Modern Agricultural Value Chains and the Future of Smallholder Farming Systems

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Abstract:

Smallholder farms continue to play a prominent role in many developing countries. A substantial debate has emerged regarding the future role of smallholder farms as a means to lift rural households out of poverty and contribute to food security as part of modern agricultural value chains. This paper builds a conceptual model to compare household income and total food output under smallholder production *versus* a hypothetical setting wherein households cease engaging as farm owner-operators, but supply land and labor to consolidated commercial farms. Based on the empirical literature, we calibrate the model to quantify the advantages in accessing working capital and output marketing that can plausibly accrue to large-scale farming operations and offset any labor efficiency decrement compared to smallholder farms. Results show that households can earn more from renting out land and labor into competitive factor markets for a wide range of plausible market conditions. The higher the price premium commanded by and less the loss in labor efficiency on large farms, and the tighter the credit constraints on smallholders, the greater is the income advantage from supplying inputs to large farms over operating small farms. An output advantage also accrues to large farms under similar conditions.

JEL Codes:
O13, Q15, Q18

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Developing countries, Food value chains, Land and labor institutions, Modern agricultural markets, Smallholder farms

1. Introduction

Smallholder farms continue to play a prominent role in agricultural production in many developing countries, especially in sub-Saharan Africa (SSA) and parts of Asia. Lowder et al. (2016) study agricultural census data from 167 countries and territories to provide a lower-bound estimate of 570 million farms worldwide, 35% in China, 24% in India, and 9% in SSA. Among these farms, they estimate that over 400 million are less than one hectare in size, and more than 475 million are less than two hectares. Further, farm sizes have increased in upper-income countries, but have decreased in most low- and lower-middle-income countries.

Amidst this structural backdrop, a substantial debate has emerged within the economic development community regarding the future role of smallholder farms. The issue is important in two critical dimensions: first small-scale farming may be a way to elevate the status of some of the world's poorest households, and, second, given that smallholder farms occupy a significant share of the world's agricultural lands, their ability to contribute productively to feeding a growing population affects our collective ability to do it.[1]

With a potential of transforming smallholder operations into large farms, many researchers have considered the future role of smallholders in light of a long list of purported advantages and disadvantages of smallholder farming in generating household income and producing food compared with large-scale, commercial farming. However, these studies typically look at one advantage or one disadvantage in isolation, leaving the net advantage or disadvantage of smallholder farming unclear (Collier and Dercon, 2014; Suttie, 2019). For example, studies have found that smallholders achieve higher yields compared to large-scale operations (Barrett et al.,

[1] The UN FAO projected global food demand to grow by 70% from 2005 to 2050 (Alexandratos and Bruinsma, 2012). Other analysts (e.g., Tilman et al., 2011; Ray et al., 2013) predicted even greater demand expansion in the range of 100-110% over the same period of time.

2010), but smallholders tend to receive relatively low farm-gate prices (Courtois and Subervie, 2015), implying their disadvantage in converting production into household income.

In response to this gap in the literature, we hope to contribute in two dimensions. First, we build a conceptual model to formalize major advantages and disadvantages of smallholders relative to large-scale farms that have been set forth in the literature. The net advantage of smallholder farming in increasing household income and food production is characterized by three parameters: the shadow price of capital for credit-constrained households, the relative efficiency of own labor against hired labor, and the relative output price. Second, we calibrate the model using estimates of the three parameters from prior empirical studies and compare household income and total agricultural outputs under smallholder production *versus* a hypothetical setting wherein smallholders supply land and labor to consolidated farms, if institutional barriers to the transformation from smallholder operations to large farms were removed.

Among a set of reasons why smallholder farming continues (Rozelle and Swinnen, 2004), we emphasize the important role of institutions, because the persistence of smallholder farming is rooted in negative and positive institutional forces of the home country. On the negative side, especially in land-scarce economies, the distribution of farmland among rural households has tended to follow the egalitarian rule. Limited farmland is often divided into numerous farms of similar and small sizes (Gottlieb and Grobovsek, 2019). Such a distribution has been slow to change partly because of institutional forces that discourage households from reallocating labor or selling or renting out their farmland through markets. Examples include insecure land tenure (de Janvry et al., 2015), local-community-based land rights (Jayne et al., 2019), restricted nonfarm labor markets for rural labor (Yao, 2000), and weak social protection for rural households (Hazell et al., 2010).

