Scaling Model Results from Field to Region: Review of Models Addressing Payment Approaches for Cropland Carbon Sequestration, and Measurement Costs

Workshop #3: Modeling to support policy
Forestry and Agriculture Greenhouse Gas Modeling Forum

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Consortium for Agricultural Soils Mitigation of Greenhouse Gases
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Thanks to:

- John Antle (Montana State University)
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- Uwe Schneider (University of Hamburg)

Outline

- Introduce economic models used to examine C sequestration
- Present results of payment approaches
  - How results change when scale of model changes
- Comparisons of results from different areas (estimate of yearly C sequestration potential)
- US scale estimate
- Models of measurement costs
  - Influence of project size/variance
  - Value of information

What models are out there?

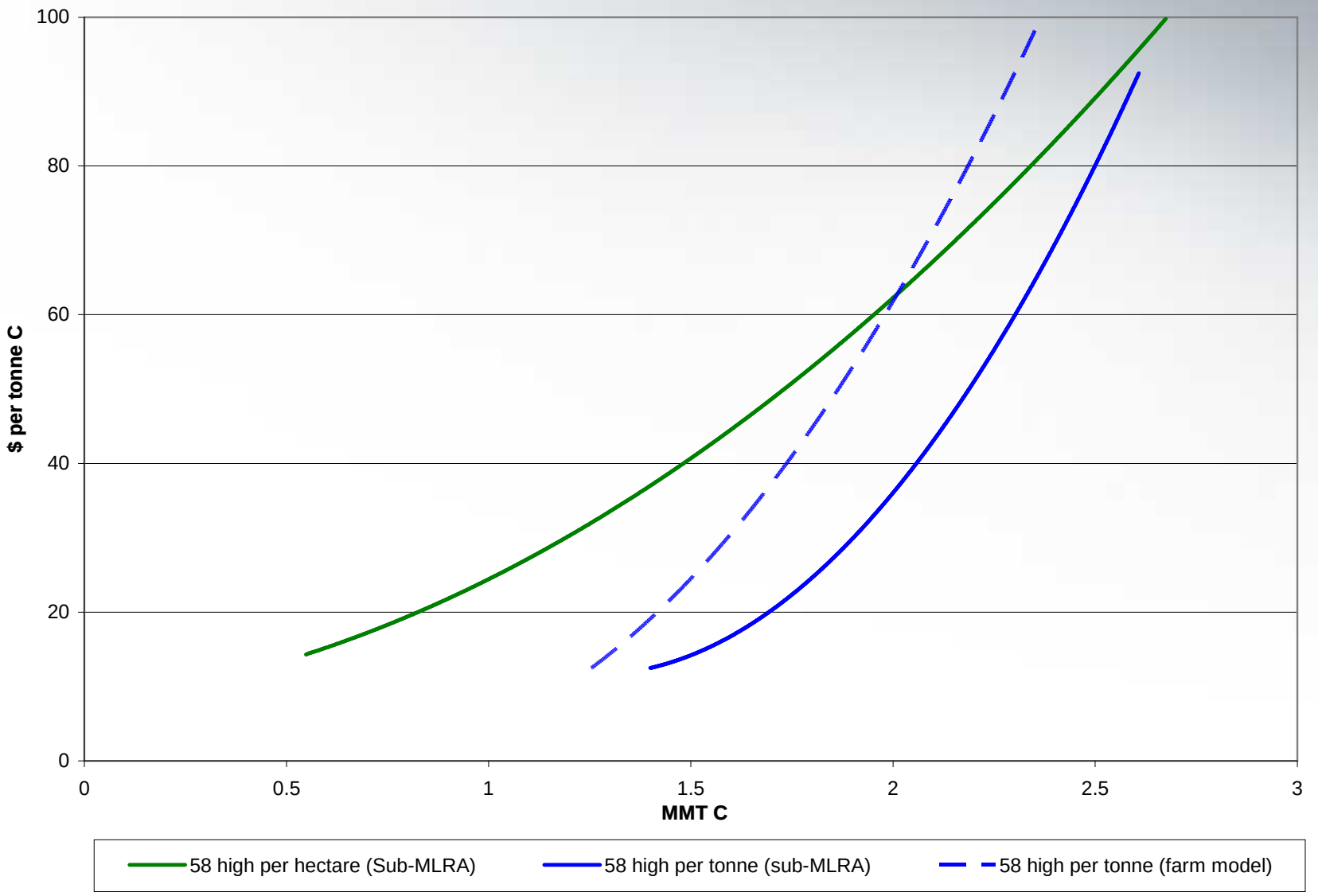
Authors	Data	Region	Modeling technique	Policies examined
Antle/Capalbo/ Mooney/Elliott/ Paustian	Sub-MLRA Farm-***on going*** (Producer survey)	Montana	Econometric and simulation	Per-tonne Per-hectare
Antle/Capalbo	County (Census)	21 States	Econometric and simulation	Per-tonne ***On going***
Kurkalova/Kling/ Zhao	State (NRI data)	Iowa	Econometric (Logit)	Per-tonne Per-hectare
Pautsch/Kurkalova/ Babcock/Kling	State (NRI data)	Iowa	Econometric (Logit)	Per-tonne Per-hectare
Schneider/McCarl (ASMGHG)	Various	US (Regions)	Operations research	Per-tonne Taxes/subsidies

