Public Policy, Induced Innovation, and Private Research: The Case of Agriculture

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Introduction

- Both the level and the composition of public and private agricultural R&D investments have changed in the U.S. (Figure 1). Private R&D has become equally important as a source of agricultural R&D efforts as the public sector.
- Objective of study: do public policy and/or market forces influence private R&D by agricultural input industries?:
  1. We test whether public agricultural R&D spending and public policy (environmental regulations) have stimulated or crowded out private agricultural R&D.
  2. Using the Hayami - Ruttan induced innovation framework, we examine whether output and resource prices have influenced the amount and direction of private agricultural R&D.

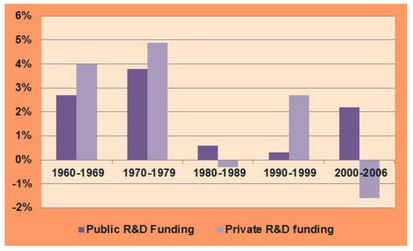

Figure 1. Annual Average Rates of Growth in Public and Private R&D Spending (in constant 2005 dollars) in the United States

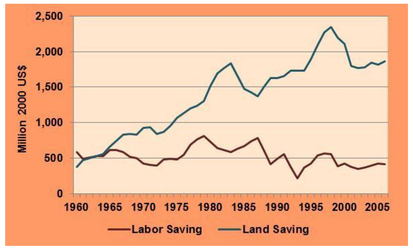

Figure 2. Private R&D Spending in the United States by Type

- The increase in labor saving R&D spending is mainly due to the increase in spending for crop seed technology and agricultural chemicals.

References

Fuglie, K.O., P.W. Heisey, J.L. King, C.E. Pray, K. Day-Rubenstein, D. Schimmelpfennig, S. Wang, and R. Karmarkar-Deshmukh. "Research Investments and Market Structure in the Food Processing, Agricultural Input, and Biofuel Industries Worldwide". ERR-130. USDA, ERS. December 2011.

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Empirical Methodology

- Our analysis uses annual time series data on public and private agricultural R&D and other economic variables for the 1960-2006 period.
- The empirical analysis makes use of a new dataset on private annual R&D spending by agricultural input industries since 1960 (Fuglie et al., 2011).
- We divide private R&D spending into two components and estimate these two equations with SUR.
- Stationarity tests (plots of ACF and PACF, ADF and PP tests) showed that all the variables were non-stationary. Thus, our econometric models use variables that are first-differenced.
- To determine the appropriate lag lengths for the explanatory variables and to choose the best model fit, the SC and AIC were employed.

Table 1. Public R&D and Induced Innovation

	Land Saving Private R&D spending		Labor Saving Private R&D spending	
Variable Name	Coefficient	Standard Error	Coefficient	Standard Error
Public R&D Spending$_{t-1}$	0.969072**	0.395336		
Price Index for Output$_{t-1}$	0.362822*	0.189051		
Extension Spending$_{t-1}$	-0.41572	0.400586		
Real Interest Rate$_{t-1}$	0.008792	0.008286		
Price Index for Land$_{t-1}$	-0.041193	0.036863		
Price Index for Labor$_{t-1}$	0.065254	0.173551		
Public R&D$_{t-3}$			0.134085	0.989724
Price Index for Output$_{t-3}$			0.951331	0.65088
Extension Spending$_{t-3}$			0.958234	1.012692
Real Interest Rate$_{t-1}$			0.010140	0.020433
Price Index for Land$_{t-3}$			-0.27757	0.170869
Price Index for Labor$_{t-3}$			-1.06539**	0.478127
TFP$_{t-3}$			0.897625	0.997967
N	43			
System Weighted R^2	0.2034			

Notes: ** denotes significance at the 5% level and * denotes significance at the 10% level.

- Private agricultural R&D spending was divided into two components based on its focus: labor saving R&D (farm machinery R&D) spending and land saving R&D (all other – biological, chemical, pharmaceutical R&D) (see Figure 2).

Discussion and Conclusions

- Public agricultural R&D has a robust and positive influence on private land-saving R&D but not labor-saving R&D. The two sectors appear to be complementary in developing land-saving technologies: a 1% increase in public R&D spending leads to a 0.6% to 1% increase in private R&D spending.
- Private R&D spending responds to government regulations. Stricter rules on agricultural chemical use stimulated more private R&D. However, recent new regulations on fuel emissions from farm vehicles did not appear to affect private R&D at least through 2006.
- Market forces have contradictory effects on private R&D. Higher agricultural output prices stimulated more private land-saving but not labor-saving R&D. Contrary to the induced innovation hypothesis, higher labor costs were associated with less, not-more, private spending on labor-saving R&D.

Table 2. Public R&D and Regulations

	Land Saving Private R&D spending		Labor Saving Private R&D spending	
Variable Name	Coefficient	Standard Error	Coefficient	Standard Error
Public R&D Spending$_{t-5}$	0.6107*	0.3548		
Price Index for Output$_{t-5}$	-1.0582**	0.3171		
Extension Spending$_{t-5}$	0.6165*	0.3689		
Real Interest Rate$_{t-5}$	-0.0105	0.0071		
Price Index for Land$_{t-5}$	0.2384**	0.0761		
TFP$_{t-5}$	-1.2580**	0.4017		
Regulation (Dummy 1)	0.2512**	0.0962		
Public R&D$_{t-3}$			0.4931	1.0184
Price Index for Output$_{t-3}$			0.0506	0.4392
Extension Spending$_{t-3}$			1.0967	1.1100
Real Interest Rate$_{t-1}$			0.0101	0.0211
Price Index for Labor$_{t-3}$			-0.8806*	0.4740
TFP$_{t-3}$			-0.4983	0.5596
Regulation (Dummy 2)			0.0034	0.2084
N	41			
System Weighted R^2	0.3127			

Notes: ** denotes significance at the 5% level and * denotes significance at the 10% level.

- Dummy 1 represents 1978 amendment to the Federal Insecticide, Fungicide and Rodenticide Act that imposed significant new regulatory requirements for new and existing agricultural chemicals.
- Dummy 2 represents the 2004 phase-in of the new emissions standards for farm machinery created by the amendments to the Clean Air Act of 1990.