On the positive side, smallholder farming has enjoyed institutional support, as it is considered an effective development model because of smallholders' advantage in achieving higher yields, known as the inverse productivity-size relationship (Barrett et al., 2010) and their ability of translating production advances into the alleviation of poverty in the short-to-medium term (Rosegrant and Hall, 2000; Larson et al., 2016).[2] The community of economic development scholars, prominent NGOs and international agencies, such as the Gates Foundation, the UN's Food and Agriculture Organization, and the World Bank (Larson et al., 2014), and governments of many developing countries in Asia and Africa have proposed/used institutional forces to direct substantial resources to smallholders including technology assistance, income transfers, trade protection (Hazell, 2005; Hazell et al., 2010), and financial support for farmer cooperatives (Ma and Zhu, 2019).

Countering the viewpoint in favor of promoting small-scale agriculture as a development strategy are arguments that the inverse productivity-size phenomenon is largely due to measurement error, imperfect definition of productivity (Sanchez et al., 2019), or measures a relationship among only very small farms, because few farms larger than five hectares, for example, are included in datasets assembled to test the relationship (Collier and Dercon, 2014; Sheng et al., 2019). Furthermore, focusing narrowly on yields of farmland misses important disadvantages of smallholder farms in adopting quality-enhancing skills and technology, realizing economies of scale in trading, marketing, and storage (Feder et al., 1985), and confronting various market imperfections in input and output markets. For example, smallholders often face credit constraints (Sial and Carter, 1996) and buyer power in wholesale markets (Osborne, 2005).

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[2] Advantage in labor efficiency of small-scale farms is magnified for labor-intensive crops or if land and capital are scarce relative to labor (Swinnen and Martens, 2007).

Recent work on economic transformations and the emergence of export-oriented value chains in emerging economies paints a picture of rapid agricultural industrialization to the betterment of local populations. This work demonstrates that emergence of commercial farming within a local economy can benefit rural households who may participate in these value chains through contract farming, outgrower arrangements, and employment opportunities available on large commercial farms or downstream enterprises created as part of the value-chain transformation (Maertens and Swinnen, 2009; Maertens et al., 2012; Suttie, 2019).

Though various advantages and disadvantages of smallholder farms compared with consolidated farms have been discussed, there has been little effort to assemble them and assess the potential net effects on poverty alleviation and food production. Our conceptual model in section 2 seeks to encompass the major factors in the debate regarding smallholder-*versus*-commercial-farming as a development strategy and to formalize the net advantage of smallholder farms. We focus on three key parameters designed to capture the essential dimensions of the debate. A first parameter represents the output price premium that may be associated with large-scale production. A second parameter quantifies smallholder farms' well-documented difficulty to efficiently utilize market inputs due to credit constraints. The third parameter accounts for a labor-efficiency advantage on small farms that is considered the foundation of the inverse productivity-size relationship.

In section 3, we parameterize the model based on the empirical literature on agricultural production in developing countries, specifically in Asia and SSA. Section 4 reports simulation outcomes of household income and output generated by households from running their small operations *versus* the alternative of supplying their land and labor to commercial farms. We find that smallholders can earn more from renting out land and labor into competitive factor markets for a wide range of plausible conditions based on the empirical literature. An advantage in total food production also accrues to large farms under similar, though not identical conditions. Section 5 considers contract farming and marketing cooperatives as alternative strategies for smallholder households to participate in modern supply chains. We conclude the paper by discussing implications of the analysis for development strategies and policies by home-country governments and donor institutions.

2. Conceptual Model

We consider a traditional agrarian local economy which is land scarce and labor abundant and lacks access to outside employment opportunities as described in Larson et al. (2016) among others. It consists of *N* homogenous households. Each is endowed with a small plot of farmland and some labor, both of which are normalized to one unit. We assume the presence of institutions that impede or prohibit the transfer of landholdings within the local economy. In the absence of an outside labor market, a household's only opportunity to earn income is through farming its land.

The production function for a smallholder farm (subscript *S*) is

$$q_s = f(h_S, l_S, k_S|\tau),$$

where h_S is the hectares of land cultivated, l_S is the effective amount of farm labor, k_S is capital expenditure on market inputs (e.g., fertilizer, herbicides, and machinery), and τ represents a technological efficiency parameter. [3] Let the production function be twice-differentiable, concave, and increasing in the three inputs.

[3] We formally define effective farm labor when setting up the production function for large farms. We call the input k as "capital" which refers to any input that must be purchased in the market and for which credit-constrained smallholders may lack resources to make the purchases.