What models are out there? (2)

Authors	**Commodities/Crops considered**
Antle/Capalbo/ Mooney/Paustian	Spring wheat; barley; winter wheat; grass ***Change from crop-fallow to grass or continuous cropping rotation***
Antle/Capalbo	Several systems (depending on area) ***Decrease fallow or change from conventional to no-till management***
Kurkalova/Kling/ Zhao	Corn; soybeans; wheat; barley; hay ***Change from conventional to no-till management***
Pautsch/Kurkalova/ Babcock/Kling	Corn; soybeans; wheat; barley; hay ***Change from conventional to no-till management***
McCarl/Schneider (ASMGHG)	Broad array of commodities and several mitigation strategies. ***E.g. tillage, manure management, biomass production among others***

Payment Approaches and Scale

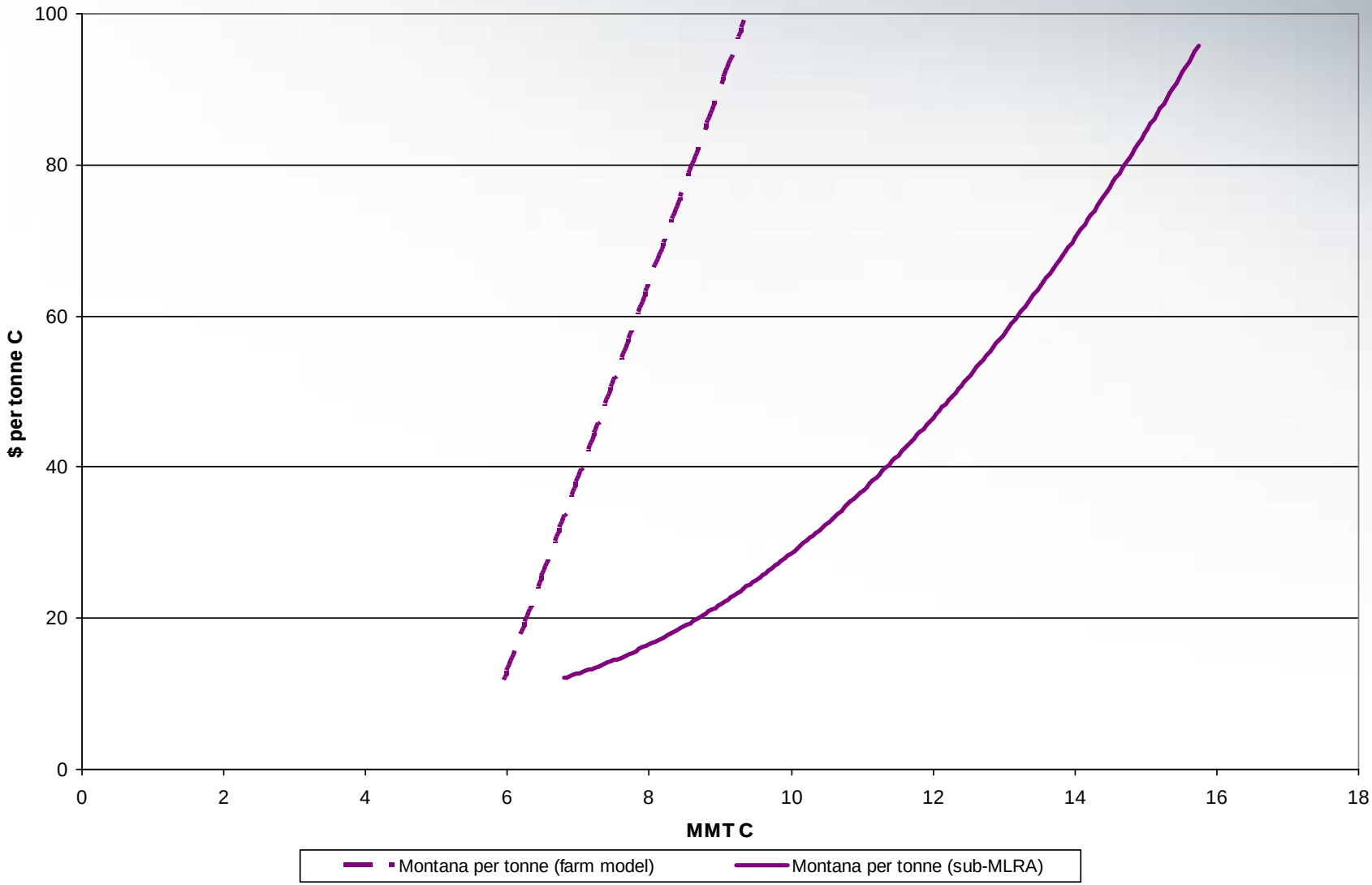
Payment approaches: results



Single region of Montana

Source: Unpublished results based on models by Antle, Capalbo, Mooney

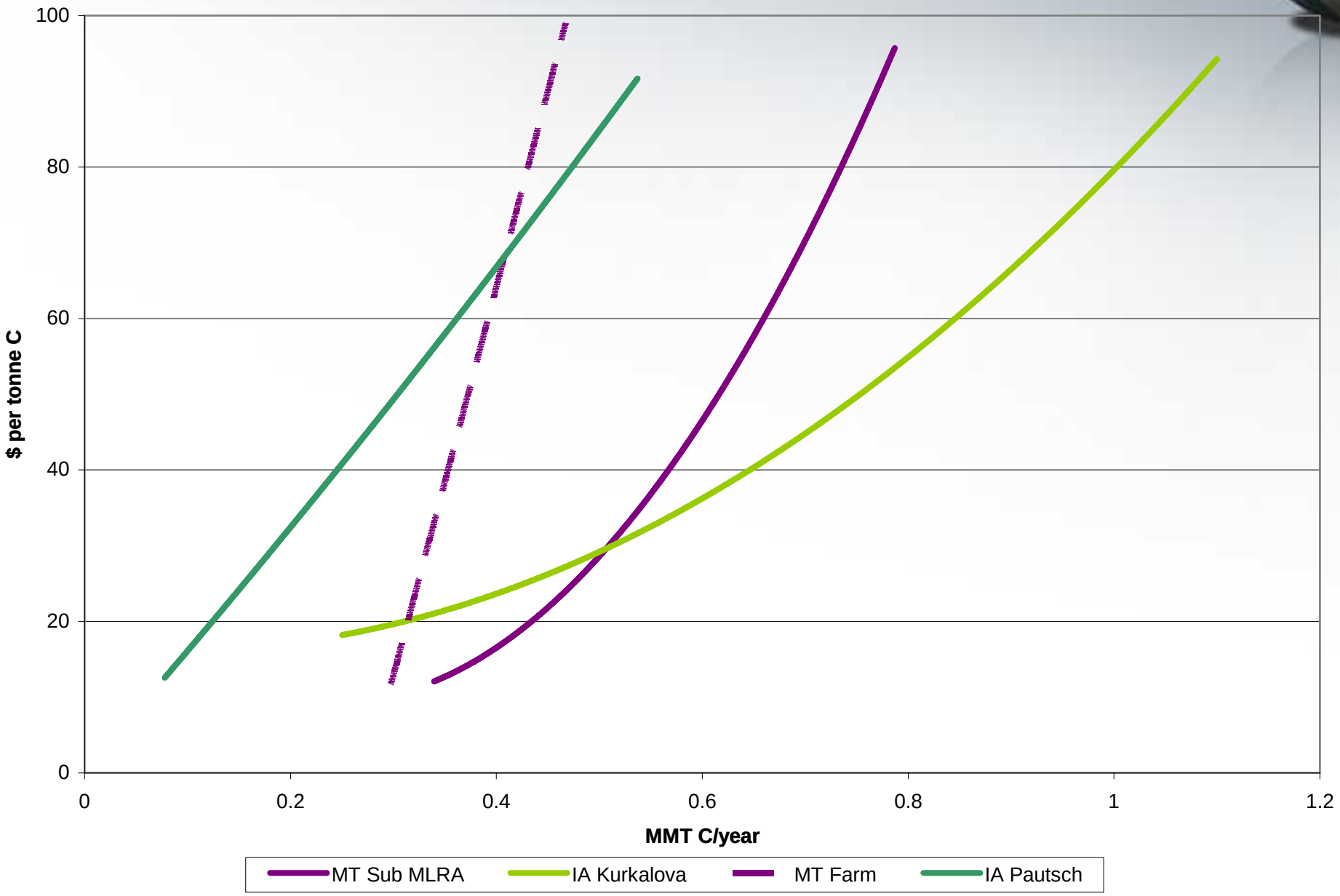
Montana results scaled from farm and sub-MLRA to region



