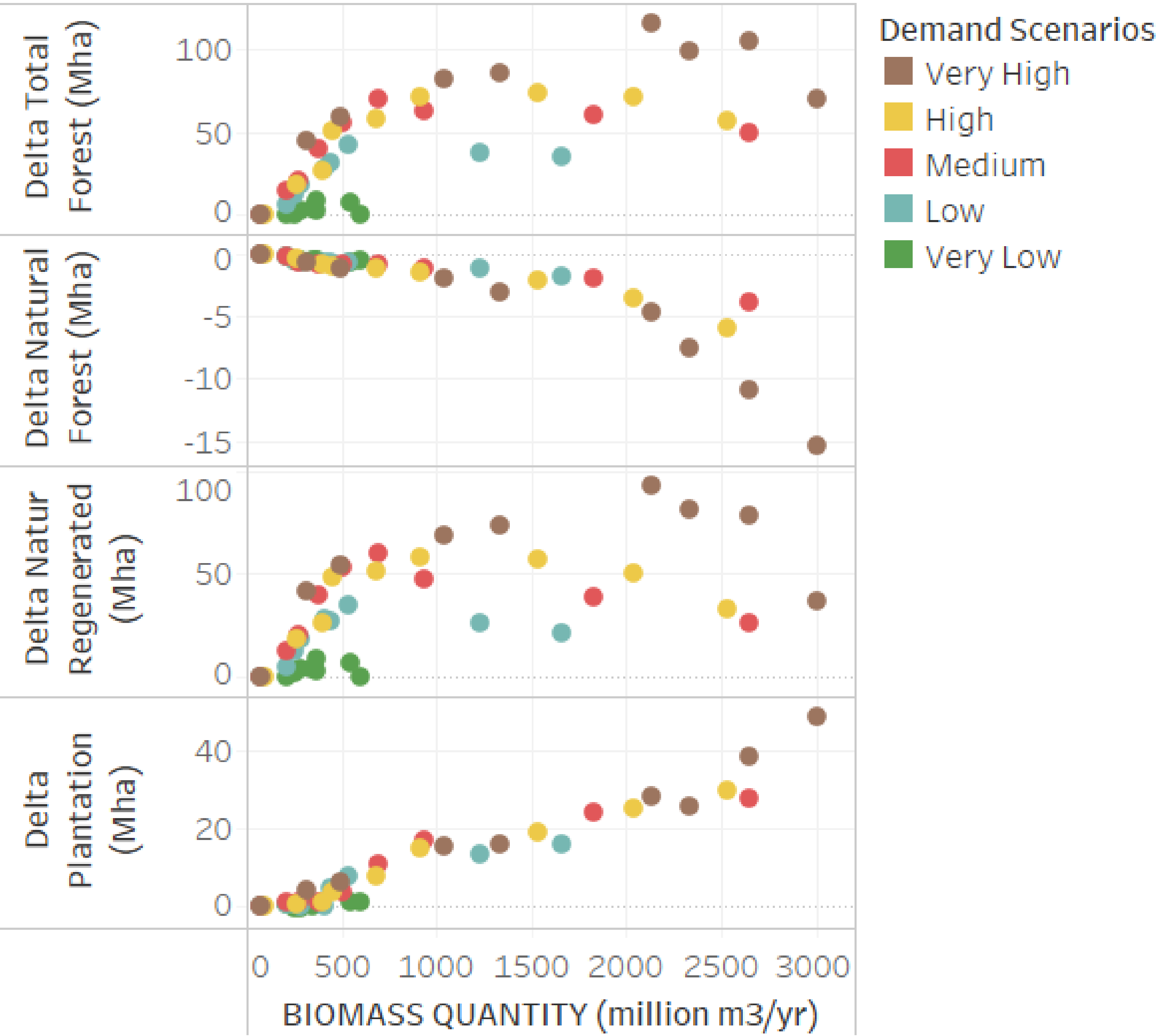


Source: Favero et al. 2022

Land use effects

Level of forest management

- *Zero:* Natural/Unmanaged Forests
- *Medium*: Naturally regenerated forests (managed with a wide range of harvesting techniques, but regenerated naturally)
- *High:* Intensively managed plantations



