The Impact of Integrated Teams: Examples from unconventional gas plays
or
How we acquired 14 new friends who don't even speak our language

Svetlana Ikonnikova and Eric Potter

Goal: predict the production performance over a 20-year period for the top four shale gas plays in the U.S.

- 2 year project funded by Sloan Foundation
- Rapidly developing plays, some mature but others just starting
- Gas prices low, so development pace is slower than anticipated
- Many uncertainties about well performance and what drives it

Impact

- Reality check on the new shale gas boom
  - How substantial?
  - How long sustained?
  - How profitable?
- Did not address:
  - How safe, how environmentally friendly, true EROI (energy return on energy invested), etc

North American Shale gas forecast by Baker Institute, 2011

tcf

TCF

2010 2040

Horn River
Montney
Fayetteville
Barnett
Haynesville
Marcellus
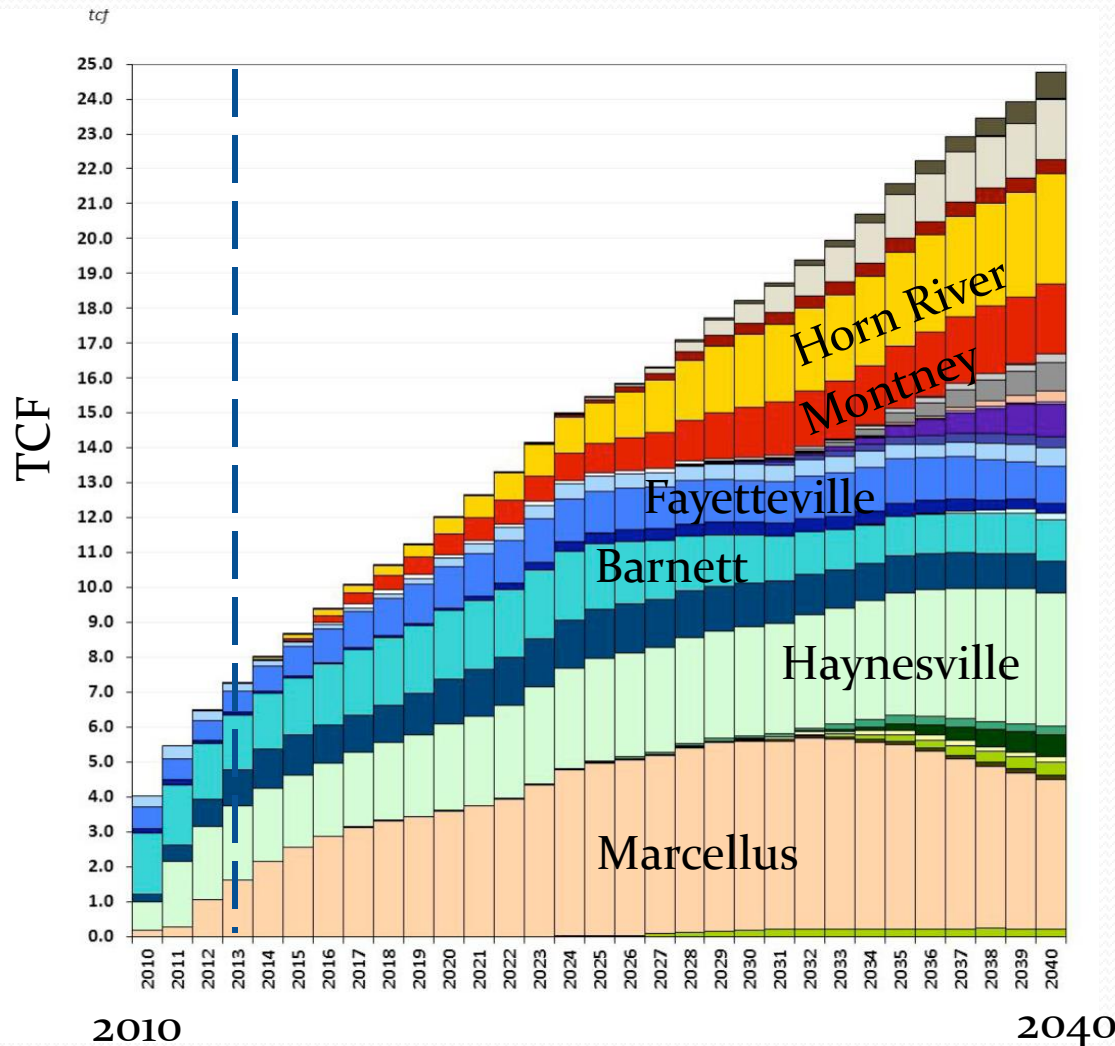
This and other studies indicate strong shale-gas production for several decades.
Do we believe this?
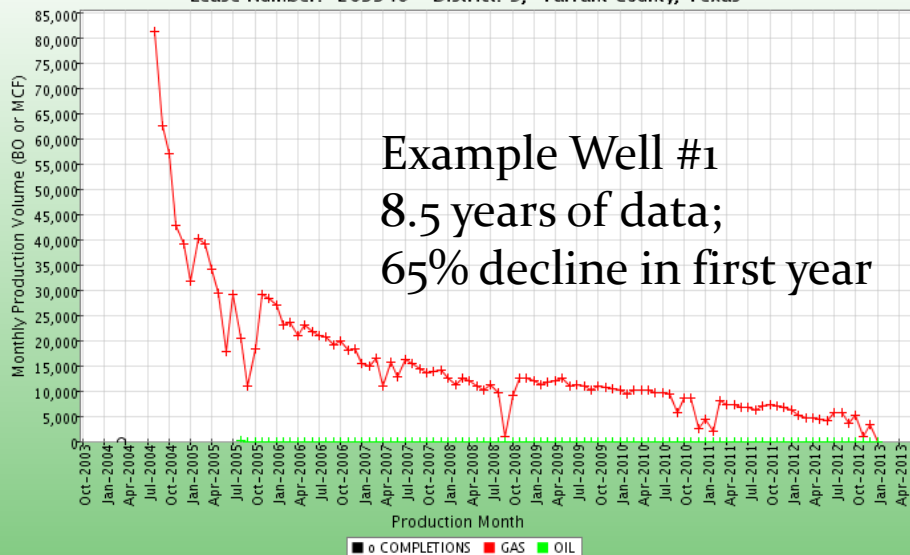
Medlock, Jaffe & Hartley, 2011