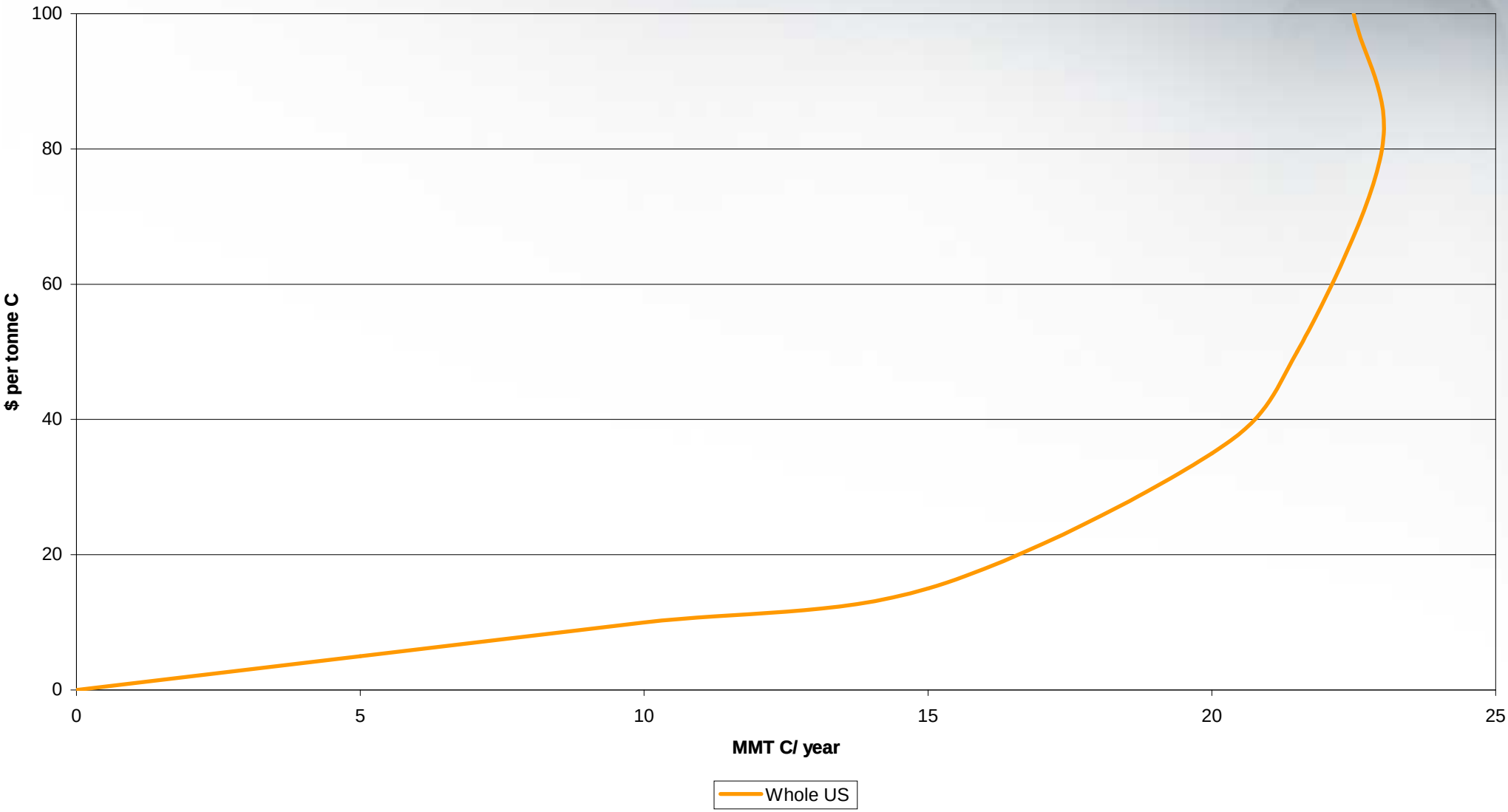
Farm and sub-MLRA model results summed across state of Montana (per-tonne payments)

