Impact of Plant Breeders Rights on Technology Availability in China

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Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006

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INTRODUCTION

The value of plant variety protection in developing countries has been questioned recently by several studies. A World Bank financed study of six developing countries . including China - could find no empirical evidence that plant breeders rights would induce new research, new varieties, or strengthen developing country seed industries (Louwars et al 2005). Another study of plant breeder's rights in China (Koo et al 2003) argues that because of the high fees required to obtain and maintain protection of a variety in China, obtaining PVP on plant varieties is not profitable for most crops.

China passed its plant variety protection act (PVPA) in 1997 and started accepting applications in 1999 for ten crops. It now covers all major crops although it is too early to empirically test the impacts of PVPA on private companies breeding research investment the data set that more than 1100 applications for new plant variety protection (PVP) were submitted to the national plant variety protection office from 1999 to 2003 presents a unique opportunity to study the impact of PVP on the supply and adoption of new plant varieties. It is possible to test whether it is profitable for research institutes to obtain PVPs on their best new varieties by estimating the impact of PVPs on the price of seed and sales of protected varieties. If protected varieties lead to higher prices, and enough seed is sold at the higher prices, there is a strong possibility that PVPA will induce a considerable amount of research.

DATA

To analyze the impacts of PVPA, we collected data on all the rice varieties sown on more than 6667 hectares that farmers grow in Guangdong, Hunan, and Zhejiang provinces during 1999-2002. The information included the varieties' sown area, seed prices, and varieties' characteristics by year and by province. The sown area data came from the Ministry of Agriculture (MOA). The seed prices came from authors' survey.

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The varieties' characteristics data came from the varieties regional tests. The information include varieties' yield potential, grain quality (normal quality, high quality, and supper quality), growing season (early, middle and late season rice), rice type (indica and japonica), variety type (conventional variety and hybrid variety) and the variety's source (public sector and private sector). The public sector included national level research institutes, provincial level rice research institutes, prefecture level research institutes, and universities. The private sector included seed companies and individuals. Besides those, we also collected the information whether the variety was protected with PVP, for which came from PVP office of MOA.

Table 1 shows the differences between protected and un-protected varieties' seed prices and sown area. It shows that the seed prices of protected varieties were higher than the non-protected varieties as expected. The average price of PVP varieties was 12.6 Yuan/kg - 4.8 Yuan/kg higher than that of the non-PVP varieties. The large share of protected varieties that are hybrids, accounts for much of the difference between the PVP and non PVP prices. The price of a PVP conventional variety is only 0.6 Yuan/kg higher than that of a non-PVP variety and the price of PVP hybrids is only 1.7 Yuan/kg higher than that of non-PVP hybrids on average. However, hybrids sell for 7 or 8 Yuan/kg more than conventional varieties. The last row of Table 1 shows that the PVP varieties are grown on a smaller average area than the non-PVP varieties. The average sown area of PVP varieties is 27 thousand hectares - 5% less than that of non-PVP varieties.

Table 1. The seed price and planted area of the PVP and Non-PVP varieties

	PVP varieties	Non-PVP varieties
Seed prices (yuan/kg)		
Conventional variety	5.1 (7)	4.5 (311)
Hybrid variety	13.1 (92)	11.4 (293)
Average	12.6 (99)	7.8 (604)
Area planted (1000 ha)		
Conventional variety	25.1 (7)	25.9 (311)
Hybrid variety	27.1 (92)	31.1 (293)
Average	27.0 (99)	28.4 (604)

Note: The number in the parentheses is the observations.
Source: Author survey from Guangdong, Hunan and Zhejiang provinces.