Future shale gas production rates

- Difficult to forecast because of interactions of geology, price, recovery per well, spacing, refracs, technology change, costs, drilling pace, well attrition, and accessibility
- Forecasting starts with aggregating single-well data like this:

Example Well #1
8.5 years of data;
65% decline in first year

Example well #2
1 year of data;
64% decline
in first year
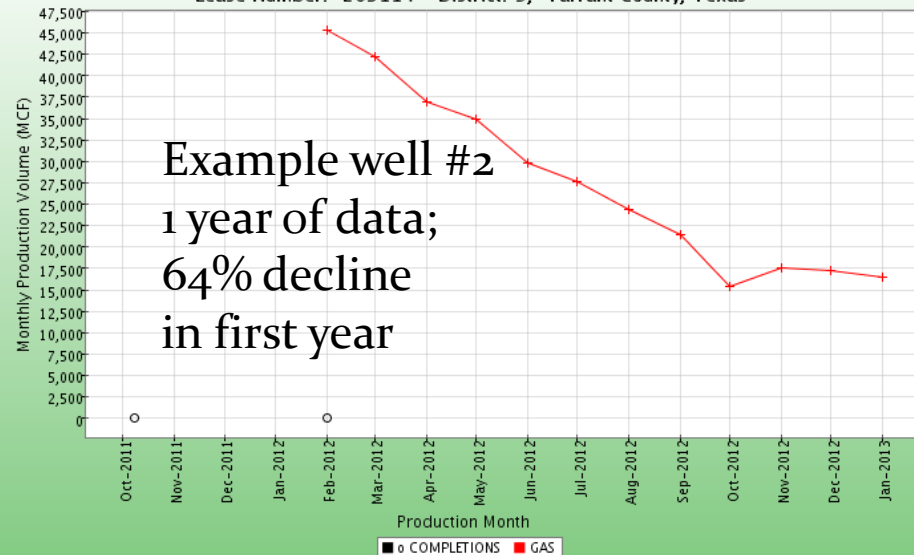
Team
~16 people

