

Explaining the Price of Voluntary Carbon Offsets

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Role of offsets in GHG policies

- Regulation of GHG emissions faces challenges due to equity and compliance cost concerns
- Offsets are incorporated into most regulatory schemes to address these concerns
 - Kyoto's Clean Development Mechanism (CDM)
 - Waxman-Markey Bill allows major role for offsets

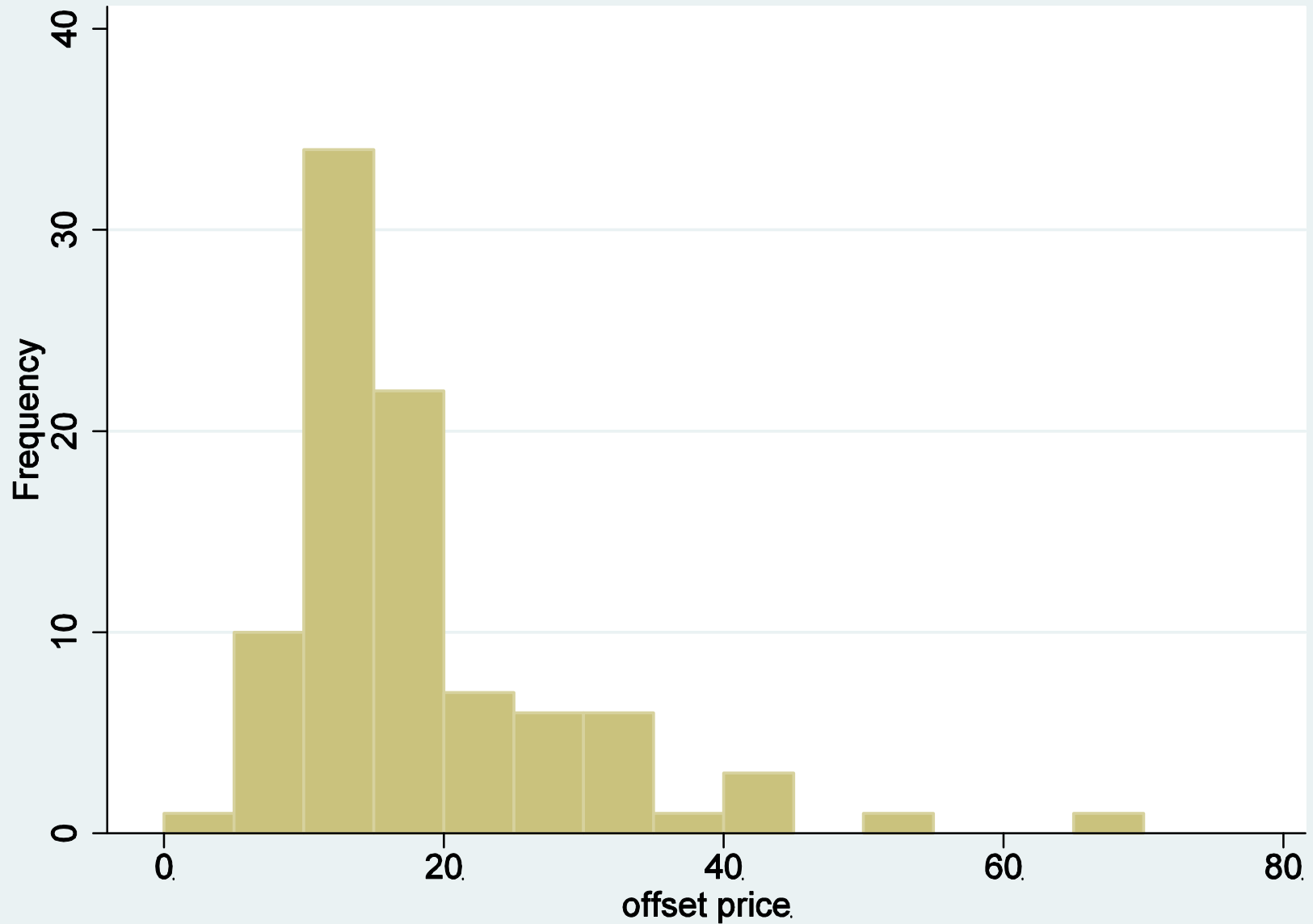
GHG offsets are also traded voluntarily

- Demand and supply of GHG offsets has developed independent of regulation
- 134.2 million metric tons of CO₂e traded in 2008, an increase of 87% from 2007
- Definition of an ideal carbon offset has lagged trading volume

Questions about offsets

- Is offset additional?
