

2026-01-14

Vertical Disintegration & Farm Productivity

- Research Overview: Past, Present, and Future
 - Past and Present
 - Research Background

Research Background

Agricultural contracting and vertical coordination (1999-2007)

- Contract design, risk allocation, quality measurement in agricultural markets
- AJAE (1999), RAE (1999), ERME (2002)

Cooperative organization and governance (2008-2020)

- Economics of member-owned firms: incentives, monitoring, entry
- AJAE (2009), Econ. Letters (2014), J. Econ. & Mgmt. Strategy (2015)

Cooperative business, supply chains, productivity measurement (2010-present)

- Cooperative business census
- Founded UW-Madison FSRDC
- CNSTAT Complex Farms report
- AJAE (2017), AEPP (2022), AEPP (2023)

Today's paper connects all three themes: examining how organizational change affects agricultural productivity using novel administrative data.

- 5 minutes on the past, 10 minutes on the future — Sampling of past work
- Producer price risk and quality measurement, stylized fact, foundation for risk management — Incentive instruments, description from survey data — Efficient contract, structural estimation
- CEOs and incentive pay — Missing markets and entry, parts 1 and 2
- Brief story and background on this path; exposed to and motivated by major data gaps relevant to the field and center

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Vertical Disintegration & Farm Productivity

- Research Overview: Past, Present, and Future
 - Future
 - Future Research: Economics of Cooperatives

Future Research: Economics of Cooperatives

1. Census of cooperatives and sector understanding

- Comprehensive description of cooperative business landscape
- Historical context and trends as foundation for education and outreach

2. Governance and financial management

- Managing member heterogeneity, board behavior, capital structure challenges
- Core subject matter for leadership training

3. Market-level interactions

- Role of cooperatives and entry/equilibrium issues in IO context

4. Cooperatives and agricultural productivity

- Role in technology diffusion, input provision, and sector growth

5. Startup and development

- Formation and growth of new cooperative organizations
- Economic rationale, public policy implications

- This the main focus of my research program for THIS position
- Historical context with research on DHIA and Farm Credit, development of dairy industry
- The next slide summarizes complementary work drawing on my experience at ERS and connected with supply chain issues

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Vertical Disintegration & Farm Productivity

- Research Overview: Past, Present, and Future
 - Future
 - Future Research: Complementary Themes

Future Research: Complementary Themes

1. Agricultural supply chains and upstream industries

- Farm consolidation effects on input supply and service markets
- Role of cooperatives in this context; farm driven disintegration

2. Productivity measurement

- Quality adjustment for service inputs in TFP accounting
- Market power and implications for ag productivity

- Complementary in sense of connecting with broader themes and context
- This section focuses on research with supply chain connection
- Disintegration term happens alongside consolidation; emphasis on consequences upstream
- Based on work initiated while at ERS
- Great jumping off point, pivot to paper presentation

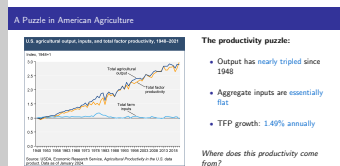
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Vertical Disintegration & Farm Productivity

Farm Vertical Disintegration and Productivity

Motivation

A Puzzle in American Agriculture



- Hook: Start with a puzzle, not a literature review
- ERS productivity accounts—output nearly 3x, inputs flat
- Standard story: R&D, technology, input quality
- But what about organizational change?

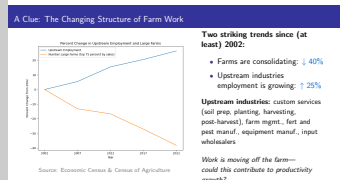
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Vertical Disintegration & Farm Productivity

Farm Vertical Disintegration and Productivity

Motivation

A Clue: The Changing Structure of Farm Work



- Data: Economic Census + Census of Agriculture, 2002–2017
- Upstream NAICS: 115112–115116 (custom farm services), 115210 (farm mgmt), 325320 (fertilizer), 333111 (tractors), 424910 (input wholesalers)
- Vertical disintegration: farms outsourcing to specialists
- Sets up the research question

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Farm Vertical Disintegration and Productivity

Motivation

The Question

The Question

Research question:

Does the emergence of specialized upstream service industries contribute to agricultural productivity growth?