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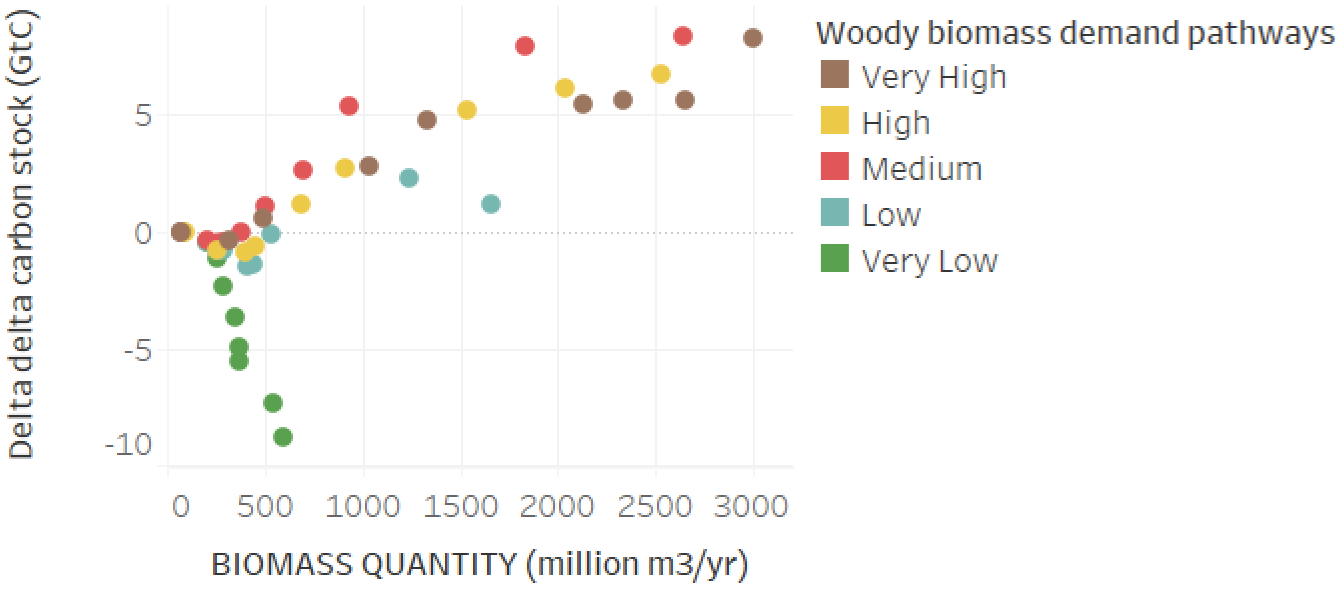
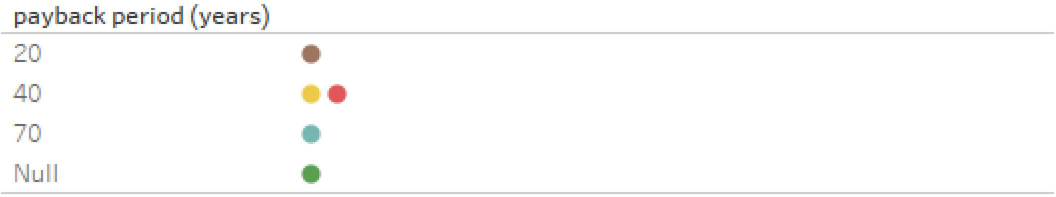
Forest carbon stock effects