Source: Unpublished results based on models by Antle, Capalbo, Mooney

Iowa and Montana (tonnes per year)



Whole US – Schneider (tonnes per year)



Benefits/information – current models

- Available models provide information about:
  - Efficient policy design (broad agreement)
  - Economic potential to sequester soil C in some regions
  - Some information on scale effects
  - Value of information/data collection
  - Variety of scales provide different information

Issues/Limitations – future directions

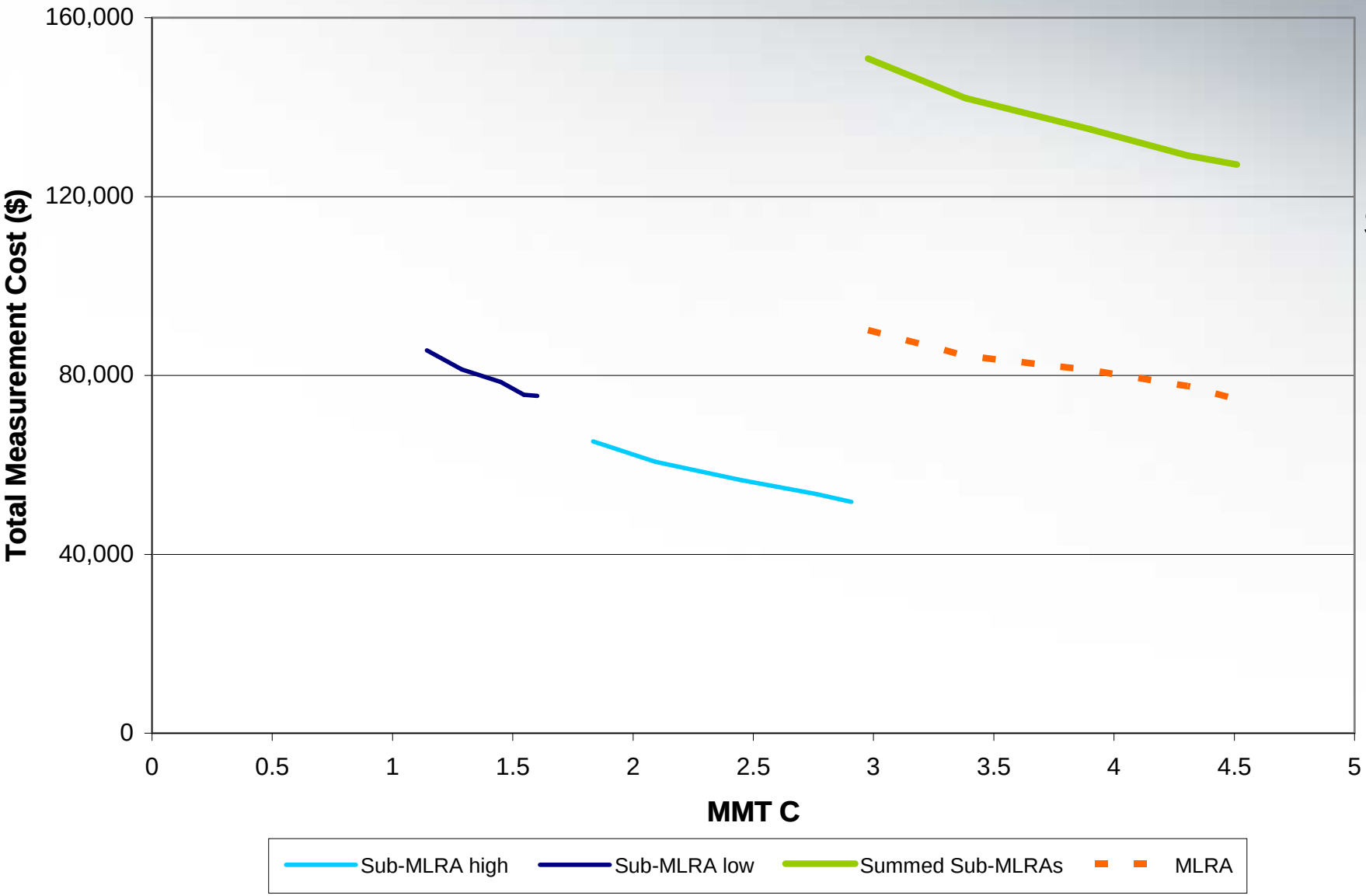
- Scale differences/ types of systems modeled makes comparisons between areas difficult
- Small scale models
  - Expand to more states
  - Include full GHG accounting (some work on going)
  - Transactions costs (some work on going)
  - Include interactions between more technologies
- Data collection at small scales can be costly
  - Develop models that can function with smaller data requirements
- Comparison of model results with empirical tests
- Adoption costs/adaptation path
- Explore model/data/parameter uncertainty