Why this matters:

- U.S. agricultural TFP growth is exceptional: **1.4% annually** (1948–2021)
- Standard story: R&D spillovers, technology adoption, input quality
- Missing piece: **organizational change** as a source of productivity

Policy relevance:

- Understanding sources of productivity growth informs R&D priorities
- Implications for rural labor markets and farm structure policy

- Big 5 #1: What is the question?
- Big 5 #2: Why is it important?
- Frame as filling a gap in the productivity literature
- Policy hook for applied audience

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Motivation
 - └ This Paper

This Paper

What we do:

- First systematic estimates of relationship between crop services (11515) and yields
- Leverage restricted Census Bureau administrative data (LBD) + Census of Ag
- County-level panel: 2002–2017, four Census waves

Preview of findings:

1. Upstream service employment **positively associated with yields**
2. Effects are **heterogeneous**: strongest for corn and soybeans
3. Large farms drive the relationship—consistent with disintegration story
4. Suggestive evidence of **causal** relationship using longitudinal variation

Takeaway: Organizational restructuring—not just technology—may be an important but overlooked source of agricultural productivity growth.

- Big 5 #3: What does existing literature say? (implicitly: not much on org change)
- Big 5 #4: What is your contribution?
- Big 5 #5: What is your key takeaway?
- Shapiro: Preview findings early—don't make them wait 45 minutes

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Background
 - └ Not a New Question

Not a New Question

From the 1974 Census of Agricultural Services:

"Until the 1960's, agriculture in America was largely self-reliant in regard to many production and harvesting practices now available from off-farm sources in the form of agricultural services. During the last three decades agricultural services have become an increasingly specialized industry. The technological and scientific changes in American agriculture have been directly related to the development of the agricultural service industry. A census of this industry is essential to provide facts necessary for:

- A. Broader view of today's farm production.*
- B. Better understanding and interpretation of long-term agricultural changes and trends.*
- C. More meaningful analysis of the interrelationships of agriculture and agricultural services."*

— U.S. Department of Commerce (1974), via Dunn & Heath (2017)

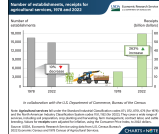
- Direct quote from 1974 Census—they saw this coming
- Same motivation we have today, 50 years later
- Discontinued due to federal budget pressures in early 1980s
- Census Bureau lacked infrastructure/resources to restart

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Background
 - └ Not a New Question (cont.)

Not a New Question (cont.)



Number of establishments providing agricultural services, 1969–2017

USDA recognized this 50+ years ago:

- Census of Ag Services: 1969, 1974, 1975
- Discontinued when Census of Ag moved to NASS

A 45-year data gap:

- No systematic tracking of service providers
- Farm expenditure data, but not industry dynamics

Revisited in 2022:

- This paper: what can we learn from existing administrative data?

- Historical context—USDA saw this coming
- Data gap explains why this question hasn't been studied
- Sets up our contribution: use LBD + Census of Ag to fill the gap
- New Census of Ag Services will enable future research

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Vertical Disintegration & Farm Productivity

Farm Vertical Disintegration and Productivity

Background

Three Perspectives on Vertical Disintegration

Three Perspectives on Vertical Disintegration		
Multiple data sources confirm the trend:		
1. Labor shifting <ul style="list-style-type: none">Contract labor: 11.6% → 19.5% of farm labor expenses (1982–2022)	2. Capital shifting <ul style="list-style-type: none">Custom work: 16.4% → 18.4% of capital expenses (2002–2022)	3. Asset ownership <ul style="list-style-type: none">Machinery owned by services: 6.1% → 14.1% (1978–2022)
Key numbers (1978–2022): <ul style="list-style-type: none">Real crop services payroll: +286% (QCEW)Real farm sales: +12%Farm machinery value: −5%; Service provider machinery: +140%		

- Figure 1 from the paper
- Three independent data sources, same story
- Contract labor from Census of Ag
- Machinery ownership from BEA Fixed Asset Tables
- Massive growth in services, flat farm sales

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Vertical Disintegration & Farm Productivity

Farm Vertical Disintegration and Productivity

Background

Why Would Disintegration Boost Productivity?

