Vertical Disintegration and the Shifting Boundary of the Farm Business

Implications for Agricultural Productivity

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Outline

Research Overview: Past, Present, and Future

Farm Vertical Disintegration and Productivity

Research Background

Agricultural contracting and vertical coordination (1999-2007)

- Contract design, risk allocation, quality measurement in agricultural markets
- *AJAE* (1999); *RAE* (1999); *ERAE* (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.

Future Research: Understanding the Sector

Cooperatives are central to my research agenda for this position.

Building a comprehensive picture of cooperative business:

- Census of cooperatives—systematic data collection and description
- Historical context: how did we get here? (DHIA, Farm Credit, dairy industry development)
- Trends and patterns as foundation for education and outreach

Why this matters:

- Cooperatives are understudied relative to their economic importance
- Good data enables good research and informed policy
- Foundation for the other two themes

Future Research: Governance and Management

Inside the cooperative firm:

Board behavior and decision-making

- How do cooperative boards function? What drives their decisions?
- Managing member heterogeneity—balancing diverse interests
- Implications for leadership training and development

Capital structure challenges

- The "curious case" of cooperative capital
- Equity redemption, retained earnings, and growth constraints
- Financial sustainability in a changing agricultural landscape

Future Research: Markets and Policy

Cooperatives in market context:

Industrial organization perspectives

- Role of cooperatives in market structure and competition
- Entry, exit, and equilibrium in markets with cooperative firms
- Implications for producer welfare and market power

Policy and development

- Formation and growth of new cooperative organizations
- Public policy support for cooperative development
- Lessons from historical and international experience

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 distintegration

2. **Productivity measurement**
   - Quality adjustment for service inputs in TFP accounting
   - Market power and implications for ag productivity

The paper I'll present next addresses both themes—examining how upstream services affect farm productivity while highlighting measurement challenges.

Farm Vertical Disintegration and Productivity

Disclaimers

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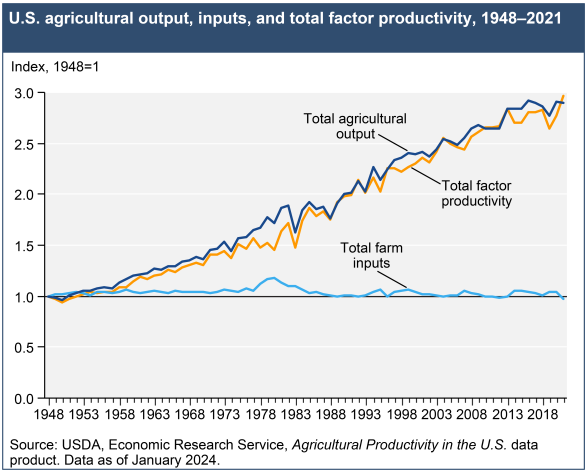
A Puzzle in American Agriculture

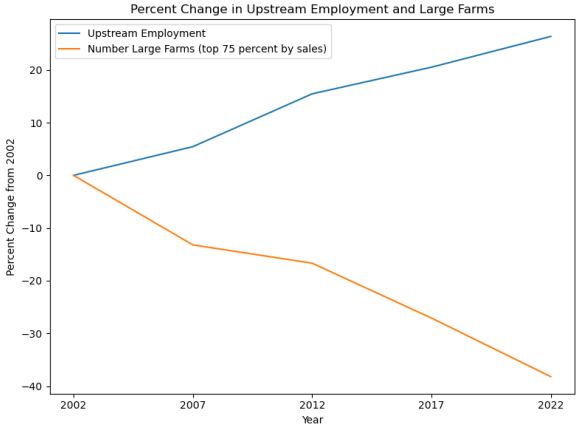


The productivity puzzle:

- Output has nearly tripled since 1948
- Aggregate inputs are essentially flat
- TFP growth: 1.49% annually

Where does this productivity come from?

A Clue: The Changing Structure of Farm Work



Source: Economic Census & Census of Agriculture

Two striking trends since (at least) 2002:

- Farms are consolidating: ↓ 40%
- Upstream industries employment is growing: ↑ 25%

Upstream industries: support actvities, fert and pest manuf., equipment manuf., input wholesalers

*Work is moving off the farm—***disintegration**

Could this contribute to productivity growth?