 - No credit given for *baseline* behavior
- Is offset permanent?
 - Response to incentive for gaming the offset option
- Is offset credible?
 - Certification accounts for information asymmetry
- What are people paying for?

Histogram of Voluntary Offset Price



Objective is to explain voluntary offset prices

- We estimate hedonic price functions to determine impact of offset characteristics on price
- We focus on several key characteristics
 - Provider characteristics (profit status, project number, etc.)
 - Project certification (CDM/GS, VCS)
 - Type of offset project (alt energy, methane capture, forestry, etc.)
 - Project location (geography, OECD classification)

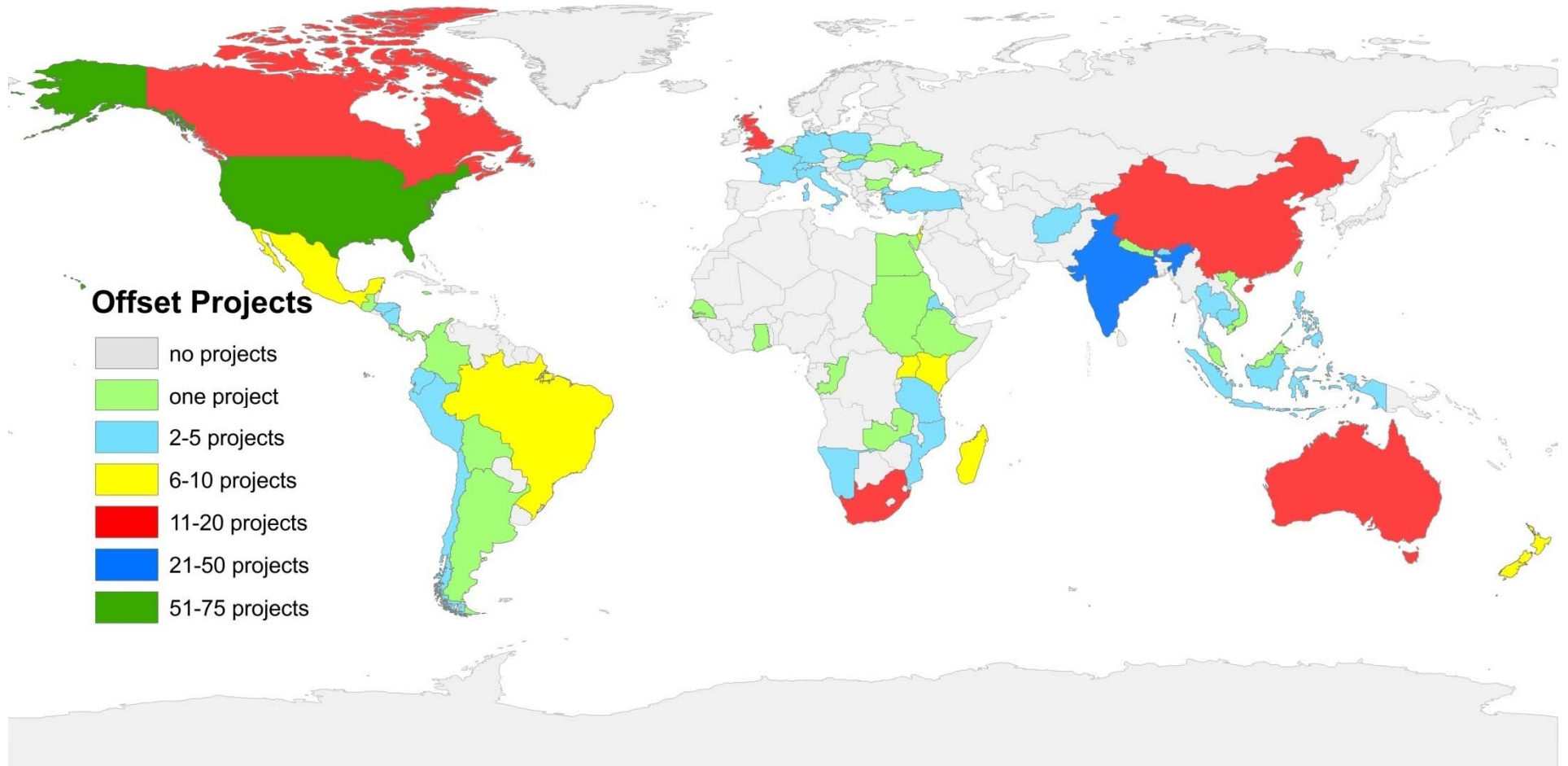
The Carbon Catalog is the key data source