Why Would Disintegration Boost Productivity?
Classic economic logic: <ul style="list-style-type: none">Specialization — Farms focus on core competencies; specialists develop expertiseScale economies — One custom harvester can serve many farmsTechnology adoption — Specialists can justify expensive, cutting-edge equipment
Additional mechanisms: <ul style="list-style-type: none">Risk smoothing — Service firms diversify across geography and seasonsLabor market efficiency — Skilled operators matched to equipmentKnowledge spillovers — Specialists transfer best practices across farms
<i>If disintegration enables these efficiencies, we should see a positive relationship between upstream service activity and farm productivity.</i>

- Intuitive appetizer—give them a mental model before regressions
- Smith/Ricardo specialization logic
- Sets up the empirical test
- Counterargument: transaction costs, coordination problems (address in discussion)

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Data and Methodology

Data Sources

Data Sources
Farm productivity (Census of Agriculture, 2002–2022): <ul style="list-style-type: none">County-level crop sales, harvested acreage, yieldsCorn, soybeans, wheat (bushels/acre); all crops (dollars/acre)Farm structure: number of farms, land distribution, HH
Service provider activity (Longitudinal Business Database, 2002–2017): <ul style="list-style-type: none">Restricted-access establishment-level microdataNAICS 1151: Support Activities for Crop ProductionCounty-level payroll as proxy for service intensityDerived from IRS Forms 941/943 (payroll tax filings)
Why LBD? Public data (CBP, QCEW) suppressed for 75% of counties with crop services—yet these counties produce half of U.S. crops

- Census of Ag: public county tables from NASS
- LBD: restricted access through FSRDC network
- Payroll better than employment (March 12 employment misses seasonality)
- Key contribution: overcoming data suppression problem

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Data and Methodology
 - └ The Data Suppression Problem

The Data Suppression Problem

QCEW Data Availability (2017):		But suppressed counties matter:		
Category	Counties	Unsupp.	Supp.	
No services	1,185	Estab.	64%	36%
Unsuppressed	481	Payroll	83%	17%
Suppressed	1,408	Crop sales	50%	50%
Total	3,074			

74.5% of counties with crop services have suppressed data

Half of U.S. crop production occurs in counties with suppressed service data

Solution: Use restricted LBD microdata to construct unsuppressed county-level payroll measures

- Table 1 from the paper
- Suppression for disclosure avoidance (few establishments)
- Can't study services-productivity relationship with public data
- LBD access through FSRDC is key contribution

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Data and Methodology
 - └ Empirical Strategy: Cross-Sectional

Empirical Strategy: Cross-Sectional
Basic specification (repeated cross-sections, 2002–2017):
$\ln(\text{Yield}_{c,t}) = \beta_0 + \beta_1 \ln(\text{Payroll}_{c,t}) + \beta_2 \ln(\text{Land}_{c,t}) + \beta_3 \ln(\text{AvgLand}_{c,t}) + \beta_4 \text{HH}_{c,t} + \epsilon_{c,t}$
<ul style="list-style-type: none">• c = county, t = Census year (2002, 2007, 2012, 2017)• Outcome: Yield (bu/acre for corn, soy, wheat; 5/acre for all crops)• Key regressor: Log payroll in NAICS 1181• Controls: Total harvested acres, mean farm size, land concentration (HH)
Interpretation: β_1 = elasticity of yield with respect to service payroll <i>Estimate separately by year and crop to allow relationship to vary</i>

- Log-log specification for elasticity interpretation
- Controls address scale and structure confounds
- Repeated cross-section (not panel FE) to see how relationship evolves
- Hypothesis: $\beta_1 > 0$ if services boost productivity

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Data and Methodology
 - └ Empirical Strategy: Longitudinal