EMPIRICAL MODEL AND ESTIMATION

The impact of PVPA on seed price and farmers' variety adoption could be due to a number of factors. A model of seed

pricing and variety's sown area can be expressed as follows:

$Pseed_{it}=g(X_i, Seedpolicy_t, PVP_i, Institution_i, Region_i)$ (1)

$Area_{it}=g(X_i, Pseed_{it}, PVP_i, Poutprice_{it}, Age_{it} Institution_i, Region_i)$ (2)

where $Pseed_{it}$ is the price of *ith* variety in *tth* year. $Seedpolicy_t$ is the seed policy in *tth* year. $Area_{it}$ is the sown area of *ith* variety in *tth* year. $Poutprice_{it}$ is *ith* variety's output (grain) price in *tth* year. Age_{it} controls for the fact that varieties that have been in the field longer have spread further. *Institution* controls for the type of institution that is selling the variety (different types of government research institutions plus private firms) and finally we have included a regional dummy to control for missing variables that are associated with the province in which the variety was applied for and which location the variety was sown.

A three stage estimation for systems of simultaneous equations was adopted. To estimate the system, we introduced a seed policy variable as the instrumental variable (IV) in the price function. The variable is created based on the new seed law was decreed and implemented in 2000. At the same time, we hypothesize that a number of control variables (varieties' morphological characteristics and three province dummy variables) can be included in both the price and sown area functions. In addition, we also posit that the variety's price and sown area were determined by the breeders' commercial and extension capability. The variety's source is used to measure the differences in the capability of different breeders. As in the PVP function estimation, all institutional sources are given a value of one while seed companies are the check and is not included.

RESULTS

Seed price model

Our PVP impact analysis shows the effects on seed price (table 2, column 1).The positive and significant coefficient of the PVP variable indicates that PVP increased seed price significantly. Ceteris paribus, PVP varieties increase seed price by 0.84 Yuan/kg over non-PVP varieties. The coefficient of a variety's yield potential is not significant but the coefficient of super grain quality variety is highly significant and higher value. Compared to early rice, middle and late season rice varieties had higher seed prices. The insignificance of yield and significance of quality variables indicates that during 1999-2002 firms thought farmers were willing to pay more for high grain quality than yield. Another possible explanation for the insignificance of yield is that the other variety characteristics such as hybrids and season which are important determinants of yield are picking up much of the yield impact.

Hybrid varieties seed price was 7.03 Yuan/kg higher than that of conventional rice varieties. The size of this price premium over conventional unprotected varieties and hybrids indicates why more than 70 percent of the rice PVPs were on hybrids or inbred lines used to make hybrids rather than conventional varieties (Huang et al 2005). Indica varieties' seed price is 1.91 Yuan/kg higher than that of japonica.

Variety sown area model

PVPA also impacts the area sown to a variety. PVP appears to have a negative impact on area planted. Table 2 reports two specifications of our Area model. The first assumed that PVPs affect area sown primarily through the price variable. The second specification hypothesized that PVP works both through prices and directly – either because the suppliers put supply constraints on the seed of protected varieties or farmers have a preference for varieties without PVPs. In both specifications higher seed prices lead to lower levels of use of a variety. This is what economic theory would lead us to expect - farmers buy less on seed that is more expensive if quality is held constant and we have tried to hold all of the other important characteristics of the varieties constant.

Table 2. Impact of PVP on seed price and sown area by variety

	Seed price (Yuan/kg) (linear model)	Variety sown area (1000 ha) (Log model)	
		Model I	Model II
Constant	2.53**	6.19**	6.08**
Time trends	-0.17	0.05	0.05
Policy variables			
Seed policy dummy	0.73*		
PVP	0.84***		-0.24*
Seed price (Yuan/kg)		-0.54*	-0.52*
Output price (Yuan/kg)		-0.31	-0.23
Varieties characteristics			
Variety age	-0.13**	0.04*	0.04
Variety age squared	0.01**	-0.002*	0.00
Yield (ton/ha)	-0.001	-0.54	-0.52
High grain quality	0.33	0.27*	0.24*
Super grain quality	1.91***	0.53**	0.51**
Middle season rice	1.18***	-0.31**	-0.32**
Late season rice	1.03***	0.30**	0.31**
Hybrid variety	7.03***	0.68**	0.72**
Indica (Japonic=0)	1.91***	-0.04	-0.05
Research institutes			
National	0.74	0.62***	0.61***
Provincial	0.73**	0.36***	0.35***
Prefecture	0.01	0.42***	0.41***
University	0.76**	0.33**	0.33**
Observations	703	703	703