- 6 geologists including 1 student and 1 post doc
- 4 petroleum engineers (1 student)
- 5 economists (2 students)
- 1 GIS/mapping/database expert
- Age range 22 to 80+
- 5 nationalities
- 2 cities
- 4 departments in 2 universities

Work Flow: Barnett Shale Basin Assessment

Log and microseismic **data**
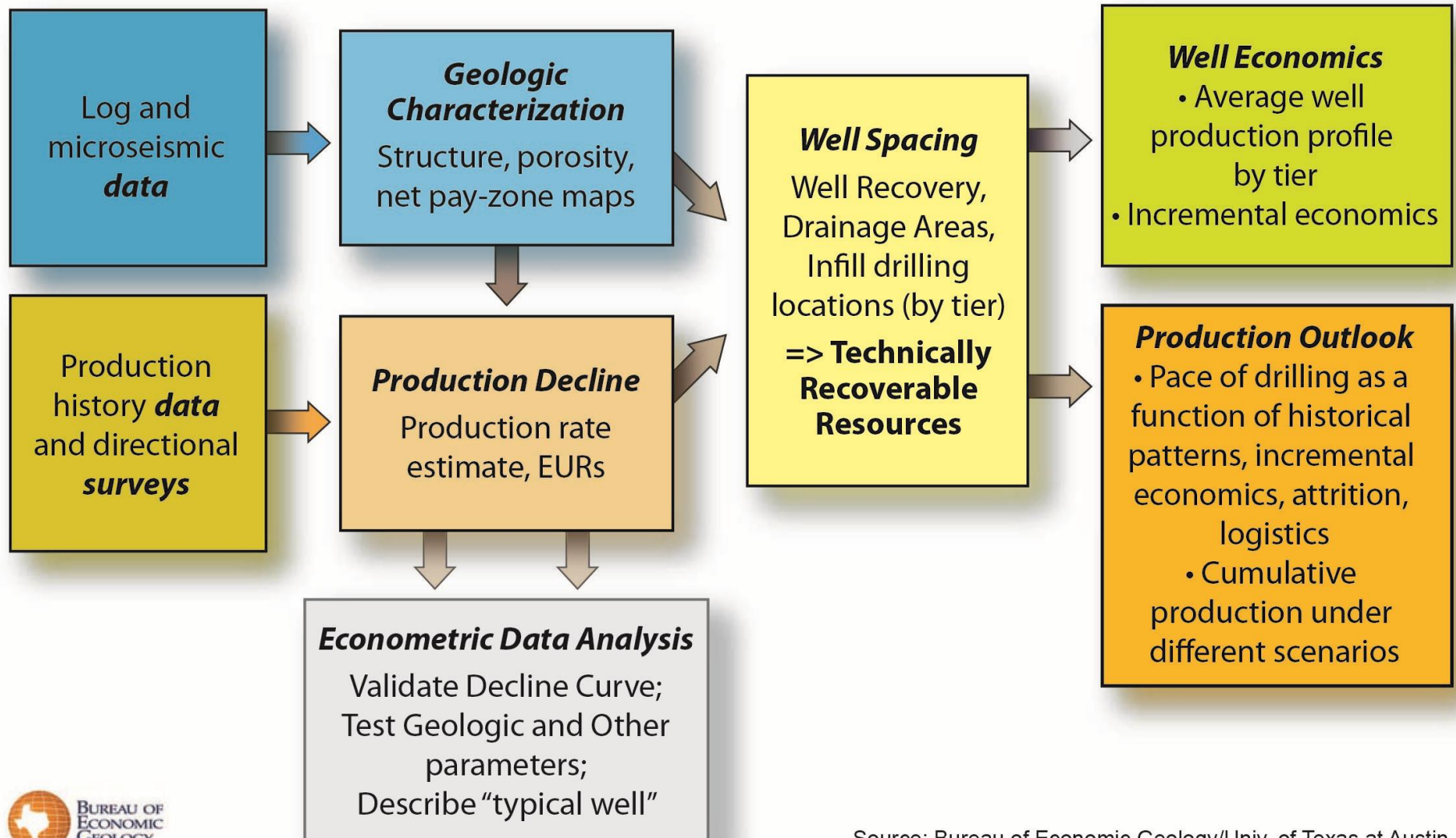
Production history **data** and directional **surveys**