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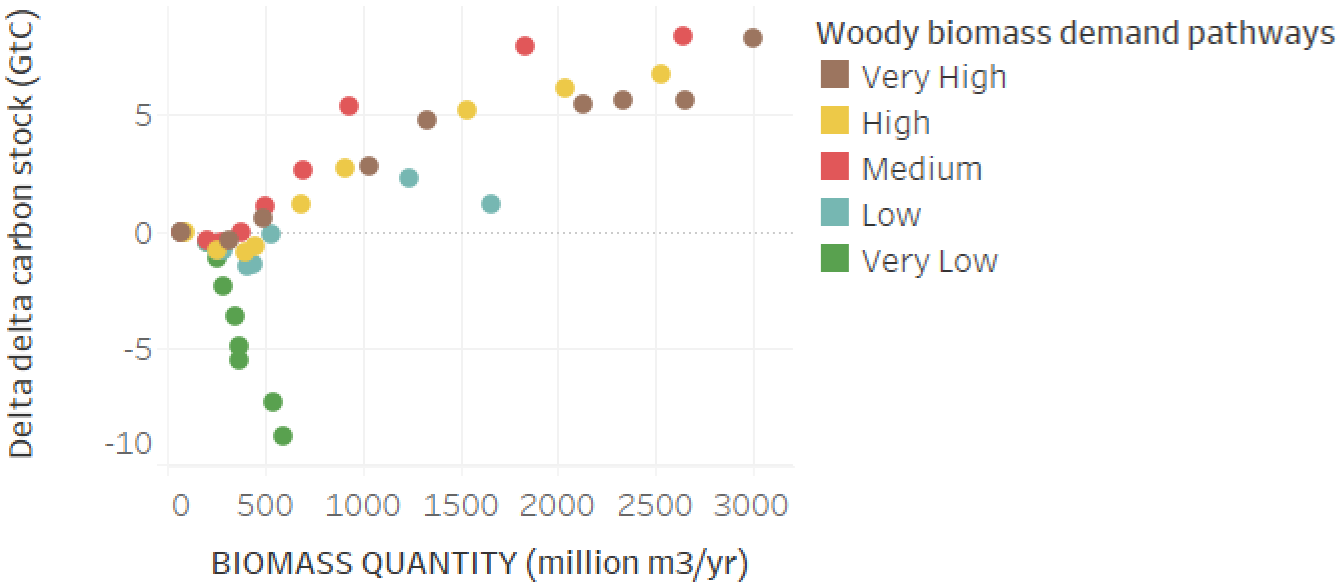

