

An Empirical Investigation of Productivity Spillovers along the Agricultural Supply Chain

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Introduction

- Many studies have found Total Factor Productivity (TFP) to be a major engine of growth for U.S. agriculture
- Growth in U.S. Ag TFP has compared very favorably to TFP growth in most other U.S. sectors
- Lack of studies analyzing productivity spillovers between the agricultural sector and other economic sectors

Objectives

- > Identify productivity linkages between the **agricultural sector** and 62 **other sectors** of the U.S. economy
- > Measure short- and long-run productivity spillovers from and to the agricultural sector
 - > TFP
 - > Labor partial productivity (LPP)
 - > Capital partial productivity (KPP)

Data

- > Annual productivity measures over 1947-2014 from KLEMS-type database by Jorgenson, Ho, and Samuels (2017)
 - > TFP, LPP, and KPP
 - > **Ag sector** and 62 **Other sectors** in the U.S. National Income and Product Accounts
 - > 62 **Other** sectors classified as
 - Ag-related (10 sectors)
 - Non-ag-related (52 sectors)
- > Ag productivity series from USDA to verify robustness of results

Estimation Methods

Time-series analysis of pair-wise association between productivity in ag sector (Ag) and other sector (Other):

- Total Factor Productivity: $\{TFP_{Ag}, TFP_{Other}\}$
 - Labor Partial Productivity: $\{LPP_{Ag}, LPP_{Other}\}$
 - Capital Partial Productivity: $\{KPP_{Ag}, KPP_{Other}\}$
- > Test for properties of individual series (e.g., trends)
 - > Test whether series in each pair tend to move together
 - > For each pair, estimate model to assess
 - > Causality (e.g., whether TFP_{Ag} “causes” TFP_{Other} or viceversa)
 - > Long- and short-term dynamics

Results: TFP series tend to move in tandem in the long run

- Productivity series consistent with unit-root assumption
- Most Total Factor Productivity pairs $\{TFP_{Ag}, TFP_{Other}\}$ are cointegrated

Percentage of sectors exhibiting pairwise TFP cointegrating relationships with agriculture.

Agricultural productivity database	Percentage of sectors exhibiting pairwise cointegrating TFP relationships with agriculture at 5% significance level	
	Ag-related sectors	Non-ag-related sectors
JHS ^a	100.0%	98.2%
USDA ^a	90.0%	88.5%

^a JHS and USDA denote respectively the databases from Jorgenson, Ho, and Samuels (2017) and the USDA (2020).

Results: response of Other sectors' TFP to shocks in Ag TFP

Shock in TFP_{Ag} → Response from TFP_{Other}

Response of TFP_{Other} to shocks in TFP_{Ag}	Ag-Related sectors' TFP (10 sectors)			Non-Ag-Related sectors' TFP (52 sectors)		
	Positive Response	Negative Response	Subtotal	Positive Response	Negative Response	Subtotal
Only significant 1-YR responses			0%		1.9%	1.9%
Significant 1-YR & 10-YR responses	20%	10%	30%	5.8%	1.9%	5.8%
Only significant 10-YR responses	10%		10%	5.8%	1.9%	5.8%
Subtotal significant			40%			13.5%
Not significant responses			60%			86.5%

Results: response of Other sectors' TFP to shocks in Ag TFP

- Shocks in Ag TFP are more likely to affect ag-related sectors' TFP than non-ag-related sectors' TFP
- Long-term responses are more likely than short-term responses in both ag-related and non-ag-related sectors

Results: response of Ag TFP to shocks in Other sectors' TFP

Shock in TFP_{Other} → Response from TFP_{Ag}

Response of TFP_{Ag} to shocks in TFP_{Other}	Shocks from Ag-Related sectors' TFP (10 sectors)			Shocks from Non-Ag-Related sectors' TFP (52 sectors)		
	Positive Response	Negative Response	Subtotal	Positive Response	Negative Response	Subtotal
Only significant 1-YR responses			0%	1.9%	1.9%	3.8%
Significant 1-YR & 10-YR responses			0%			0%
Only significant 10-YR responses	10%	10%	20%	1.9%	11.5%	13.4%
Subtotal significant			20%			17.2%
Not significant responses			80%			82.8%

Results: response of Other sectors' TFP to shocks in Ag TFP

- Shocks in Other sectors' TFP are relatively unlikely to affect Ag TFP
- When shocks in Other sectors' TFP affect Ag TFP, the effect tends to occur over the long-term

Results: LPP, KPP series less likely to move in tandem than TFP

Productivity type	Agricultural productivity database	Percentage of sectors exhibiting pairwise cointegrating relationships with agriculture at 5% significance level					
		Ag-related sectors			Non-ag-related sectors		
		Entire Period	First Half	Second Half	Entire Period	First Half	Second Half
TFP	JHS ^a	100.0%	40.0%	50.0%	98.2%	48.1%	46.2%
TFP	USDA ^a	90.0%	40.0%	40.0%	88.5%	36.5%	48.1%
LPP	JHS ^a	80.0%	10.0%	20.0%	28.8%	15.4%	11.5%
LPP	USDA ^a	50.0%	0.0%	50.0%	21.2%	28.8%	73.1%
KPP	JHS ^a	40.0%	60.0%	60.0%	15.4%	48.1%	67.3%
KPP	USDA ^a	30.0%	90.0%	40.0%	17.3%	63.5%	40.4%

^a JHS and USDA denote respectively the databases from Jorgenson, Ho, and Samuels (2017) and the USDA (2020).

Summary

U.S. TFP data for agriculture and 62 other sectors over 1947-2014 shows that

- Increases in Ag TFP **caused** long-lasting increases (reductions) in the TFP of 15% (5%) of 62 other sectors
- Shocks in the TFP of 15% other sectors had long-lasting spillover effects into Ag TFP (3% with same-sign, and 11% with opposite-sign)
- Labor and capital partial productivities (LPP and KPP) in agriculture had little association with LPP and KPP in non-ag-related sectors
- Relationships between productivity in agriculture and in non-ag-related sectors were relatively stable across both halves of the sample for TFP and LPP, but not for KPP