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: 1.49% annually (1948–2021)
- Standard story: R&D spillovers, technology adoption, input quality
- Missing piece: **organizational change** as a source of productivity
  - Accounts for data imitations in hedonic adjustment
  - Complements R&D and technology adoption stories

Policy relevance:

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

This Paper

What we do:

- First systematic estimates of relationship between crop services (1151) 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. Effects stronger in counties with larger average farm size
4. Suggestive evidence of causal relationship using longitudinal variation

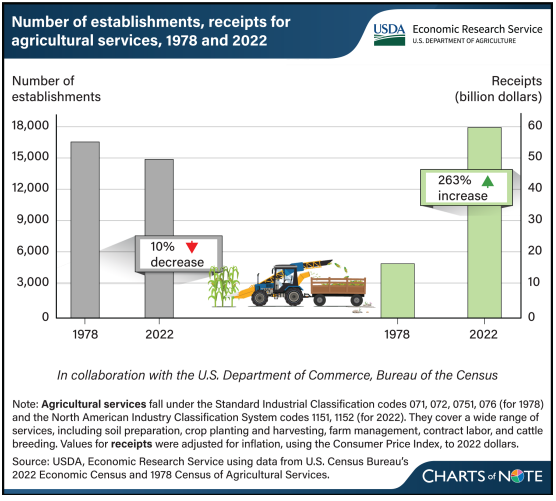
Takeaway: *Organizational restructuring—not just technology—may be an important but overlooked source of agricultural productivity growth.*

Not a New Question

From the 1974 Census of Agricultural Services:

> *"Until the 1940'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 & Hueth (2017)

Not a New Question (cont.)



USDA recognized this 50+ years ago:

- Census of Ag Services: 1969, 1974, 1978
- Discontinued when Census of Ag moved to NASS

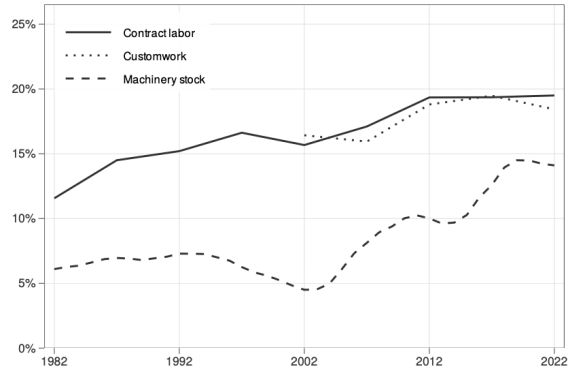
A 45-year data gap:

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

Revived in 2022

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

Three Perspectives on Vertical Disintegration



Source: Census of Agriculture, BEA Fixed Assets

Three measures, same story:

- **Contract labor:** 11.6% → 19.5%
- **Custom work:** 16.4% → 18.4%
- **Machinery:** 6.1% → 14.1%

Work and capital moving off the farm

Why Would Disintegration Boost Productivity?

Classic economic logic:

- **Specialization** — Farms focus on core competencies; specialists develop expertise
- **Scale economies** — One custom harvester can serve many farms
- **Technology adoption** — Specialists can justify expensive, cutting-edge equipment

Additional mechanisms:

- **Risk smoothing** — Service firms diversify across geography and seasons
- **Labor market efficiency** — Skilled operators matched to equipment
- **Knowledge spillovers** — Specialists transfer best practices across farms

If disintegration enables these efficiencies, we should see a positive relationship between upstream service activity and farm productivity.

Data Sources

Farm productivity (Census of Agriculture, 2002–2022):

- County-level crop sales, harvested acreage, yields
- Corn, soybeans, wheat (bushels/acre); all crops (dollars/acre)
- Farm structure: number of farms, land distribution, HHI

Service provider activity (Longitudinal Business Database, 2002-2017):

- Restricted-access establishment-level microdata
- NAICS 1151: Support Activities for Crop Production
- County-level payroll as proxy for service intensity
- Derived from IRS Forms 941/943 (payroll tax filings)

Why LBD? Public data (QCEW) suppressed for 75% of counties with crop services—yet these counties produce half of U.S. crops

The Data Suppression Problem

QCEW Data Availability (2017):

Category	Counties
No services	1,185
Unsuppressed	481
Suppressed	**1,408**
Total	3,074

74.5% of counties with crop services have suppressed data

But suppressed counties matter:

	Unsupp.	Supp.
Estab.	64%	36%
Payroll	83%	17%
Crop sales	50%	50%

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

Empirical Strategy: Cross-Sectional

Basic specification (repeated cross-sections, 2002–2017):

$$\ln(\text{Yield}) = \beta_0 + \beta_1 \ln(\text{Payroll}) + \beta_2 \ln(\text{Land}) + \beta_3 \ln(\text{AvgLand}) + \beta_4 \text{HHI} + \varepsilon$$

- All variables constructed at county-year, Census years (2002, 2007, 2012, 2017)
- **Outcome:** Yield (bu/acre for corn, soy, wheat; \$/acre for all crops)
- **Key regressor:** Log payroll in NAICS 1151
- **Controls:** Total harvested acres, mean farm size, land concentration (HHI)

Interpretation: β_1 = elasticity of yield with respect to service payroll

Estimate separately by year and crop to allow relationship to vary

Empirical Strategy: Longitudinal

Addressing simultaneity: Does service activity cause productivity, or do productive counties attract services?

Dynamic specification:

$$\Delta \ln(\text{Yield}_{c,t+5}) = \beta_0 + \beta_1 \ln(\text{Yield}_{ct}) + \beta_2 \ln(\text{Payroll}_{ct}) + \mathbf{X}'_{ct}\boldsymbol{\gamma} + \varepsilon_{ct}$$

- **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

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	0.048***
2012	0.194***	0.063***	0.028***	0.033***
2017	0.193***	0.020***	0.007	0.024***

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

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

The Role of Farm Scale

Does the services-yield relationship vary with farm structure?

