"The Role of Intellectual Property Rights in Seed Technology Transfer through Trade: Evidence from US Field Crop Exports"

Minyu Zhou
Ian Sheldon

Seminar
Economic Research Service, USDA
Washington DC
March 28, 2013

Motivation

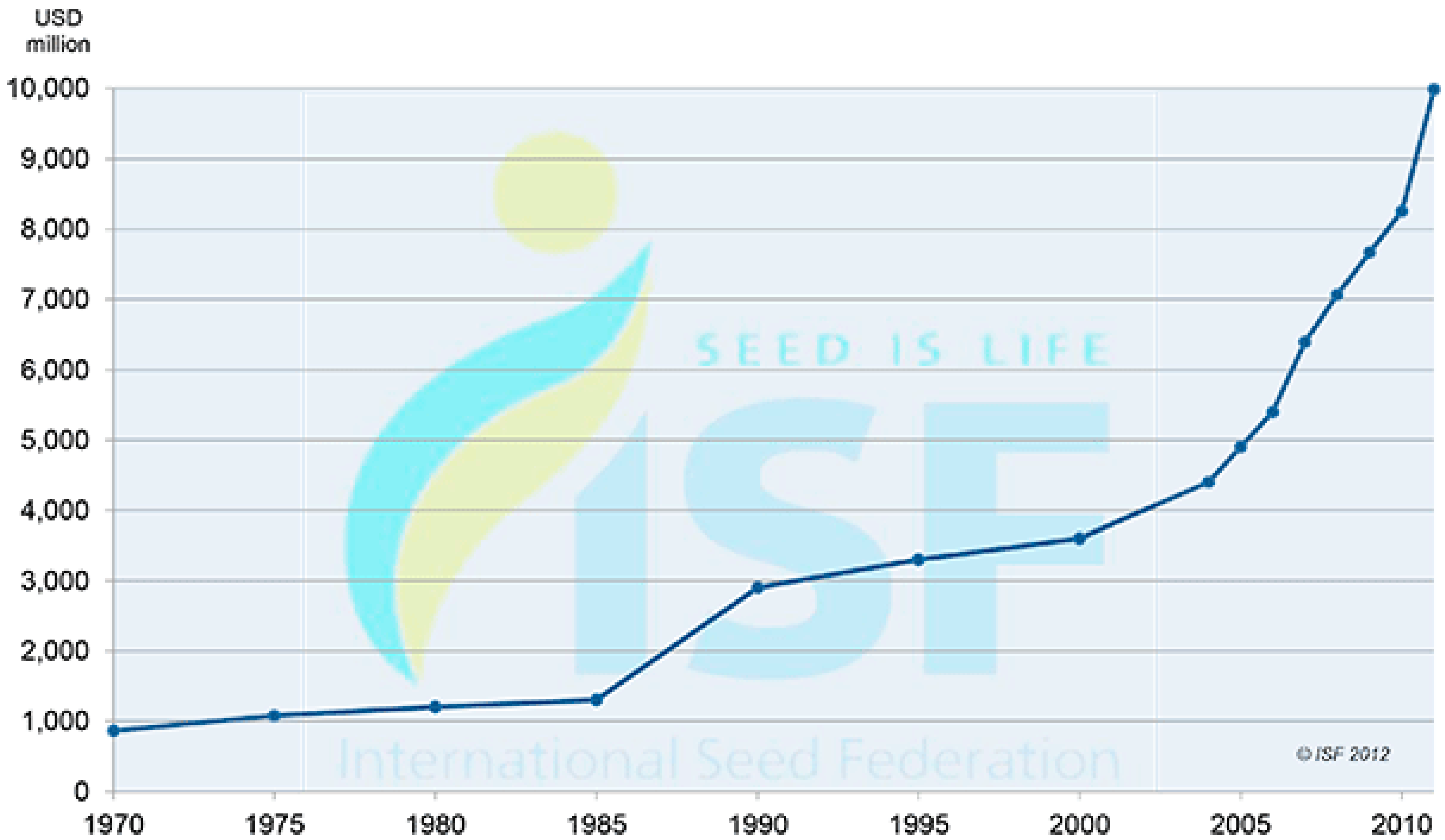
- Issues relating to global food security back in public spotlight (FAO, 2012)
- Innovations in agricultural technology necessary to mitigate decline in yield growth rates (Martin, 2012)
- Improved seed varieties, along with chemical technology and irrigation responsible for past global yield increases (UPOV, 2009)
- Plant breeding requires large scale R&D – top-20 firms re-investing 12-15% of sales/year, with a 10-15 year development cycle for new varieties