Empirical Strategy: Longitudinal
Addressing simultaneity: Does service activity cause productivity, or do productive counties attract services?
Dynamic specification:
$\Delta \ln(\text{Yield}_{c,t+1}) = \beta_0 + \beta_1 \ln(\text{Yield}_{c,t}) + \beta_2 \ln(\text{Payroll}_{c,t}) + \mathbf{X}_{c,t}' \gamma + \epsilon_{c,t}$
<ul style="list-style-type: none">• Outcome: 5-year yield growth (log difference)• Key regressor: Base-year service payroll• Control for base-year yield: Addresses reverse causality, mean reversion
Interpretation: $\beta_2 > 0$ means counties with larger service sectors experience faster subsequent yield growth, conditional on initial productivity

- Key innovation: use lagged payroll to predict future growth
- Controls for initial productivity level
- Not full causal identification, but addresses main endogeneity concern
- Equation 3 from the paper

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Vertical Disintegration & Farm Productivity

Farm Vertical Disintegration and Productivity

Results

Cross-Sectional Results: Services and Yields

Cross-Sectional Results: Services and Yields				
Key finding: Persistent positive relationship between service payroll and yields				
Year	All Crops	Corn	Soybeans	Wheat
2002	0.228***	0.035***	0.008*	0.043***
2007	0.196***	0.027***	0.009	0.046***
2012	0.184***	0.063***	0.030***	0.033***
2017	0.193***	0.020***	0.007	0.024***

Elasticity of yield w.r.t. crop service payroll. Controls: land, avg. farm size, HHR.

Interpretation: 1% increase in service payroll → 0.02-0.06% higher corn yields

- Table 3 from the paper
- All crops uses \$/acre; individual crops use bu/acre
- Soybeans weakest association—less labor intensive?
- Coefficients smaller for individual crops (payroll affects all crops)

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Vertical Disintegration & Farm Productivity

Farm Vertical Disintegration and Productivity

Results

The Role of Farm Scale

The Role of Farm Scale	
Does the services-yield relationship vary with farm structure?	
By total harvested land:	By average farm size:
<ul style="list-style-type: none">• Wheat: Effect <i>stronger</i> in larger counties• Corn: Effect <i>weaker</i> as acreage increases• Soybeans: No significant pattern	<ul style="list-style-type: none">• Effect often <i>positive</i>• Service providers have more impact in counties with larger farms
<small>Suggests different mechanisms by crop</small>	
Implication: One-size-fits-all analysis obscures important heterogeneity	

Consistent with disintegration story: large farms outsource more

- Figure 3 from the paper shows marginal effects
- Wheat: scale economies in services matter more
- Corn: diminishing returns at larger scale
- Large farms drive the relationship—they're the ones outsourcing

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Farm Vertical Disintegration and Productivity

Results

Longitudinal Results: Services and Yield *Growth*

Longitudinal Results: Services and Yield Growth				
Question: Do larger service sectors predict faster yield growth?				
Period	All Crops	Corn	Soybeans	Wheat
2002-2007	0.006	0.009*	0.006	0.020***
2007-2012	0.030***	0.046***	0.028***	0.007*
2012-2017	0.010***	-0.004	-0.003	0.000
2017-2022	-0.001	0.017***	0.005	0.001

Coefficient on base-year payroll, controlling for base-year yield and farm structure.

Key pattern: Positive effects in early periods, **weakening over time**

- Table 4 from the paper
- Addresses simultaneity: does service activity *cause* productivity?
- Controlling for base-year yield addresses reverse causality
- Weakening suggests diminishing returns as sector matures

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Results
 - └ Economic Magnitude: How Much Does It Matter?

Economic Magnitude: How Much Does It Matter?					
Thought experiment: Compare counties at 50th vs. 75th percentile of services					
Period	All Crops	Corn	Soybeans	Wheat	
2002-2007	—	+1.2 pp	—	+2.7 pp	
2007-2012	+4.0 pp	+6.6 pp	+3.5 pp	+1.0 pp	
2012-2017	+4.6 pp	—	—	—	
2017-2022	—	+2.0 pp	—	—	

Difference in 5-year productivity growth rate (percentage points)

Example: A county at 75th percentile of crop services in 2007 experienced 6.6 percentage points higher corn yield growth over 2007-2012 than a county at 50th percentile