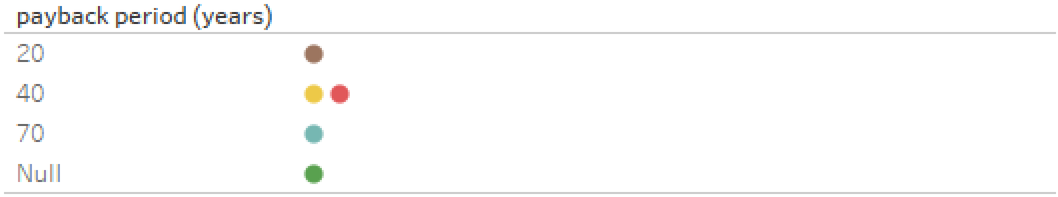

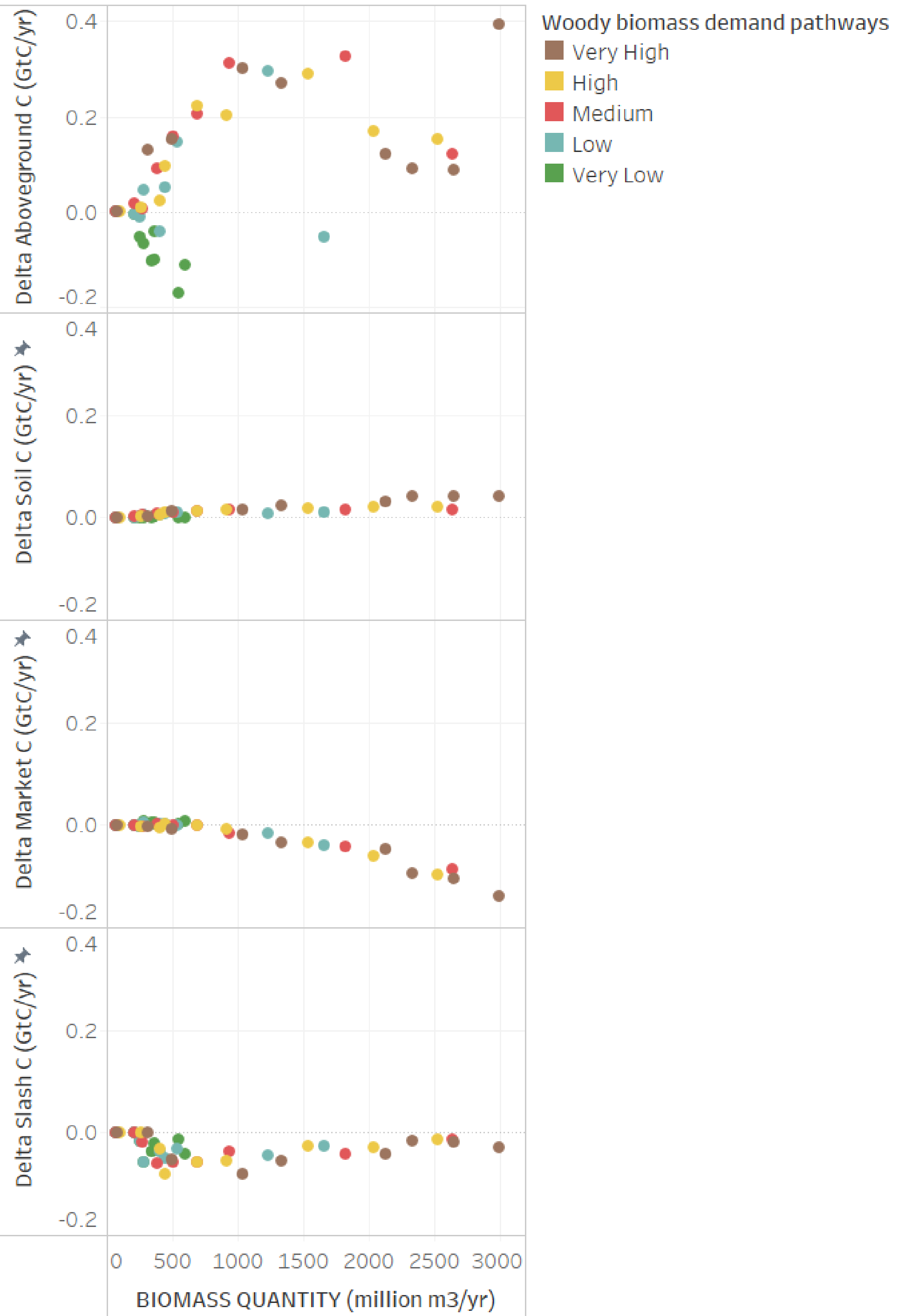

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Summary results

Effects of woody-biomass demand (value of wood increases)

1. more land will be converted to managed forests
2. more investments will be devoted to increasing growth and yield of managed forests
3. some traditional timber products will be replaced by woody biomass production

Summary results

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Corresponding effects on forest carbon?

- **Carbon debt under low bio-energy demands** because higher timber prices encourage more harvesting of natural forests but not enough to drive an increase in investments in forest regeneration

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Corresponding effects on forest carbon?

- **Increase forest carbon stock (after initial reduction*)** under high demand pathways because they will encourage investments in forest management increasing the global carbon balance

*this study does not include avoided emissions because of fossil fuel substitution

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Corresponding effects on natural/unmanaged forest?

- **All demand scenarios project a loss of unmanaged forests, higher under high demands**

Policy solutions

Policy options proposed to regulate bio-energy demand and avoid <u>carbon debt:</u>

- Tax on bio-energy consumption (Schlesinger et al. 2018)
  - Tax on bio-energy demand is not efficient because it does not recognize that forests also sequester carbon through growth
  - An efficient approach needs either a carbon tax and subsidy (Van Kooten, et al. 1995, *AJAE*) or carbon rental (Sohngen & Mendelsohn, 2003, *AJAE*)
- Carbon rental approach (Favero et al. 2020)