- Publicly-available, online directory of carbon offset providers and projects
- Mission is to increase transparency in offset markets
- Our analysis is based on all information available on the site as of December 2008

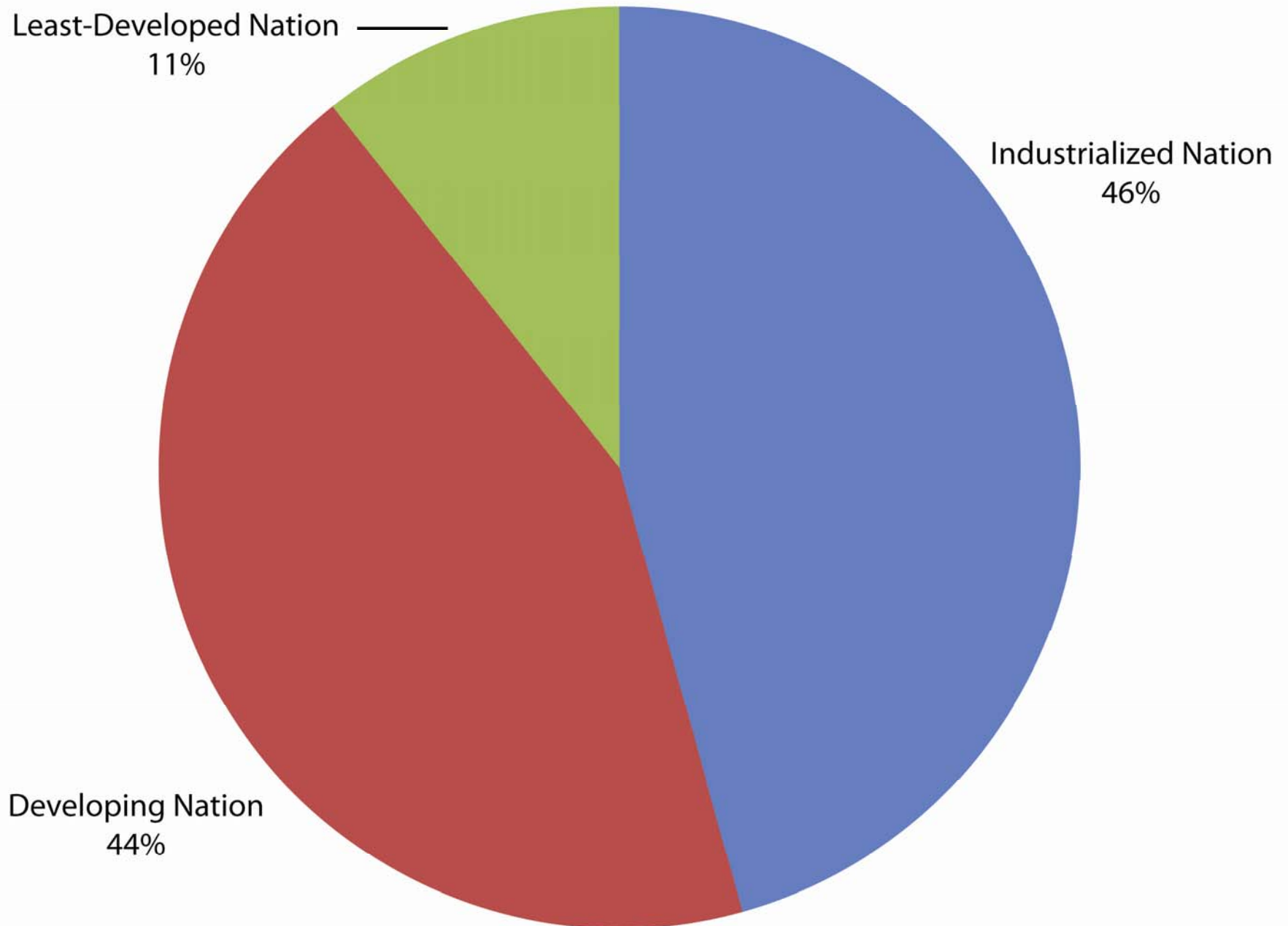
Overview of dataset

- 97 Offset providers located around the world
 - Location (nation)
 - Number of projects managed
 - For-profit or not-for-profit organization
- 280 unique offset-supplying projects
 - Location (nation)
 - Project Type (emission reduction mechanism)
 - Certification (CDM/GS, VCS)
- Offset price is recorded at the provider level

