Does the Adoption of Risk Reducing Strategies Affect Crop Productivity in High Value Crops? A Semi-Parametric Approach

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Background

- Farmers face various production and climatic risks in high value crop production.
- As risk averse agents, farmers use different risk reducing measures ranging from traditional risk management practices to the adoption of market-based insurance programs.
- In productivity estimation under risky environment in high value crop production, production risk needs to be accounted for in production function.
- In the conventional risk and productivity analyses (Just and Pope 1979; Di Falco et al. 2007; Mishra et al. 2019),where riskiness is modelled as variance of the error term of the production function, risk is treated as ex-post.
- However, farmers do not know about whether negative shocks will occur at the beginning of crop/ production season (Vigani and Kathage, 2019)
- We posit that crop decisions are done when there is anticipation of uncertainty about outcomes (but not actual occurrence)—ex-ante risk. In that, risk is likely changes production technology (as a shifter) and then ex-post output are affected that way (Lien et al., 2022).
- Literature suggests a number of risk management strategies of high value crop growers (for example, Khanal et al., 2021 among Indian farmers), broadly under diversification, use of risk reducing instruments devised, and pre- and post- crop practices.
- Some specific pre- and post- crop practices (good agricultural practices, GAPs) as risk management strategies, are specifically important in high value crops because growers aim to meet national mandate, standard practices and regulations, that fit in value chains of national and export-oriented production for assurance of sales/prices. Farmers likely see the adoption of GAPs as risk reducing strategy.

Data

- Data is based on a primary survey among 602 smallholder onion growers conducted during March and April, 2016, in the Nashik and Jalgaon districts of India
- Onion growers were chosen randomly from 15 villages in three blocks; blocks were classified into three categories of low, medium, and high production; one block from each category randomly selected.
- Five sample villages randomly chosen from each three blocks; thirty-five households randomly chosen from each village.
- In-person interviews and risk experiments done among selected growers.

Methods

- We denoted risk-related variables as Z variables; as ex-ante treatment of risk, we assume that risk changes the production technology, i.e., production function shifts with Z.
- We considered three Zs, Z1: diversification index (count of total agricultural enterprises adopted, DF), Z2: number of risk reducing instrument adopted among contract farming, crop insurance, livestock insurance, RI; Z3: adoption of GAPs, GAP
- Following Lien et al. (2022), we build risk as a shifter in production function, $Y = f|_z(\text{X})$, where Y is output (gross onion revenue), $f|_z(.)$ denotes production function shifts with Z and there have multiple production functions for different level of Z; parameters are specific to Z, we assume $\beta(Z)$ non-parametric.
- Our Cobb-Douglas specification (Y and X are in logs), fitting semi-parametric smooth coefficient (SPSC) where intercept and slope parameters are non-parametric, model is represented as:

$$Y_i = \alpha(Z_i) + X_{1i}\beta_1(Z_i) + X_{2i}\beta_2(Z_i) + X_{3i}\beta_3(Z_i) + u_i, i = 1, \ldots.. n$$

X_{1i}, X_{2i}, X_{3i} are log of land, labor, and material inputs; Z_i is the vector of risk related variables;

- In SPSC, we get input elasticities as functions of Z_i and observation-specific values for them; mean, quantiles and density of those are reported

Table 1: Descriptive statistics (N = 507).

Variables	Label	Mean	Std. dev.	Min	Max
Output					
Gross revenue (Rupees)	Y_1	121,587	116,685	1,200	960,000
Inputs					
Land (acre)	X_1	5.13	10.07	0.50	100.00
Labor (man-year equivalents)	X_2	0.33	0.29	0.04	2.08
Materials (Rupees)	X_3	81,065	50,184	8,600	385,150
Risk reducing strategies					
Diversified farm (DF) (0-8)	Z_1	2.94	1.63	0.00	8.00
Use of risk reducing instruments (RI) (0-3)	Z_2	0.25	0.55	0.00	2.00
Good agricultural practices (GAP) (0-40)	Z_3	13.72	6.69	0.00	40.00

Table 2: Summary statistics of elasticities of the risk reducing strategies diversified farm ($Z_1 = DF$), use of risk reducing instruments ($Z_2 = RI$), and good agricultural practices ($Z_3 = GAP$) at means and quantiles.

Marginal impacts	Mean	Q25	Q50	Q75
Direct impact DF	-0.057	-0.071	-0.064	-0.053
Direct impact RI	-0.021	-0.126	-0.078	-0.024
Direct impact GAP	-0.165	-0.808	-0.542	-0.207
Indirect impact DF	0.06	0.056	0.067	0.076
Indirect impact RI	0.022	0.013	0.076	0.123
Indirect impact GAP	0.231	0.215	0.622	0.887
Overall impact DF	0.003	0.001	0.004	0.006
Overall impact RI	0.001	-0.008	0.002	0.011
Overall impact GAP	0.065	-0.013	0.047	0.119

Table 3: Summary statistics of the intercept, the elasticities and the returns to scale (RTS) at means and quantiles.