* significant at 10%; ** significant at 5%; *** significant at 1%

Specification 2 shows that there is an additional significant negative impact from PVPs holding prices and other characteristics constant. The mechanism behind this negative impact is not clear. One explanation is that PVP protection

restricted the number of seed companies that can sell the PVP varieties' seeds compared to the non-PVP varieties. Most farmers would not know whether the varieties they are purchasing are protected by PVP or not. So, we would not expect that this is a demand side impact. On the supply side companies may not have invested enough in producing sufficient supplies of seed early in the adoption process because of the uncertainties about the actual quantity that will be demanded by farmers and the large losses that a company incurs if they produce seed that they can not sell. The uncertainty about demand is multiplied by the fact that in the first few years firms are selling seed under a temporary registration permit which the government can revoke if the varieties' tests turn up any problems with the varieties.

The evidence from our data on rice varieties suggests that PVPA has allowed companies to raise the price of seed to farmers even after holding grain quality and yield potential of the varieties constant. Most protected varieties are hybrids (92 out of 99 in Table 1). This strategy of protecting hybrids appears to be particularly effective since the protected hybrids have a price premium of 7 yuan per kg over unprotected varieties. Grain quality of a variety also allows companies to increase the price of seed but yield potential, unless that characteristic is embodied in the hybrid variable, did not increase prices. Provincial government research institutions and universities were able to charge more than private companies. This is not surprising given that they private companies tend to be small and relative young companies which do not have the same prestige and standing of the government research institutes.

The econometric analysis in Table 2 also indicates that variety protection working reduces the area planted with a variety substantially due both to the fact that it takes seed firms a while to ramp up production and also to the uncertainty about whether the government will revoke their temporary permits to produce the varieties. It also indicates that the higher prices will reduce seed used substantially while other characteristics such as better quality, hybrids, and the nature of the institute that developed the variety substantially increase use. Since the protected varieties typically combine higher prices with better quality and are hybrids, the true impact of PVP on quantity sold is difficult to sort out.

We find that applying for PVPs on hybrids can be profitable. Table 1. shows the average impact of all factors on the average area and price of varieties with and without PVPs. Using these values the advantage of selling protected versus unprotected varieties was calculated in Table 3. Since hybrids make up 92 percent of the protected rice varieties in our sample, we use the prices and area of hybrids. Area planted can be translated into sales by using the seeding rate for hybrids which is 15 kg/ha (Koo et al 2003). Table 3 shows that the increase in revenue from protecting hybrid varieties is only about 7,050 yuan per year. On average new hybrids are replaced every five years in these regions of China. This more than the cost of obtaining and maintaining PVPs which is 6,400 Yuan initially plus 1,500 Yuan for the first three years, 1,950 Yuan for the next three (Koo et al 2003). So, protection is probably profitable over the lifetime of a hybrid rice variety.

Table 3. Average increase in revenue

	Mean of Hybrid Prices and Area from Table 1
Unprotected	
Area sown (ha)	31,100
Seed rate (kg/ha)	15
Price (yuan/kg)	11.4
	5,318,100
Protected	
Area sown (ha)	27,100
Seed rate (kg/ha)	15
Price (yuan/kg)	13.1
	5,325,150
Increased revenue	7,050

Souce:Caculated by authors.

This analysis was conducted in the earliest years of the Plant Variety Protection Act in China. It suggests that protecting rice hybrids may be profitable. It does not suggest that the profits so far will provide much incentive for companies to invest a lot of money in rice research. However, the fact that companies are raising prices for their protected varieties suggests hope that they will be able to raise them more in the future so that they can support more research. Our analysis also suggests the need to revisit this data in the future and to see if prices and sales expand.

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