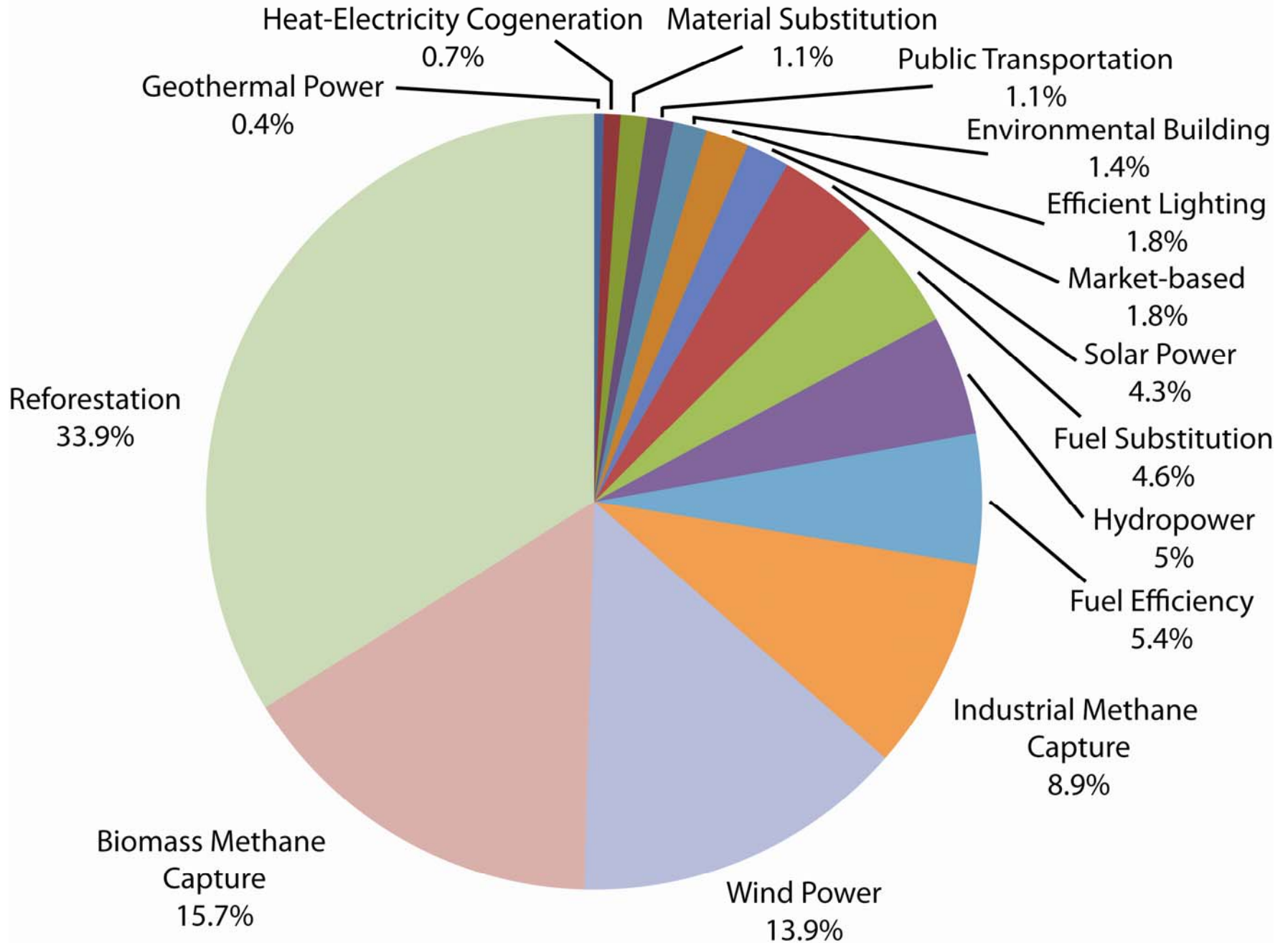
Project Location



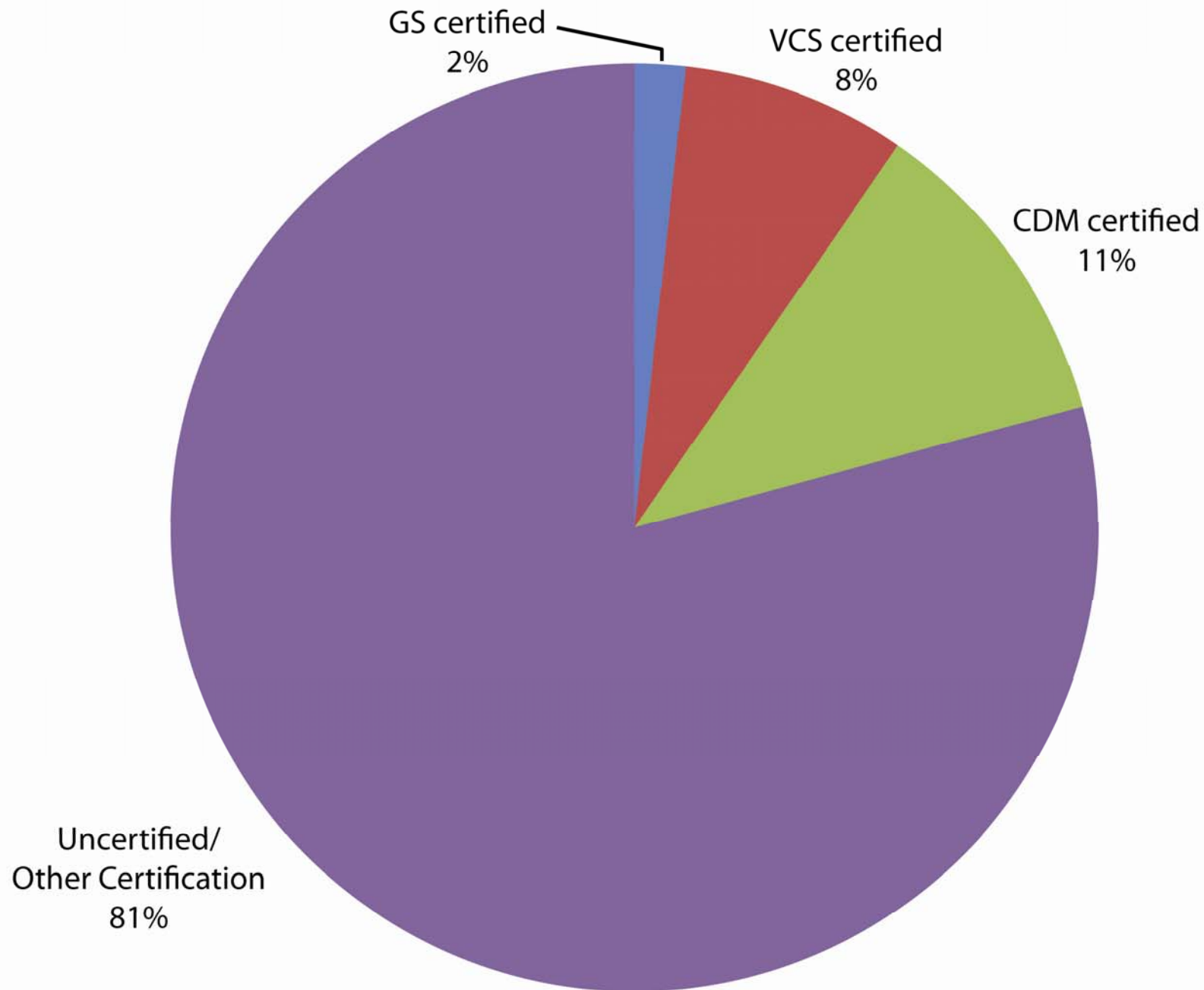
Project Location: OECD Classification



Project Type



Certification of Projects



Methodology

- We estimate hedonic price functions at both the provider- and project-level of analysis
- Provider-level functions are of the following form

$$P_t = f(\text{loc}_t, \text{nprof}_t, \text{nproj}_t, \text{nonind}_t, \text{forest}_t, \text{kyoto}_t) + \varepsilon_t$$

Provider-Level Results

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
North America	-6.909** (2.670)			