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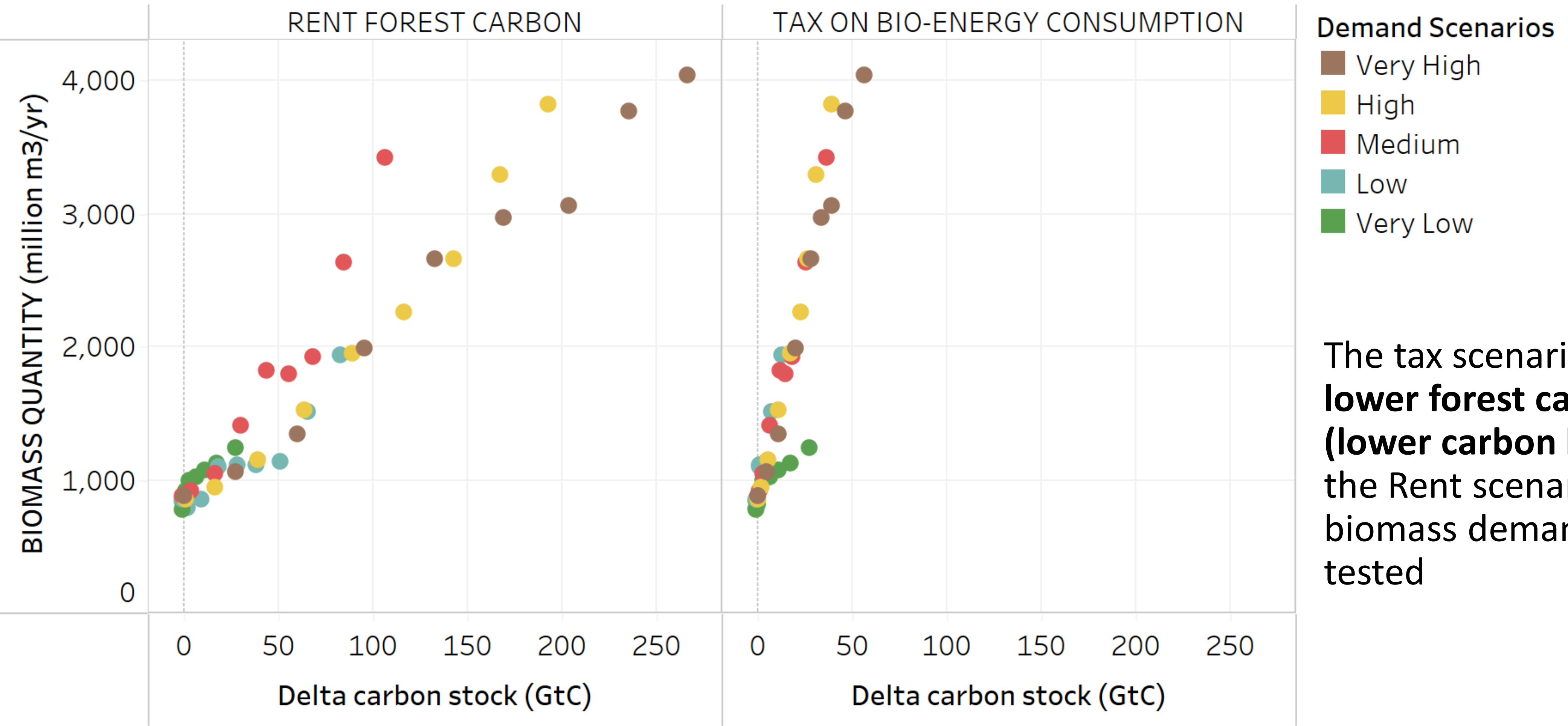
Test both policies with GTM

- Rental scenario: forest owners receive rents for the stock of carbon in forests
- Tax scenario: tax on carbon emissions upon harvests for energy

Measure policy efficiency as the policy that delivers the highest level carbon benefit (=increase in forest carbon) per quantity of bio-energy produced