Geologic Characterization
Structure, porosity, net pay-zone maps

Production Decline
Production rate estimate, EURs

Well Spacing
Well Recovery, Drainage Areas, Infill drilling locations (by tier)
=> Technically Recoverable Resources

Well Economics
• Average well production profile by tier
• Incremental economics

Production Outlook
• Pace of drilling as a function of historical patterns, incremental economics, attrition, logistics
• Cumulative production under different scenarios

Econometric Data Analysis
Validate Decline Curve; Test Geologic and Other parameters; Describe "typical well"

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Source: Bureau of Economic Geology/Univ. of Texas at Austin

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Team "Languages"

- Stratigraphy
- Structure
- Organic Geochemistry
- Decline-curve analysis (future performance of existing wells – curve-fitting and the underlying physical basis)
- Economics
- Panel analysis
- Computer mapping and spatial analysis
- Petrophysics

Terminology

- Keep in mind others may not know terms you use...
  - Permeability means nothing to economists;
  - Externalities means nothing to geologists;
  - Devonian means nothing to engineers.
- The same terms may have different meanings for different people, e.g.
  - matrix may mean something that has nothing to do with numbers....

Hassles

- Team not fully staffed when project began
- Needed complete geological workup prior to launching many other tasks
- Having incomplete geological datasets (no seismic, few cores, etc)
- Deadline pressure – 4 major studies in 2 years
- Communicating among disciplines takes time
- Perfecting a workflow never ends; how much older work do you re-do?
- Highly-charged politics surrounding shales; conflict-of-interest concerns
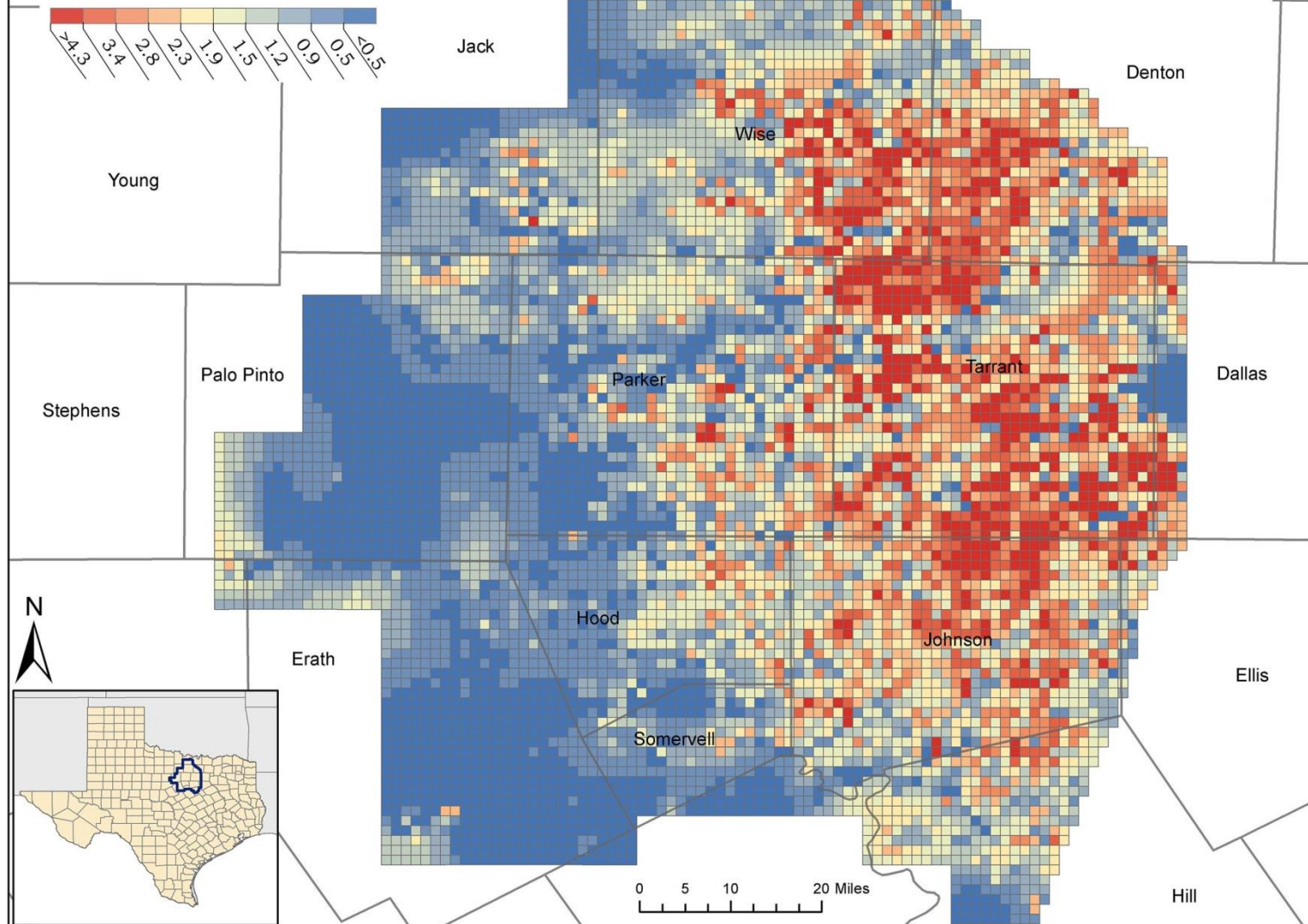
Teamwork difficulties

1. Language – terminology
2. Identification of objectives, difference of perspectives (on what the problems are, and how they can be solved)
3. Ability to stay focused to deliver to other team members what they need for their analysis