Marginal impacts	Mean	Q25	Q50	Q75
Intercept	6.031	5.705	5.975	6.104
Land	0.284	0.271	0.309	0.323
Labor	0.330	0.302	0.315	0.326
Materials	0.494	0.482	0.495	0.517
RTS	1.109	1.094	1.111	1.135

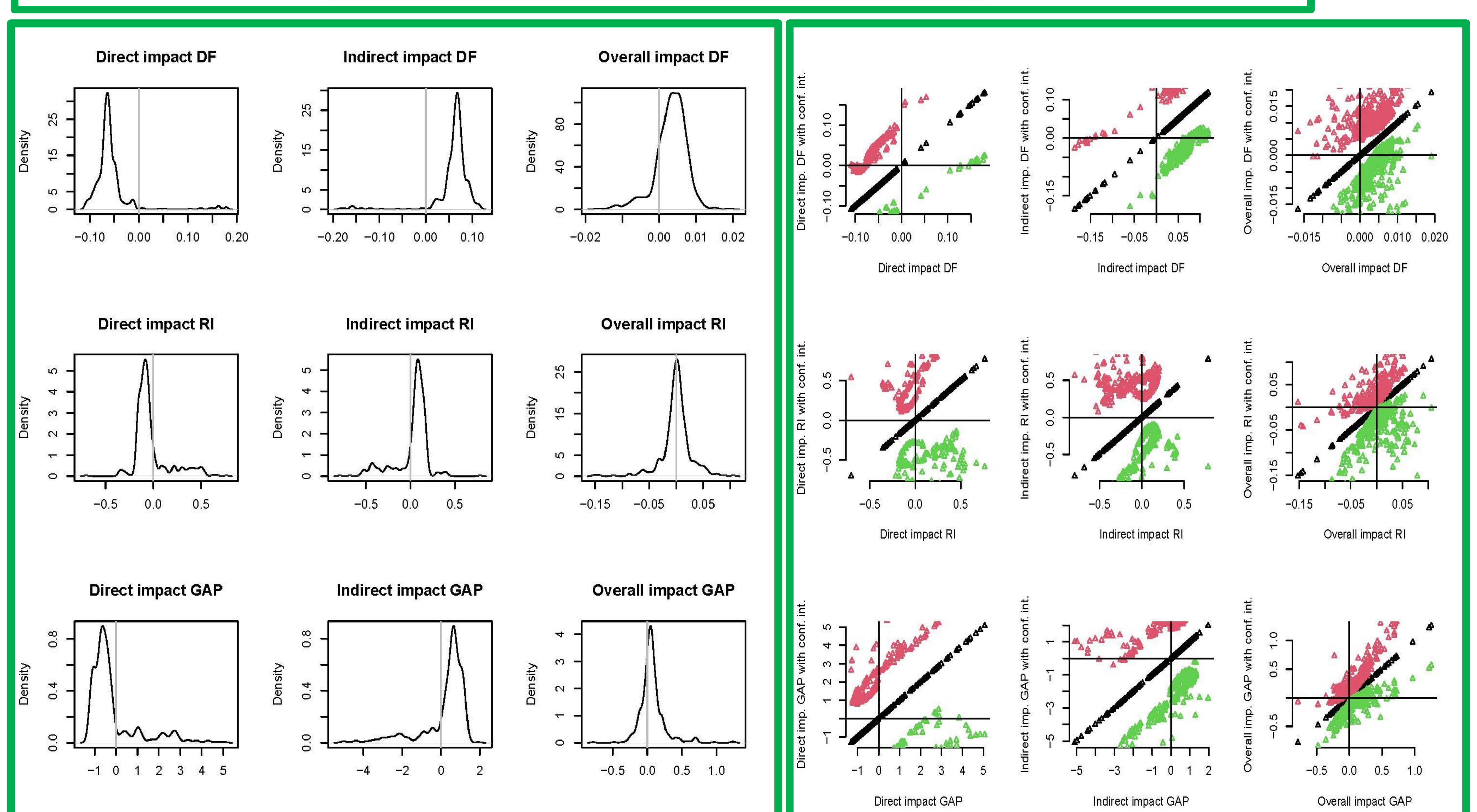

Figure 1:Density plots of impacts of risk variables (left); 45⁰ plot of estimated gradient of risk reducing strategies (right)