By total harvested land:

- **Wheat:** Effect stronger in larger counties
- **Corn:** Effect weaker as acreage increases
- **Soybeans:** No significant pattern

Suggests different mechanisms by crop

By average farm size:

- Effect often positive
- Service providers have more impact in counties with larger farms

Consistent with disintegration story: large farms outsource more

Implication: One-size-fits-all analysis obscures important heterogeneity

▸ Panel A: Total Land ▸ Panel B: Avg Farm Size

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***	0.049***	0.028***	0.007*
2012–2017	0.035***	−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**

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	—	2.7
2007–2012	4.0	6.6	3.5	1.0
2012–2017	4.6	—	—	—
2017–2022	—	2.0	—	—

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

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; effects larger in counties with larger avg. farm size

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 yield growth

Why Is the Relationship Weakening?

Observed pattern: Services-yield relationship strongest in 2007–2012, fading since

Possible explanations:

1. **Maturing industry**
   - Entry and exit rates declining since 1990s
   - "Creative destruction" drives innovation; less dynamism $\rightarrow$ slower gains

2. **Exhausted scale economies**
   - Early adopters captured largest gains

3. **Farm consolidation**
   - Largest farms increasingly self-sufficient
   - Service providers working with fewer, larger clients

Industry Dynamism Is Declining

Evidence from the LBD:

Entry and exit rates falling:

- Business entry/exit rates in crop services declining since 1990s
- Less "creative destruction"
- Fewer new entrants bringing innovations

When the industry was young, new firms drove productivity gains

Establishment counts stable:

- Mean establishments/county: 5.75 (2002) $\rightarrow$ 5.19 (2017)
- Slight decline, not growth
- Industry has matured

Sector reached equilibrium size

Implication: Biggest productivity gains may have come from early industry growth; mature industry offers fewer marginal improvements

Local Market Concentration: A Surprising Finding

Contrast with farming sector:

Farms are consolidating:

- Number of farms declining
- Average farm size increasing
- Land concentration rising

Well-documented trend

Services are NOT consolidating:

- Largest provider's payroll share:
- 2002: 73.0%
- 2017: 73.9%
- Essentially unchanged

Unexpected stability

Why does this matter?

- Service providers working with fewer, larger farms
- But local market power hasn't increased
- Suggests competitive pressure remains

Implications for Productivity Measurement

How does this affect TFP accounting?

Quality mismeasurement:

- Services = substitute for own-capital
- Same price index applied to both
- But: machinery managed by specialists is more productive
- $\Rightarrow$ Service input quality *understated*
- $\Rightarrow$ TFP growth *overstated*

Takeaway: Vertical disintegration creates measurement challenges not fully addressed in current TFP frameworks

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 $\Leftrightarrow$ understated quality in farm input prices
- Same unmeasured quality differential flows through intermediate goods markets

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

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 service providers enable technology access at scale
- U.S. experience: services sector grew *alongside* productivity gains

Upstream value chain "thickening" deserves attention in development contexts

Limitations and Future Directions

Limitations:

- County-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

Conclusion

What we asked:
Does the emergence of specialized upstream service industries contribute to agricultural productivity growth?

What we found:

- 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

Why it matters:

- Organizational change is an overlooked source of productivity growth
- Standard TFP frameworks may not fully capture these dynamics
- Understanding the farm-services boundary is essential for policy

Key Takeaway

The "boundary of the farm" is not fixed.

As specialized service industries emerge,
work moves off the farm—and productivity rises.

This organizational restructuring deserves
greater attention in productivity research.

Thank You

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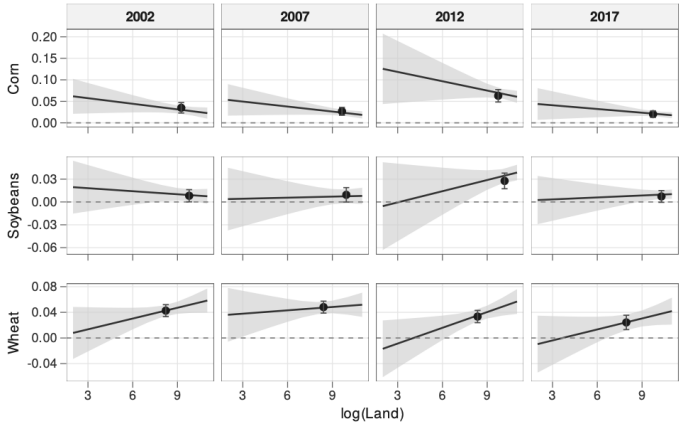
Slides available upon request

Marginal Effects: By Total Harvested Farmland

◁ Back to Results

A. At different levels of total harvested farmland



Marginal Effects: By Average Farm Size

◁ Back to Results

B. At different levels of average harvested farmland