30-Year Natural Gas Productivity
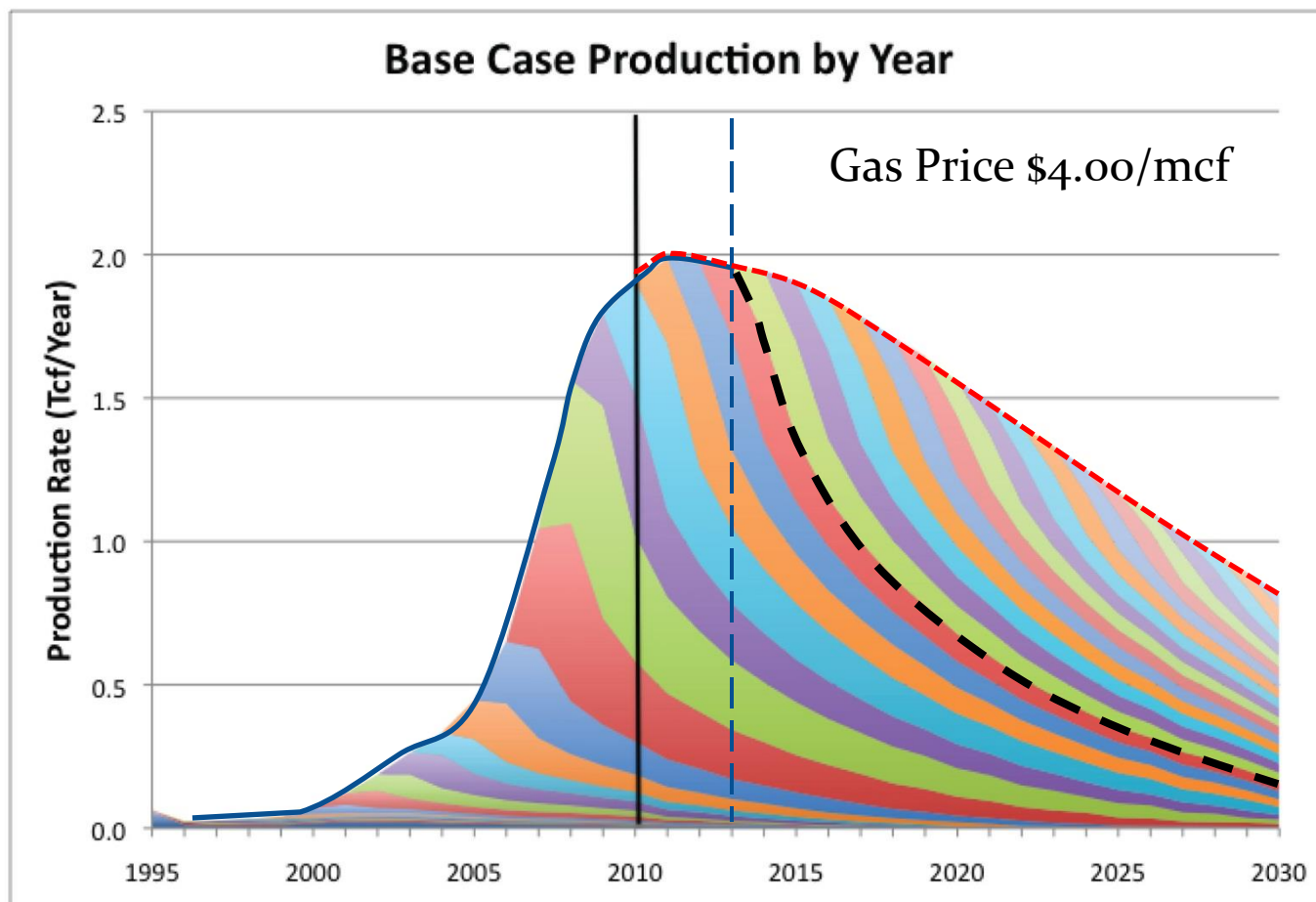## Barnett Shale, TX*

*Each sq. mile block is colored based on the estimated productivity of the average 4,000 ft. horizontal well in that block. 30-year production projection (Bcf). For further details, see Ikonnikova et al. (2013).

Legend values: >4.3 | 3.4 | 2.8 | 2.3 | 1.9 | 1.5 | 1.2 | 0.9 | 0.5 | <0.5

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County labels: Montague, Cooke, Jack, Denton, Wise, Young, Palo Pinto, Parker, Tarrant, Dallas, Stephens, Hood, Johnson, Ellis, Erath, Somervell, Hill

N

0 5 10 20 Miles

Production Outlook for the Barnett Shale through 2030

Base Case Production by Year

Gas Price $4.00/mcf

Source: Bureau of Economic Geology/Univ. of Texas at Austin
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Uncertainties

- The total outlook / project uncertainty is the combination of all the incremental uncertainties.
- It is a challenge to put all the uncertainties together and see their interplay

Rewards

- Recognition for tightly-integrated complex study
- Likelihood of continued funding
- Publications
- Pride in contributing sound science that will aid in policy and business decisions
- Friendships

Questions?