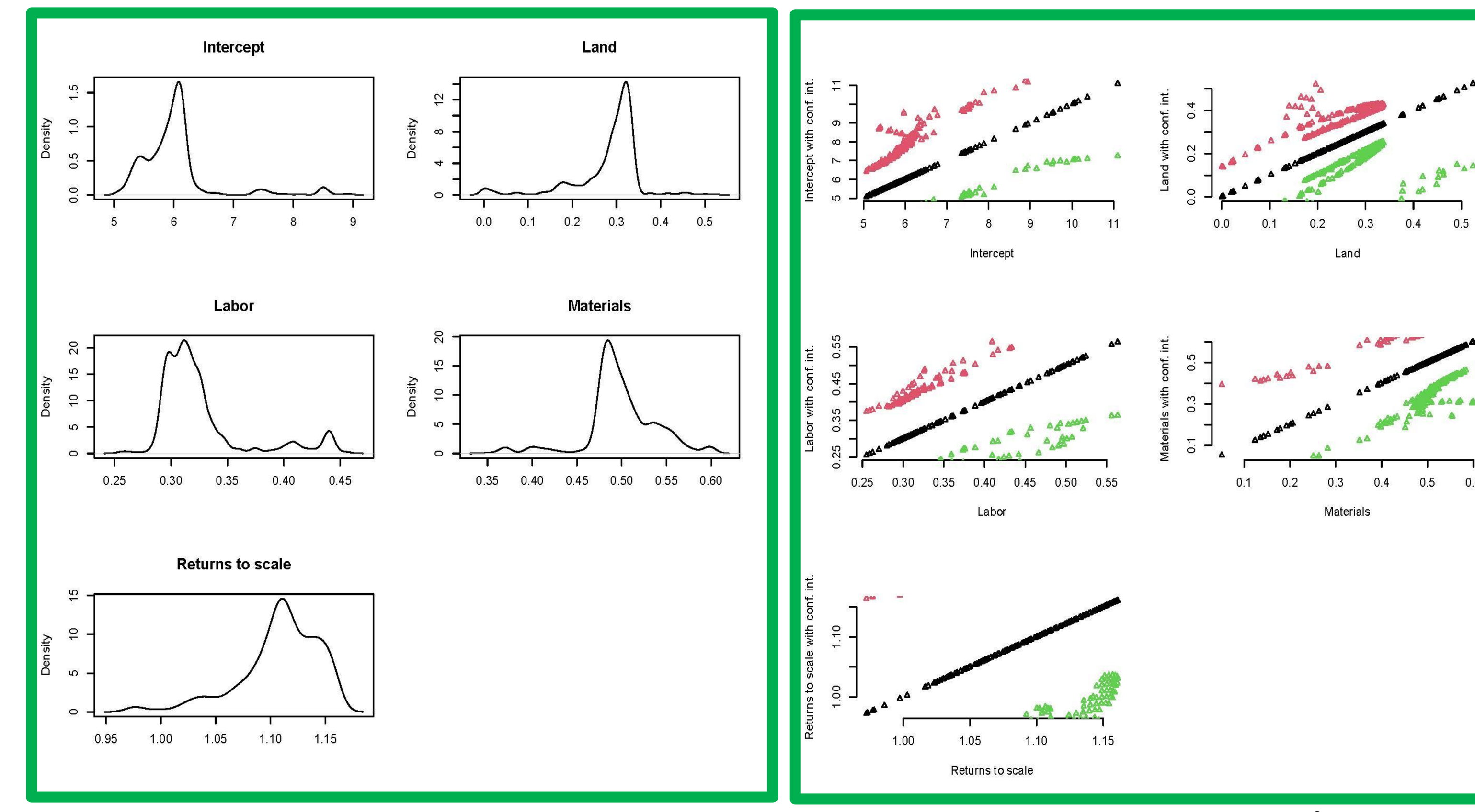

Figure 2: Kernel density plots of input elasticities and returns to scale (left); 45⁰ plot of estimated gradient of elasticities and returns to scale (right)

Results and Discussion

- We examined the effect of risk reduction strategies (diversification, risk reducing instruments, and GAPs) on onion grower's productivity in India.
- Use of semi-parametric SPSC model show observation-specific values; density plots and mean estimates show significant positive impacts of risk reducing strategies on productivity.
- Among risk reducing strategies considered, adoption of GAP has highest impact on productivity, indicates that farmers, perhaps intend mitigating risk of failure, lower sales, or lower quality through adoption of GAP—which help them to increase productivity in high value crops.
- However, the significance of risk reducing strategies is not apparent to all farmers. Table 2 also shows the heterogeneous impacts across quantiles.
- Specifically, the bottom quantile farmers experienced negative productivity linked with RI and GAP—probably because the intended standard maintenance or quality enhancement on high value crop probably not substantiated to increase productivity for very small growers.
- Table 3 and figure 2 show the effects of input elasticities. The elasticity of materials is the highest, followed by that of labor.
- Returns to scale (RTS) of 1.09 to 1.14 suggests that the production function exhibits increasing returns to scale.
- Together, input elasticities and RTS results suggest that high value crop like onion growers can reduce their cost of production, specifically per unit material costs and labor, by increasing the scale of their farming operations.

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