Without loss of generality, we normalize the output price received by smallholders to $p = 1$. The price of capital is exogenously given at v. A smallholder farm with fixed land and labor inputs $(h_S, l_S) = (1,1)$ chooses k_S to maximize its net income subject to the credit constraint $vk_S \leq B_S$. The constraint is introduced to reflect the possibility of underdeveloped credit markets. The fixed land-labor ratio needs not to be allocatively efficient, but cannot be adjusted in this closed economy. The smallholder's objective function is

$$\max_{\{k_S\}} \pi_S = f(k_S | h_S = 1, l_S = 1, \tau) - vk_S$$

$$s.t.\, vk_S \leq B_S \qquad (\lambda)$$

If the optimal capital input, $k_S^*(v)$ is less than B_S, the smallholder farm is not constrained in its ability to apply market inputs, and the shadow price of capital is $\lambda = 0$. Hence, the first-order condition for k_S^* is $\frac{\partial f}{\partial k_S} = v$. To reflect a binding credit constraint, we introduce a parameter $\gamma = 1 + \lambda > 1$ and re-express the realized optimization condition as

$$\frac{\partial f}{\partial k_S} = \gamma v.$$

The condition $\gamma > 1$ indicates that smallholders underutilize market inputs relative to the unconstrained optimum. The larger is γ, the less efficient is the allocation of market inputs on smallholder farms. The perceived optimal input level of k_S for a smallholder farm is a function of the price of capital, the efficiency parameter for market inputs, and the technology parameter, given the fixed values for *h* and *l*:

$$k_S^* = k(v, \gamma, \tau | h_S = 1, l_S = 1).$$

Substituting k_S^* into the objective function yields the smallholder value function $\pi_S^*(v, \gamma, \tau)$, with $\frac{\partial \pi_S^*}{\partial \gamma} < 0$.

2.1 Imagining the Emergence of Large Farms

We now consider a hypothetical environment wherein the government secures land titles, opens the land market, and puts in place other policies to enable consolidation of farmland. Large farms can emerge in this setting through foreign direct investment (Reardon and Barrett, 2000), upstream vertical integration by processing and trading enterprises (Maertens et al., 2012), or internal farm expansion led by capital-rich farmers within the smallholder community (Eswaran and Kotwal, 1986; Jayne et al., 2019).

We assume, however, that land consolidation in this land-scarce economy is not so extreme as to create a handful of "mega farms" as has occurred in some Eastern European and Latin American countries (Deininger and Byerlee 2012), which often manage over 10,000 hectares of land and could exercise market power in the land rental and farm labor markets. Specifically, assume that M large commercial farms are formed, where M is smaller than N and large enough to ensure that each large farm is a price taker in factor markets.

To better facilitate the direct comparison between small-farm *versus* commercial-farm operations, we do not allow large farms to adopt labor-saving technologies (i.e., reducing the output elasticity of labor relative to that of capital in the production function). We hence are able to highlight the efficiency loss of hired farm labor. The opportunity for large farms to convert from producing a traditional staple to a high-value commodity is not considered explicitly, either. Considering different crops is like to require introducing different output-land, -labor, and -capital elasticities for small and large farms, even under the assumption that the two production functions had the same form. Though adopting labor-saving technologies and growing high-value crops are consistent with the theme of our analysis, we do not model them formally to avoid markedly increasing complexity of the comparison.

Large commercial farms may employ a distinct production technology relative to smallholder farms (e.g., using more efficient machines). Let the technological efficiency of large farms be denoted by $\tau' \geq \tau$. Large farms also have better ability to access capital or credit necessary to obtain efficient amounts of market inputs. This advantage is manifested by setting $\gamma = 1$ for large farms.

Next, let the output price for large farms be denoted as $\sigma \geq 1$, where $(\sigma - 1) \times 100$ denotes the percent output price premium for large farms. A large farm may obtain a higher farm gate price than smallholders for several reasons: (i) smallholders are subjected to buyer power due to poor access to multiple selling opportunities (Mitra et al., 2018) or accurate and timely price information (Courtois and Subervie, 2015), (ii) smallholder prices are discounted because of high transactions costs associated with handling small volumes of outputs (Poulton et al., 2010), (iii) smallholder production receives price discounts based on quality associated with their inability to afford expensive third-party certification, such as GlobalGap, to adopt quality-enhancing or land-intensive technologies or market inputs, such as pesticides or pest-resistant seeds according to buyers' private standards (Reardon et al., 2009; Ahsanuzzaman and Zilberman, 2018), and hence to access high-value markets, such as export sales and direct sales to supermarkets (Farina and Reardon, 2000).

Note that these factors are often interrelated. For example, failure to meet buyers' quality standards forecloses these market outlets and constrains the set of potential buyers, potentially leaving smallholders exposed to greater oligopsony power. Further, the trends of modern agricultural value chains towards increasing downstream market concentration, vertical coordination, and product differentiation continue and, if anything, are accelerating (Sexton, 2013;

Saitone and Sexton, 2017). It implies that the market forces discussed here are only likely to accrue greater importance and quantitative significance over time.