Modest but economically meaningful differences

- Table 5 from the paper
- Makes elasticities concrete
- 6.6 pp difference over 5 years is substantial
- Blank cells = coefficient not statistically significant

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Results
 - └ Results Summary

Results Summary
1. Persistent positive relationship Counties with larger crop services sectors have higher yields (2002-2017)
2. Heterogeneity matters Effects vary by crop type and farm scale; large farms drive the relationship
3. Dynamic evidence supports causality Larger services sectors predict faster subsequent yield growth
4. But relationship is weakening Consistent with maturing industry, exhausted scale economies
Bottom line: Organizational restructuring—vertical disintegration—appears to be an overlooked source of agricultural productivity growth

- Wrap up results before moving to discussion
- Key message: disintegration contributes to productivity
- But effects may be diminishing as sector matures
- Sets up discussion of implications

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Discussion
 - └ Why Is the Relationship Weakening?

Why Is the Relationship Weakening?
Observed pattern: Services-yield relationship strongest in 2007-2012, fading since
Possible explanations:
1. Maturing industry <ul style="list-style-type: none">• Entry and exit rates declining since 1990s• "Creative destruction" drives innovation, less dynamism → slower gains
2. Exhausted scale economies <ul style="list-style-type: none">• Early adopters captured largest gains• Remaining farms may face higher transaction costs
3. Farm consolidation <ul style="list-style-type: none">• Largest farms increasingly self-sufficient• Service providers working with fewer, larger clients

- Important to address why effects are weakening
- Industry dynamism declining—business dynamics literature
- Consistent with Stigler: scale economies eventually exhausted
- Farm consolidation may be shifting the equilibrium

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Vertical Disintegration & Farm Productivity

Farm Vertical Disintegration and Productivity

Discussion

Industry Dynamism Is Declining

Industry Dynamism Is Declining	
Evidence from the LBD:	
Entry and exit rates falling:	Establishment counts stable:
<ul style="list-style-type: none">• Business entry/exit rates in crop services declining since 1990s• Less "creative destruction"• Fewer new entrants bringing innovations	<ul style="list-style-type: none">• Mean establishments/country: 5.75 (2002) → 5.19 (2017)• Slight decline, not growth• Industry has <i>matured</i>
When the industry was young, new firms drove productivity gains	
Implication: Biggest productivity gains may have come from early industry growth; mature industry offers fewer marginal improvements	

- Business dynamics literature: declining dynamism across economy
- Crop services sector fits this pattern
- Creative destruction theory: entry/exit drives innovation
- May explain why relationship weakened post-2012

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Farm Vertical Disintegration and Productivity

Discussion

Local Market Concentration: A Surprising Finding

Local Market Concentration: A Surprising Finding	
Contrast with farming sector:	
Farms are consolidating:	Services are NOT consolidating:
<ul style="list-style-type: none">• Number of farms declining• Average farm size increasing• Land concentration rising	<ul style="list-style-type: none">• Largest provider's payroll share: 2002: 73.0%• 2017: 73.9%• <i>Essentially unchanged</i>
Well-documented trend	Unexpected stability
Why does this matter?	
<ul style="list-style-type: none">• Service providers working with fewer, larger farms• But local market power hasn't increased• Suggests competitive pressure remains—good for farmers	

- Table 2 from the paper
- Surprising finding: no concentration increase
- Contrasts with farm consolidation, processor consolidation
- May reflect geographic nature of service provision
- Important for market power concerns in Discussion

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Discussion

Implications for Productivity Measurement

Implications for Productivity Measurement	
How does this affect TFP accounting?	
Quality mismeasurement:	Market power concerns:
<ul style="list-style-type: none">• Services → substitute for own-capital• Same price index applied to both• But: machinery managed by specialists is <i>more productive</i>• ⇒ Service input quality <i>understated</i>• ⇒ TFP growth <i>overstated</i>	<ul style="list-style-type: none">• High local concentration in services• Contract workers paid less than hired workers• If monopsony: wages < marginal product• ⇒ Labor share understated• ⇒ Another source of TFP bias
Takeaway: Vertical disintegration creates measurement challenges not fully addressed in current TFP frameworks	

- Links to productivity measurement literature
- Quality adjustment is key issue
- Wang & Loduca (2025): contract workers paid less
- Suggests some “TFP growth” may be mismeasured input growth

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Discussion
 - └ Connection to Manufacturing TFP Research

Connection to Manufacturing TFP Research

Recent work reveals linked measurement challenges:

Atalay et al. (2025): "Why Is Manufacturing Productivity Growth So Low?"