Modeling measurement costs

What models/studies are out there?

Authors	Region	Modeling technique	Policies examined
Kurkalova/Kling/ Zhao	Iowa	Econometric (Logit)	Efficiency difference between measurement schemes based on different data scales. The difference in efficiency provides an upper bound estimate of the amount that could be spent on transactions costs, such as measurement.
Mooney/Antle/ Capalbo/Paustian	Montana	Econometric and simulation.	Modeled the cost of implementing a stratified random sampling scheme to measure soil C sequestered by producers entering into per-tonne contracts to sequester C. Identified cost sensitivities to size of region, variance of C, error and confidence level selected and max number of samples that could be taken before a per-hectare program was more efficient than a per-tonne program.

Project scale and measurement cost



Single region of Montana

Project size and variance: influence on measurement costs per hectare*

	Coefficient of variation (%)							
Project Size (ha)	10		20		30		40	
	Sample	Cost /ha ($)	Sample	Cost /ha ($)	Sample	Cost /ha ($)	Sample	Cost /ha ($)
10	3	327.18	7	328.78	8	329.18	9	329.58
100	4	32.76	14	43.88	26	55.07	39	66.31
1,000	4	3.28	16	4.40	34	5.54	58	7.78
10,000	4	0.33	16	0.44	35	0.55	62	0.89

*Single strata – based on representative cost estimates

Source: Mooney, S., S. Brown and D. Shoch. 2003. Measurement and Monitoring Costs: influence of parcel contiguity, carbon variability, project size and timing of measurement events. Unpublished report. Winrock International.

Scale of measurement technology Kurkalova, Kling and Zhao

- Examined costs of implementing four scales of measurement technology for soil C in Iowa
  - Field scale
  - County scale
  - Crop reporting district scale
  - State scale

- Cost savings of between 11 and 48 percent if you adopt field scale measurement technologies
- Savings related to heterogeneity exhibited by region

Models/Studies of measurement costs

- Allow us to explore a wide range of scenarios/different assumptions
  - More flexible than a single empirical project
  - Insight into factors/issues that influence measurement costs
  - Helpful for identifying/organizing measurement related project issues
- Future
  - Beneficial to have greater interaction between models/modellers and available empirical examples
  - Wider array of possible measurement schemes/technologies

References for models examining alternative policies

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