

# 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

Past and Present

Future

## Farm Vertical Disintegration and Productivity

Motivation

Background

Data and Methodology

Results

Discussion

Conclusion

## 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.*

## **1. Census 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

### **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

Research Overview: Past, Present, and Future

## Farm Vertical Disintegration and Productivity

## Disclaimers

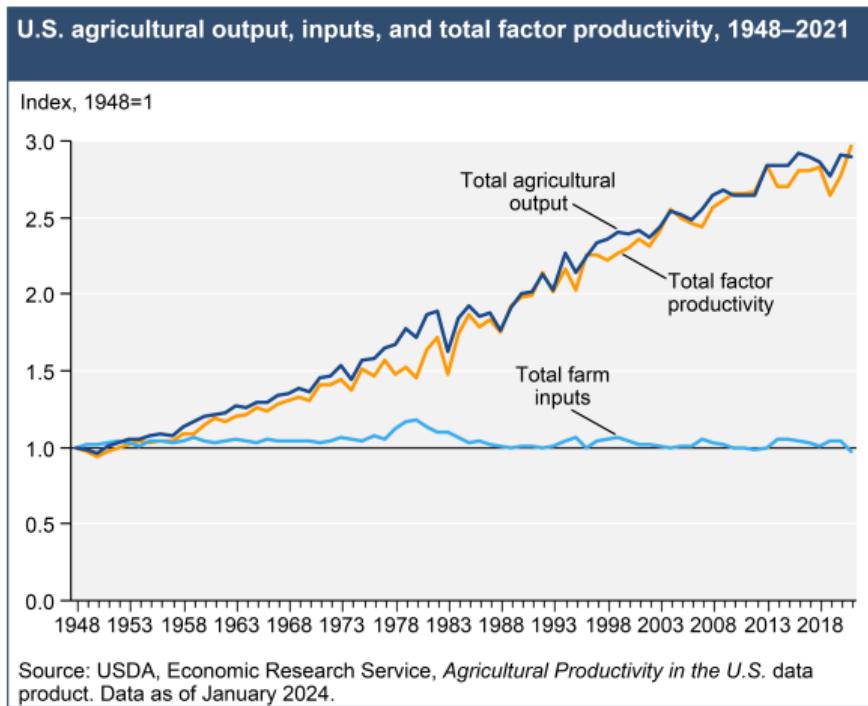
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# A Puzzle in American Agriculture

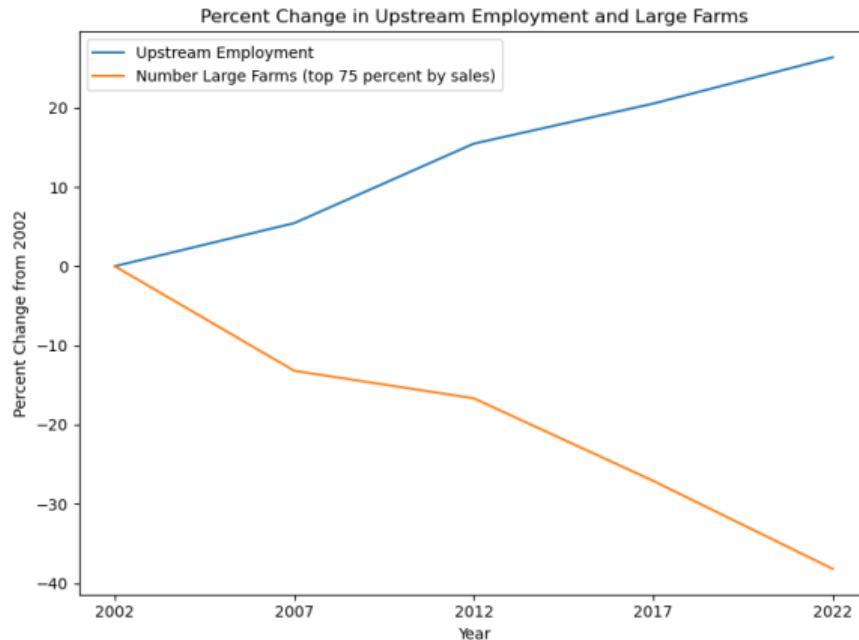


## The productivity puzzle:

- 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

◀ Motivation

**Two striking trends since (at least) 2002:**

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

**Upstream industries:** custom services (soil prep, planting, harvesting, post-harvest), farm mgmt., fert and pest manuf., equipment manuf., input wholesalers