- Producer price indices *understate quality improvements* in durable goods
- Leads to systematic *understatement* of manufacturing TFP growth

Connection to our findings:

- Manufacturers supply precision equipment, GPS-guided machinery to service providers
- Understated quality in manufacturing output prices ⇔ understated quality in farm input prices
- *Some unmeasured quality differential* flows through intermediate goods markets

Implication: Comprehensive productivity accounting requires coordinated attention to quality adjustment across linked industries

- Atalay et al. NBER WP 34264
- Nice connection: same problem from opposite ends of supply chain
- Manufacturing understates output quality → Ag understates input quality
- Suggests need for integrated approach to productivity measurement

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Discussion
 - └ Broader Implications: Agricultural Development

Broader Implications: Agricultural Development

Why this matters beyond U.S. agriculture:

Downstream value chains:

- Large literature on connecting farmers to processors and consumers
- Market access, contract farming, supply-chain coordination
- (Reardon 2015; Barrett et al. 2022)

Technology adoption:

- Extensive research on farm-level adoption decisions
- Information, risk, heterogeneity
- (Feder et al. 1985; Suri 2011)

Missing piece: Upstream market development

- Technology adoption depends on *existence of input markets*
- Specialized services provides enable technology access at scale
- U.S. experience: services sector grew alongside productivity gains

Upstream value chain "thickening" deserves attention in development contexts

- Relevant for ISU's international focus
- Downstream value chains well-studied
- Upstream market development less so
- U.S. case suggests services enable technology adoption
- Policy implication: support input market development

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Discussion
 - └ Limitations and Future Directions

Limitations and Future Directions

Limitations:

- Country-level analysis—can't observe farm-level outsourcing decisions
- Payroll is proxy for service intensity, not direct output measure
- Cannot fully separate services effect from technology adoption
- Equilibrium relationships, not structural causal estimates

Future research directions:

- **2022 Census of Ag Services:** First since 1978—new microdata opportunities
- **Farm-level analysis:** Link service use to individual farm outcomes
- **Broader supply chain:** Extend to fertilizer, chemicals, equipment sectors
- **Quality adjustment:** Develop crop-specific service price indices

- Honest about limitations
- 2022 Census is a big deal—revived after 44 years
- Sets up future research agenda
- Connects to position at ISU—supply chain focus

2026-01-14

Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Conclusion
 - └ Conclusion

Conclusion
<p>What we asked:</p> <p>Does the emergence of specialized upstream service industries contribute to agricultural productivity growth?</p> <p>What we found:</p> <ul style="list-style-type: none">• Yes—counties with larger crop services sectors have higher yields• Effect is heterogeneous: varies by crop, scale, and time• Longitudinal evidence consistent with causal interpretation• But gains appear to be diminishing as the sector matures <p>Why it matters:</p> <ul style="list-style-type: none">• Organizational change is an <i>overlooked source</i> of productivity growth• Standard TFP frameworks may not fully capture these dynamics• Understanding the farm-services boundary is essential for policy

- Circle back to opening question
- Clear answer: yes, with nuance
- Broader implication for how we think about productivity

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Vertical Disintegration & Farm Productivity

- └ Farm Vertical Disintegration and Productivity
 - └ Conclusion
 - └ Key Takeaway

Key Takeaway
<p><i>The “boundary of the farm” is not fixed.</i></p> <p><i>As specialized service industries emerge, work moves off the farm—and productivity rises.</i></p> <p><i>This organizational restructuring deserves greater attention in productivity research.</i></p>

- Big 5 #5: What is the key takeaway?
- Memorable framing for the audience
- Connects to title of the paper