Motivation

- **Self-producing nature of (non-hybrid) seed makes plant breeding particularly susceptible to imitation/reproduction**
- **Industry lobbies hard for protection through intellectual property rights (IPRs); process intensified with advent of GM crops**
- **Trade important channel through which technology is transferred across borders – decisions to export often a function of effectiveness of local IPRs**
- **1995 TRIPs agreement of WTO designed to harmonize IPRs for cross-border trade**

T · H · E OHIO STATE UNIVERSITY

Global Seed Trade



Source: International Seed Federation (2012)

Motivation

- **TRIPs applies minimum IP standards to members; specifically Article 27.3(b) extends IPRs to new plant/seed varieties**
- **Specifically, requirement for provision of patent protection or *sui generis* system such as plant breeder's rights as provided in International Union for Protection of New Plant Varieties (UPOV)***
- **Objective is to evaluate impact of countries' IPRs on field crop seed imports from US, and also allowing for how growing GM crops might affect relationship**

*** First signed in 1968, with revisions in 1978 and 1991**

IPRs and Trade

- Theory ambiguous about impact of IPRs on trade (Grossman and Helpman, 1995):
  - market expansion vs. market power
  - FDI and licensing vs. trade
- Essentially an empirical question: evidence for both hypotheses in economics literature - Maskus and Penubarti (1995); Smith (1999); Ivus (2010)
- Mixed results for impact of IPRs on seed trade: no effect - Yang and Woo (2006) and Eaton (2009); variation across crop types (Galushko, 2012) – all using version of gravity equation

Empirical Model

- Key problem is how to deal with zero observations in bilateral trade data
- Helpman, Melitz and Rubinstein's (2008) two-stage estimation method has very strong distributional assumptions (Silva and Tenreyro, 2009)
- Westerlund and Wilhelmsson (2011) develop fixed effects panel Poisson maximum likelihood (ML) method that can be applied to continuous variables
- Approach takes care of problems of zero trade and heteroskedasticity, as well as bias due to country-specific heterogeneity

Empirical Model

- Common formulation of gravity model is:

$$\lambda_{ijt} = E(M_{ijt} \mid Y_{it}, Y_{jt}, D_{ijt}) = \exp(\gamma D_{ijt}) Y_{it}^{\beta_1} Y_{jt}^{\beta_2} \qquad (1)$$

where M_{ijt} is bilateral trade between *i* and *j*, at time *t* Y_{it} and Y_{jt} are GDP levels of *i* and *j*, and D_{ijt} are dummy variables such as membership of FTAs

- Cross-section estimates of (1) typically biased due to limited heterogeneity between country pairs – instead with panel data use $N=n(n-1)$ country-pair fixed effects, α_{ij}, entering (1) multiplicatively:

$$E(M_{ijt} \mid Y_{it}, Y_{jt}, D_{ijt}, \alpha_{ij}) = \exp(\alpha_{ij} + \gamma D_{ijt}) Y_{it}^{\beta_1} Y_{jt}^{\beta_2}$$

$$= \exp(\alpha_{ij}) \lambda_{ijt}$$

THE OHIO STATE UNIVERSITY

Empirical Model

- Implicitly defines regression:

$$M_{ijt} = \exp(\alpha_{ij})\lambda_{ijt} + e_{ijt}$$

which can be written as:

$$M_{ijt} = \exp(\alpha_{ij})\lambda_{ijt}\upsilon_{ijt} \qquad (2)$$

where e_{ijt} is mean zero disturbance term, other is $\upsilon_{ijt} = 1 + e_{ijt} / \exp(\alpha_{ij})\lambda_{ijt}$, heteroskedastic disturbance term with $E(\upsilon_{ijt} | Y_{it}, Y_{jt}, D_{ijt}, \alpha_{ij}) = 1$

- To circumvent possibility that α_{ij} is correlated with explanatory variables, use fixed rather than random effects estimation

THE OHIO STATE UNIVERSITY

Empirical Model

- Common approach to estimate (2) is:

$$\ln(M_{ijt}) = \alpha_{ij} + \ln(\lambda_{ijt}) + \ln(\upsilon_{ijt})$$
$$= \alpha_{ij} + \ln(D_{ijt}) + \ln(Y_{it}) + \ln(Y_{jt}) + \ln(\upsilon_{ijt}) \qquad (3)$$

