Agricultural Productivity, Hired Labor, Wages, and Poverty: Evidence from Bangladesh

SHAHE EMRAN [a] and FORHAD SHILPI [b,*]

[a] *IPD at Columbia University, USA*
[b] *World Bank, USA*

Summary. — The rice yield and real agricultural wage in Bangladesh increased by 3.8% and 2.1% per annum respectively from 2000 to 2010. Over the same period, the share of hired labor in agriculture decreased from 19.4% to 15.5%. A focus of this paper is to understand if the observed changes in wages and hired labor are in part due to agricultural productivity growth as reflected in increasing rice yield. To estimate the effects of agricultural productivity, we take advantage of an Upazila (subdistrict)-level panel data set from Bangladesh and exploit variations in rainfall across Upazilas and over time. We find that a positive rainfall shock has a significant positive effect on crop yields, wages, per capita household expenditure and labor supplied to market activities (including own farming). The effect on hired labor is, in contrast, negative and statistically significant. In a standard neoclassical model, higher agricultural productivity affects wages and hired labor through labor demand; a rightward (leftward) shift increases (reduces) both wages and the amount of hired labor. The finding of a negative hired labor response to agricultural productivity growth with a higher wage thus appears puzzling. We develop a model where heterogeneity in labor supply response due to differences in productivity in home goods production can lead to a decline in hired labor when agricultural productivity increases, even though the equilibrium wage increases. Since the poor in rural areas depend disproportionately on wage labor, a decline in hired labor may be interpreted by some as evidence of adverse effects on poverty and inequality. The theoretical analysis, however, shows that the poor benefit from agricultural productivity growth even when the labor supply responses result in a decline in hired labor.
© 2016 Published by Elsevier Ltd.

Key words — agricultural productivity, home production, wage, hired labor, labor supply response, poverty

1. INTRODUCTION

The effects of agricultural productivity growth on rural poverty have been a topic of lively debate during the past couple of decades among development economists (see, among others, Datt & Ravallion, 1998; Datt & Ravallion, 2011; Foster & Rosenzweig, 2004). [1] While Datt and Ravallion (1998) find agricultural yield growth to be an important factor behind poverty reduction in India during 1960–90, Foster and Rosenzweig (2004) report that agricultural productivity growth also increased inequality. In a standard model of the rural labor market, changes in agricultural productivity affect employment and wages by shifting the demand for labor. An early concern in the literature on the green revolution (Griffin, 1974) emphasized possible adoption of labor-saving technology such as tractors along with new varieties of rice and wheat, thus suggesting that the labor demand curve would shift to the left. The alternative view, substantiated by accumulated evidence over 1970s and 1980s, is that productivity growth due to high-yielding varieties of rice and wheat in fact increased the demand for labor. These alternative views yield sharp predictions about the effects of agricultural productivity growth: both wages and employment (and hired labor) increase (rightward demand shift) or decrease (leftward demand shift) in tandem. In this perspective, the effects of productivity growth on wages are sufficient to discriminate between the alternative views, which may explain the almost exclusive focus on wages in most of the literature, and the consequent neglect of any potential effects on labor supply and hired labor.

In Bangladesh, the rice yield and real agricultural wage increased by 3.8% and 2.1% annually during 2000–10, respectively. The share of hired labor in agriculture decreased from 19.4% in 2000 to 15.5% in 2010. To the extent the observed changes in wages and hired labor are partly due to agricultural productivity growth (higher rice yield), the existing explanations that focus exclusively on the demand for labor fail to explain the evidence. In this paper, we make two contributions. First, we develop a more complete model where heterogeneity in the labor supply response to the wage plays an important role, and show that agricultural productivity growth may cause wages, and hired labor employment to move in the opposite directions. Second, we provide credible estimates of the effects of agricultural productivity growth on wages, hired labor, and labor allocation between home goods production and market-oriented activities. The evidence shows that higher rice yields in Bangladesh increase wages in agriculture, but reduces the amount of hired labor, thus contradicting the widely held demand shift views where they move in the same direction. The results are, however, consistent with the model developed in this paper which brings into focus the role played by heterogeneity in labor supply response.

Since the poor in rural areas depend disproportionately on wage labor, a decline in hired labor can be interpreted by some as evidence that agricultural productivity growth has had adverse effects on the poorest households in Bangladesh. Our theoretical and empirical analysis, however, shows that such an interpretation would be incorrect, as the decline in hired labor reflects the fact that households have more productive use of their labor in own farming. We also provide evidence that there is a positive effect of agricultural productivity growth on household per capita consumption, which strengthens the conclusion that the households benefit from agricultural productivity growth even though the prevalence of hired labor declines.

---

[*] Final revision accepted: December 6, 2016.

The focus on heterogeneous labor supply response is important in the context of developing countries where wage employment in rural labor markets is often limited (Rosenzweig, 1988), and a substantial amount of "surplus labor" in the form of underemployed and unemployed family labor exists.[2] In many developing countries, poor households are poor because most of their labor endowment is employed in low-productivity home-based non-marketed activities such as foraging, child care, and food preparation, not because they are (openly) unemployed.[3] When low-productivity home production is prevalent, the poverty impact of agricultural productivity may depend primarily on how the allocation of labor from home production to own farming and wage labor changes in response to agricultural productivity growth.[4] The analysis in this paper highlights the potential pitfalls in drawing policy recommendations from piecemeal analysis that focuses solely on the labor market outcomes. Little or no response of wages to agricultural productivity growth does not necessarily imply no effects on poverty, since a substantial increase in labor supply to more productive agricultural activity can lead to significant reduction in poverty even at a constant wage rate.