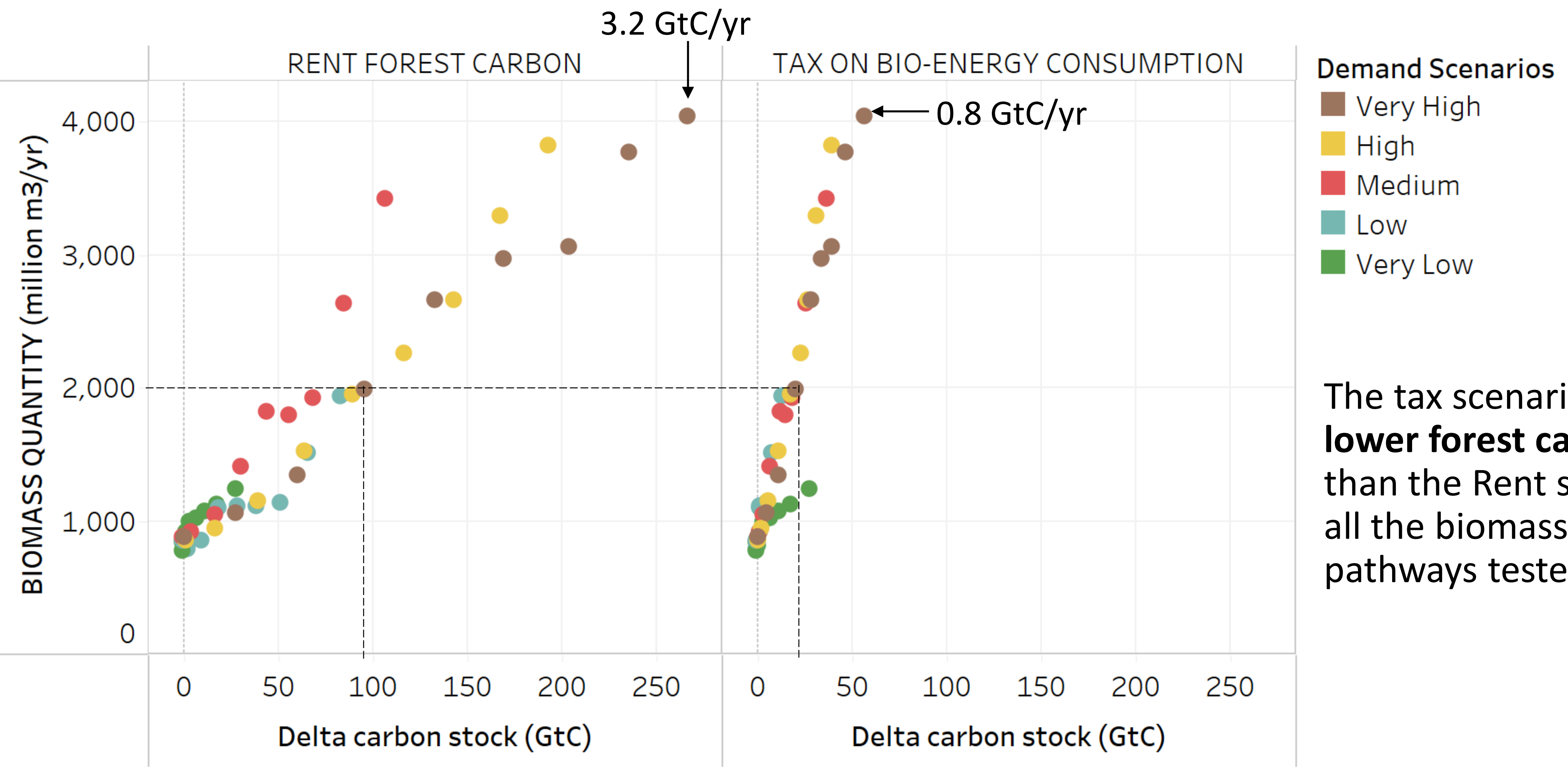
Effects of the policies on forests carbon stock



The tax scenario delivers **lower forest carbon stock (lower carbon benefits)** than the Rent scenarios for all the biomass demand pathways tested