- (3) can only be estimated with OLS if $M_{ijt} \neq 0$, and dropping observations $M_{ijt} = 0$ induces bias
- Alternative is to estimate (2) directly through exponential regression function:

$$\lambda_{ijt} = \exp(\alpha_{ij} + \gamma D_{ijt} + \beta_1 \ln(Y_{it}) + \beta_1 \ln(Y_{jt}) \qquad (4)$$

which follows from multiplicative form of (1), and ensures non-negativity of M_{ijt}

Estimating Model and Data

- Estimate specification of (4) with data for 107 countries over period 1985-2009

Variable	Data source
Field crop seed imports (US$)	USDA’s GATS (Global Agricultural Trade System)
GDP (constant 2000 US$)	World Bank’s World Development Indicators
Arable land (thousand hectares)	World Bank’s World Development Indicators
Free Trade Agreement (FTA)	Office of the US Trade Representative web site
UPOV78, UPOV91	UPOV web site
TRIPs	WTO web site
GM crops planting status	James - Global Status of Commercialized Biotech/GM Crops, 1996-2009

Results: Full Sample (107 countries)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	seedIMP	seedIMP	seedIMP	seedIMP	seedIMP	seedIMP
logGDP	2.438***	2.044***	2.162***	2.383***	2.005***	2.130***
	(0.625)	(0.718)	(0.687)	(0.590)	(0.677)	(0.656)
logland	0.616	0.828	0.857	0.581	0.815	0.828
	(0.736)	(0.724)	(0.745)	(0.701)	(0.699)	(0.713)
FTA	0.868**	0.791*	0.799**	0.765*	0.726	0.722*
	(0.390)	(0.473)	(0.393)	(0.403)	(0.489)	(0.410)
UPOV78	-0.0357		0.00456	-0.0998		-0.0449
	(0.175)		(0.188)	(0.160)		(0.179)
UPOV91	0.372		0.405	0.365		0.397
	(0.362)		(0.366)	(0.351)		(0.358)
TRIPs		1.379**	1.398**		1.357**	1.355**
		(0.619)	(0.635)		(0.614)	(0.633)
growGM				0.262	0.124	0.195
				(0.244)	(0.256)	(0.233)

Results: Sub-Sample (62 countries)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	seedIMP	seedIMP	seedIMP	seedIMP	seedIMP	seedIMP
logGDP	2.513***	2.106***	2.230***	2.445***	2.056***	2.189***
	(0.649)	(0.750)	(0.716)	(0.611)	(0.705)	(0.682)
logland	0.647	0.868	0.895	0.601	0.849	0.857
	(0.772)	(0.754)	(0.775)	(0.732)	(0.725)	(0.739)
FTA	0.871**	0.793*	0.800**	0.761*	0.719	0.717*
	(0.387)	(0.468)	(0.389)	(0.401)	(0.487)	(0.407)
UPOV78	-0.0360		0.00649	-0.106		-0.0489
	(0.173)		(0.188)	(0.158)		(0.179)
UPOV91	0.381		0.417	0.374		0.410
	(0.362)		(0.366)	(0.349)		(0.356)
TRIPs		1.388**	1.410**		1.363**	1.361**
		(0.626)	(0.642)		(0.620)	(0.640)
growGM				0.288	0.144	0.220
				(0.248)	(0.258)	(0.235)

Results: Sub-Periods (Full Sample)

VARIABLES	1985-2009	1985-1994	1995-2009
logGDP	2.130***	-0.0971	3.101***
	(0.656)	(0.885)	(1.079)
logland	0.828	2.982***	0.738
	(0.713)	(0.796)	(1.075)
FTA	0.722*	0.183	1.531***
	(0.410)	(0.288)	(0.253)
UPOV78	-0.0449	0.616***	-0.275
	(0.179)	(0.154)	(0.230)
UPOV91	0.397		-0.199
	(0.358)		(0.300)
TRIPs	1.355**		-0.166
	(0.633)		(0.672)
growGM	0.195		0.0448
	(0.233)		(0.184)

Summary

- IP standards contentious issue in trade between developed and developing countries
- Investigate if IPRs promote or hinder seed technology diffusion through trade using data for 107 countries over period 1985-2009
- Estimate standard gravity model using Poisson fixed effects estimator
- Evidence TRIPs has positive effect on US seed exports
- Key concerns with results: GM data issues and how to capture enforcement of IPRs