To estimate the effects of agricultural productivity, we take advantage of an Upazila (subdistrict)-level panel data set from Bangladesh, and exploit variation in rainfall across Upazilas and over time. We implement an approach that focuses on the effects of rainfall shocks in reduced form regressions on the outcome variables (wage, employment in own farming and in hired labor, hours worked for market-oriented activities, and per capita consumption) and also on the measure of agricultural productivity (crop yield). The evidence from the reduced form regressions is sufficient to test the theoretical predictions, which relies on the fact that spatial and temporal variation in rainfall can be interpreted as shifts in the production function, because rainfall is a major determinant of crop yield in Bangladesh (Bhowmik & Costa, 2012; Sarker, Alam, & Gow, 2012).

We also provide an instrumental variables interpretation of our estimates, using rainfall variation across Upazilas and over time (relative to the mean) as an instrument for crop yield (rice yield). The regressions include Upazila fixed effects to remove the time invariant unobserved spatial heterogeneity, and year fixed effects to wipe out the common price (international) and other macroeconomic shocks. To be as clinical as possible, we allow for time-varying direct impacts of these factors by including interactions of a flood-prone area dummy and travel time to metropolitan cities (Dhaka and Chittagong) with the time trend. We include an extensive set of control variables to account for time-varying direct effects of infrastructure and other area characteristics.[5] Empirical estimation issues and the strategy to deal with them are discussed in detail in Section 2.[6]

The regression estimates reported later show that a positive rainfall shock has a significant (at the 1% level) *positive* effect on wages; a 1% increase in rainfall (relative to the mean) increases wages by about 0.46%. The effect on hired labor is, in contrast, *negative* and statistically significant at the 5% level; a 1% increase in rainfall reduces hired labor by 0.73%. The negative response of hired labor is not due to an increase in nonfarm employment; total agricultural employment remains nearly unchanged in response to a positive rainfall shock. Our results also indicate that households increase hours supplied to the market-oriented activities in response to a positive rainfall shock, thus providing additional evidence of reallocation of labor from home production. We include own farming and wage labor in "market-oriented activities".

When interpreted as instrumental variables estimates of the effects of productivity increase, the estimates show substantial impact of an increase in rice yield on wages, hired labor, and labor supply to the market activities.

We provide an intuitive graphical exposition of the main insight of our theoretical analysis to explain the apparently puzzling finding of a negative response of hired labor to a positive agricultural productivity shock. The negative response of hired labor is consistent with the case where labor reallocation from home production by labor deficit households is stronger than that by labor-surplus households in the initial equilibrium. The recent literature on the effects of agricultural productivity on rural labor markets mainly focuses on labor reallocation between agriculture and non-agricultural sectors while taking labor supply as fixed (Foster & Rosenzweig, 2004). There is also a long tradition of examining the economy-wide impacts of agricultural productivity growth using Computable General Equilibrium (CGE) models (for a review of the literature, see Schneider & Gugerty, 2011). Some of the CGE-based analyses consider the implications of surplus labor (e.g., Dorosh & Thurlow, 2014), but they do not explicitly model the labor market interactions that can give rise to surplus labor endogenously. In spirit, our analysis is perhaps closest to that of Fontana and Wood (2000). Fontana and Wood (2000) simulated the effects of trade policy changes (e.g., rise in import price of food, incentives provided to manufacturing, etc.) on female and male allocation of time among reproduction (child bearing and rearing), leisure and market activities, and on rural wages, using a Social Accounting Matrix (SAM). In response to an increase in imported food price, Fontana and Wood (2000) find that both women and men reallocate their labor from home production (reproduction and leisure) to market work—primarily in agriculture—and rural wages increase in the new equilibrium. In contrast with Fontana and Wood (2000), we make a distinction within employment in market activities between hired labor and self-employment in agriculture, and our focus is on the effects of improvements in agricultural productivity.

The rest of the paper is organized as follows. Section 2 develops a model of the rural economy that focuses on the implications of labor supply heterogeneity. discusses The empirical strategy is discussed in Section 3, followed by a description of data in Section 4. The empirical results as well as an intuitive diagrammatic explanation of the findings are discussed in Section 5. The paper concludes in the final section.

2. A MODEL OF THE EFFECTS OF AGRICULTURAL PRODUCTIVITY GROWTH ON RURAL LABOR MARKET

We construct a simple model of a farm economy consisting of two (types of) households (h and k). Each household owns A units of agricultural land, but they differ in terms of the endowment of labor, household h (L_h^0) with more labor than household k $(L_k^0 < L_h^0)$.[7] The households produce two goods: food (agriculture) and a home good. The concept of home good we use is essentially that of Becker (1965) and consists of services that are primarily produced and consumed within the household. The archetypal home production includes food (meal preparation), children, and housing (Becker, 1965; Heckman, 2015; Fontana & Wood, 2000). The households also differ in a second dimension; they have access to different technologies for home good production.