Australasia	-5.936* (3.383)			
Europe	—			
Nonprofit	1.324 (2.290)			
Multiple projects	-1.183 (2.356)			
Projects in non-industrialized nations ^f	-0.333 (3.027)			
Forestry-based projects ^f	-1.385 (2.654)			
Kyoto (CDM or GS certification) ^f	13.293*** (3.343)			
Constant	20.910*** (3.340)			
<i>R</i> -squared	0.319			
<i>N</i>	85			

Notes: Dependent variable is offset price. Standard errors are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Provider-Level Results

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
North America	-6.909** (2.670)	-0.285** (0.131)		
Australasia	-5.936* (3.383)	-0.248 (0.166)		
Europe	—	—		
Nonprofit	1.324 (2.290)	0.096 (0.112)		
Multiple projects	-1.183 (2.356)	-0.054 (0.115)		
Projects in non-industrialized nations ^f	-0.333 (3.027)	0.034 (0.148)		
Forestry-based projects ^f	-1.385 (2.654)	-0.164 (0.130)		
Kyoto (CDM or GS certification) ^f	13.293*** (3.343)	0.586*** (0.164)		
Constant	20.910*** (3.340)	2.862*** (0.164)		
<i>R</i> -squared	0.319	0.308		
<i>N</i>	85	85		

Notes: Dependent variable is offset price. Standard errors are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Provider-Level Results