*Work is moving off the farm—  
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

## 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. 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.*

## Not a New Question

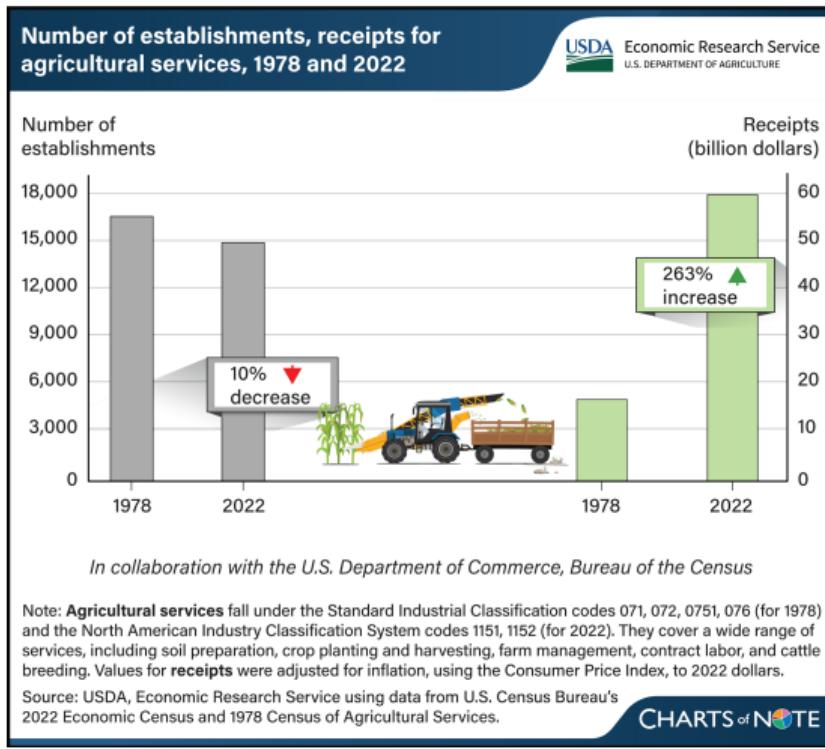
### **From the 1974 Census of Agricultural Services:**

*"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

Multiple data sources confirm the trend:

## 1. Labor shifting

- Contract labor: 11.6%  
→ 19.5% of farm labor expenses
- (1982–2022)

## 2. Capital shifting

- Custom work: 16.4%  
→ 18.4% of capital expenses
- (2002–2022)

## 3. Asset ownership

- Machinery owned by services: 6.1% → 14.1%
- (1978–2022)

Key numbers (1978–2022):

- Real crop services payroll: +288% (QCEW)
- Real farm sales: +12%
- Farm machinery value: -5%; Service provider machinery: +140%

## 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 (CBP, 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          |
| <b>Suppressed</b> | <b>1,408</b> |
| 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):**

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

- $c$  = county,  $t$  = Census year (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:**  $\beta_1$  = 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:**

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

- **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

## 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

## 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 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*

## 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

## 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 → slower gains

#### 2. Exhausted scale economies

- Early adopters captured largest gains
- Remaining farms may face higher transaction costs

#### 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

### Establishment counts stable:

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

*Sector reached equilibrium size*

*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

# 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—good for farmers

## 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*

### Market power concerns:

- High local concentration in services
- Contract workers paid less than hired workers
- If monopsony: wages  $<$  marginal product
- $\Rightarrow$  Labor share understated
- $\Rightarrow$  Another source of TFP bias

**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