Source: Favero et al. 2020

Effects of the policies on forests carbon stock



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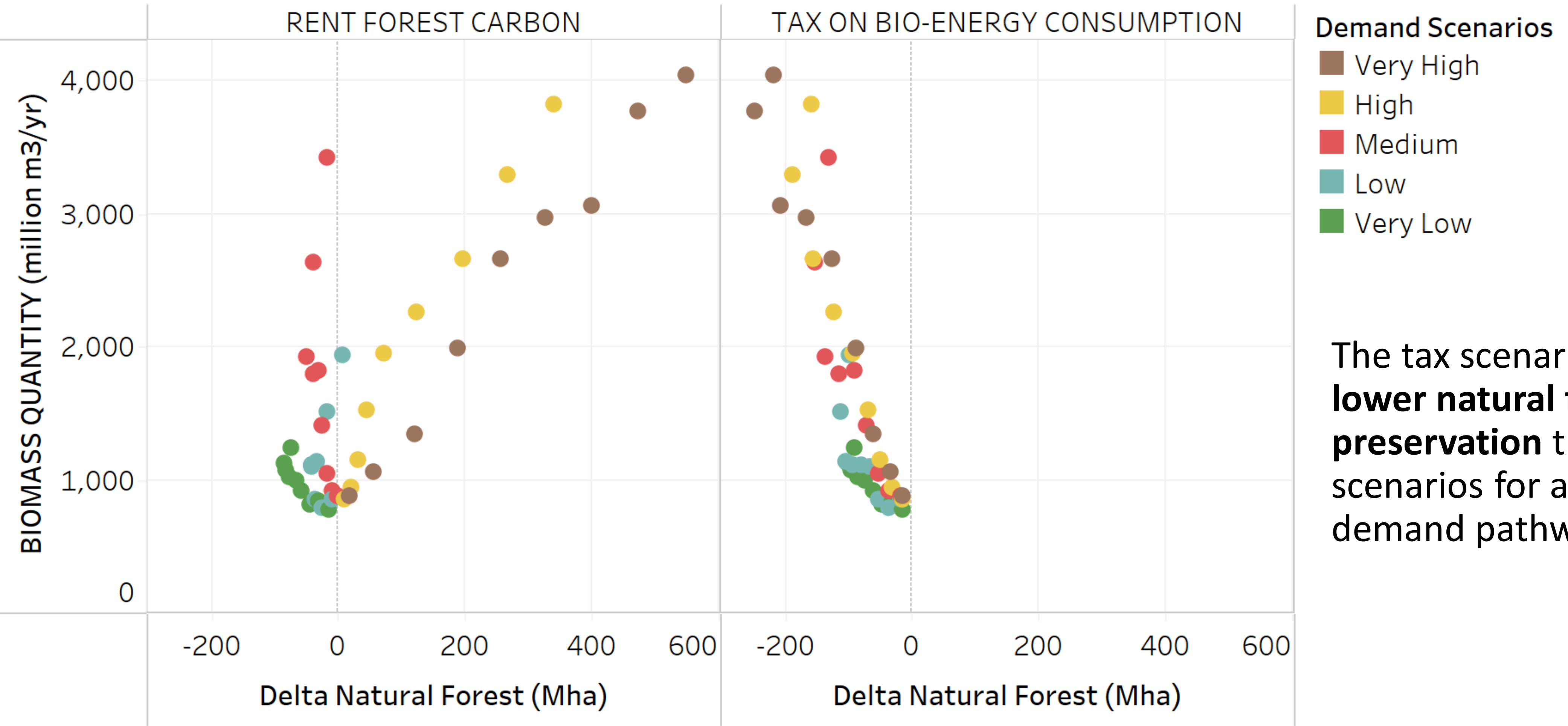
Effects of the policies on natural forests



The tax scenario delivers **lower natural forest preservation** than the Rent scenarios for all the biomass demand pathways tested

Source: Favero et al. 2020

Conclusions

Regulation

- Policy instruments available to reduce negative effects of bio-energy demand
- Other policy options: direct constraints on supply
    - No bio-energy sourced from residues, natural forests etc. (see EU REDII)

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- Policy instruments available to reduce negative effects of bio-energy demand
- Other policy options: direct constraints on supply
  - No bio-energy sourced from residues, natural forests etc. (see EU REDII)

- Other important aspects:
  - Climate change effects of forests availability and productivity
  - New wood-based products & their mitigation potential
  - Valuing ecosystem services of forest
  - Assess role played by the forestry sector in the mitigation portfolio: Link forestry model with an IAM

Thank you!

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