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
North America	-6.909** (2.670)	-0.285** (0.131)	-7.487*** (2.567)	
Australasia	-5.936* (3.383)	-0.248 (0.166)	-7.061** (3.326)	
Europe	—	—	—	
Nonprofit	1.324 (2.290)	0.096 (0.112)	1.728 (1.353)	
Multiple projects	-1.183 (2.356)	-0.054 (0.115)	-0.842 (2.419)	
Projects in non-industrialized nations ^f	-0.333 (3.027)	0.034 (0.148)	0.158 (2.479)	
Forestry-based projects ^f	-1.385 (2.654)	-0.164 (0.130)	-1.406 (2.577)	
Kyoto (CDM or GS certification) ^f	13.293*** (3.343)	0.586*** (0.164)	15.435*** (3.937)	
Constant	20.910*** (3.340)	2.862*** (0.164)	21.404*** (3.162)	
<i>R</i> -squared	0.319	0.308	0.291	
<i>N</i>	85	85	85	

Notes: Dependent variable is offset price. Standard errors are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Provider-Level Results

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
North America	-6.909** (2.670)	-0.285** (0.131)	-7.487*** (2.567)	-0.309** (0.127)
Australasia	-5.936* (3.383)	-0.248 (0.166)	-7.061** (3.326)	-0.291 (0.164)
Europe	—	—	—	—
Nonprofit	1.324 (2.290)	0.096 (0.112)	1.728 (1.353)	0.115 (0.116)
Multiple projects	-1.183 (2.356)	-0.054 (0.115)	-0.842 (2.419)	-0.045 (0.119)
Projects in non-industrialized nations ^f	-0.333 (3.027)	0.034 (0.148)	0.158 (2.479)	0.075 (0.122)
Forestry-based projects ^f	-1.385 (2.654)	-0.164 (0.130)	-1.406 (2.577)	-0.172 (0.127)
Kyoto (CDM or GS certification) ^f	13.293*** (3.343)	0.586*** (0.164)	15.435*** (3.937)	0.652*** (0.194)
Constant	20.910*** (3.340)	2.862*** (0.164)	21.404*** (3.162)	2.881*** (0.156)
<i>R</i> -squared	0.319	0.308	0.291	0.269
<i>N</i>	85	85	85	85

Notes: Dependent variable is offset price. Standard errors are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Methodology (continued)

- Project-level equations include project type, location, and certification type
- Equations of the following form

$$P_i = f(\text{offsettype}_{ij}, \text{OECD}_{ij}, \text{kyoto}_{ij}, \text{VCS}_{ij}) + \varepsilon_{ij}$$

- Must cluster standard errors in these models

Project-Level Results

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
Industrial methane	0.156 (2.190)	0.126 (0.226)		
Biomass methane	7.708*** (2.913)	0.518** (0.235)		
Hydropower	5.516* (2.871)	0.456* (0.246)		
Solar	6.159* (3.192)	0.486* (0.252)		
Wind	5.312* (2.681)	0.428* (0.234)	-----	-----
Other	2.519 (2.264)	0.294 (0.221)		
Forestry	—	—		
Developing nation	—	—		
Least-developed nation	—	—		
Industrialized nation (CDM or GS certification)	—	—		
VCS	—	—		
Constant	14.225*** (1.970)	2.445*** (0.214)		
R-squared	0.097	0.131		
N	319	319		

Notes: Dependent variable is offset price. Standard errors clustered at the provider level are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Project-Level Results

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
Industrial methane	0.156 (2.190)	0.126 (0.226)	0.844 (2.125)	0.158 (0.211)
Biomass methane	7.708*** (2.913)	0.518** (0.235)	3.875 (2.349)	0.325 (0.208)
Hydropower	5.516* (2.871)	0.456* (0.246)	2.716 (2.384)	0.311 (0.214)
Solar	6.159* (3.192)	0.486* (0.252)	6.091* (3.616)	0.490* (0.272)
Wind	5.312* (2.681)	0.428* (0.234)	3.167 (2.592)	0.318 (0.223)
Other	2.519 (2.264)	0.294 (0.221)	2.742 (2.277)	0.308 (0.227)
Forestry	–	–	–	–
Developing nation	–	–	3.307** (1.319)	0.172** (0.083)
Least-developed nation	–	–	3.802* (1.981)	0.208* (0.105)
Industrialized nation (CDM or GS certification)	–	–	– 8.115*** (2.430)	– 0.407*** (0.119)
VCS	–	–	-2.728 (1.649)	-0.046 (0.125)
Constant	14.225*** (1.970)	2.445*** (0.214)	12.258*** (1.973)	2.335*** (0.212)
R-squared	0.097	0.131	0.222	0.213
N	319	319	319	319

Notes: Dependent variable is offset price. Standard errors clustered at the provider level are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Project-Level Results – forestry focused

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
Forestry	-3.725 (2.633)	-0.385 (0.261)		
Developing nation	3.689*** (1.264)	0.193** (0.082)		
Least-developed nation	3.740* (1.889)	0.202* (0.104)
Industrialized nation	—	—		
CDM/GS certified	7.783*** (2.451)	0.356*** (0.114)		
VCS	-4.236** (1.654)	-0.192** (0.087)		
Forestry × Developing nation	—	—		
Forestry × Least-developed nation	—	—		
Constant	15.323*** (1.372)	2.654*** (0.079)		
<i>R</i> -squared	0.218	0.225		
<i>N</i>	319	319		

Notes: Dependent variable is offset price. Standard errors clustered at the provider level are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Project-Level Results – forestry focused

Variable	(a)		(b)	
	Linear	Log-linear	Linear	Log-linear
Forestry	-3.725 (2.633)	-0.385 (0.261)	-0.286 (2.429)	-0.152 (0.239)
Developing nation	3.689*** (1.264)	0.193** (0.082)	5.498*** (1.533)	0.322*** (0.083)
Least-developed nation	3.740* (1.889)	0.202* (0.104)	8.330*** (2.126)	0.488*** (0.105)
Industrialized nation	–	–	–	–
CDM/GS certified	7.783*** (2.451)	0.356*** (0.114)	7.444*** (2.364)	0.326*** (0.108)
VCS	-4.236** (1.654)	-0.192** (0.087)	-4.956*** (1.604)	-0.241*** (0.080)
Forestry × Developing nation	–	–	-5.459*** (1.963)	-0.394*** (0.140)
Forestry × Least-developed nation	–	–	-11.156*** (2.773)	-0.697*** (0.164)
Constant	15.323*** (1.372)	2.654*** (0.079)	14.149 (1.386)	2.575*** (0.078)
R-squared	0.218	0.225	0.252	0.263
N	319	319	319	319

Notes: Dependent variable is offset price. Standard errors clustered at the provider level are reported in parentheses. Three, two, and one asterisk(s) indicate statistical significance at the 99-, 95- and 90-percent levels, respectively.

Discussion of results

- Empirical challenge of distinguishing between supply and demand mechanisms
- Isolating the drivers of offset price has significant value to policy development

Discussion – location

- European providers have 30% price premium
 - May be related to spatial variation in regulation
- Significant and robust price premium ($> 25\%$) for projects in non-industrialized nations
 - Assume lower project cost in these nations
 - Possible evidence of desire for poverty alleviation

Discussion – offset type

- The number of projects managed by a provider and for-profit status have no impact on offset price
- Forestry projects tend to have lower prices
 - May reflect concerns about leakage and permanence
- Significant decrease in offset price (>40%) for forestry projects in non-industrialized nations
 - Opportunity cost of land
 - Strength of institutions

Discussion -- certification

- CDM/GS certification has price premium of between 30% and 60%
 - Access to regulated markets, with higher WTP
 - Addresses concerns about additionality, permanence, and credibility
- VCS certification associated with a discounted price
 - The effect of third-party certification is unclear

Conclusions

- Limited sample size and early state of market call for cautious interpretation of results
- We do observe robust results to guide future research and policy
- More data and market thickness required to further explore preliminary results

Thanks for your time

- Questions?