Finally, we embed into the model the possibility of a labor efficiency advantage of small farms that is thought to underpin the inverse productivity-size relationship. Formally, we introduce the concept of *effective labor*, namely, amount of efforts per unit of working time. Due to moral hazard or other incentive-compatibility problems (Feder, 1985; Sanchez et al., 2019), hired labor may not perform to its full efficiency. For l units of hired labor on the large farm, the effective labor input is only ωl where $\omega \leq 1$.

The optimization problem for a large-scale commercial farm (subscript L) is

$$\max_{\{h_L, l_L, k_L\}} \Pi_L = \sigma f(h_L, \omega l_L, k_L|\tau') - v k_L - r h_L - w l_L$$

where r denotes the land rental rate, and w is the wage rate for farm labor, both of which are determined by market forces within the local economy. The large farms compete for land and labor supplied by the smallholder households. Homogeneity of large farms and households implies a symmetric solution in the equilibrium. Thus, the equilibrium land size and labor employment of each large farm is $h_L^* = l_L^* = \frac{N}{M} = n$.

Given the input price of v, let k_L^* represent the optimal employment of market inputs for a large farm. The value function for each large farm is

$$\Pi_L^* = \sigma f(n, \omega n, k_L^*|\tau') - v k_L^* - r^* n - w^* n,$$

where r^* and w^* represent the equilibrium land rental and wage rate, respectively. Given that large farms acquire land and labor as perfect competitors, the factor prices equate to their marginal value products in the equilibrium. Correspondingly, the income function of each household that rents out its land and supplies its labor to a large farm is

$$\pi_L^* = r^* + w^*.$$

2.2 Compare Household Income under Small- and Large-Farm Scenarios

To enable a quantitative comparison of household income in the two scenarios (i.e., a comparison between π_S^* and π_L^*), we assume that the farm production function follows a Cobb-Douglas form with constant returns to scale (CRS). To focus the comparison on σ, ω, and γ, we let smallholder farms and large farms adopt the same technology, namely, $\tau = \tau' = 1$.[4] The production function for either farm type is

$$f(h, l, k|\tau) = h^{\alpha}(\omega l)^{\beta} k^{1-\alpha-\beta}, \tag{1}$$

where $\alpha, \beta,$ and $1-\alpha-\beta$ are the output elasticities of land, effective labor, and capital respectively. The perceived optimal capital utilization for a small farm is $k_S^* = \left(\frac{1-\alpha-\beta}{\gamma v}\right)^{\frac{1}{\alpha+\beta}}$. For easier expression, we denote $1-\alpha-\beta$ by ε, and write the corresponding maximized household income as

$$\pi_S^* = k_S^{*\varepsilon} - vk_S^* = (\gamma - \varepsilon)\gamma^{\frac{-1}{1-\varepsilon}}\left(\frac{\varepsilon}{v}\right)^{\frac{1}{1-\varepsilon}}.$$

Similarly, the objective function of a representative large farm can be expressed as

$$\Pi_L = \sigma h_L^{\alpha}(\omega l_L)^{\beta} k_L^{\varepsilon} - vk_L - rh_L - wl_L.$$

Taking the first-order-condition with respect to k_L, the equilibrium capital expenditure equals

$$k_L{}^* = \left[\frac{\sigma\varepsilon h_L^{\alpha}(\omega l_L)^{\beta}}{v}\right]^{\frac{1}{1-\varepsilon}}.$$

In competitive factor markets, the equilibrium input prices equal the marginal value products. Thus, we take the first-order conditions of land and labor and evaluate them at $k_L{}^*$ to obtain competitive factor prices.

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[4] Under the current functional form, having $\tau' > 1$ is mathematically the same as having $\sigma > 1$. Thus, we can see how such a multiplier affects the relative income and food output by examining σ only.

$$r^*|_{h_L=n,l_L=n} = \alpha\sigma^{\frac{1}{1-\varepsilon}}\left(\frac{\varepsilon}{v}\right)^{\frac{\varepsilon}{1-\varepsilon}}\omega^{\frac{\beta}{1-\varepsilon}},$$

$$w^*|_{h_L=n,l_L=n} = \beta\sigma^{\frac{1}{1-\varepsilon}}\left(\frac{\varepsilon}{v}\right)^{\frac{\varepsilon}{1-\varepsilon}}\omega^{\frac{\beta}{1-\varepsilon}}.$$

For ease of exposition, denote $\omega^\beta = \Omega \leq 1$. The parameter Ω summarizes the extent of the production inefficiency on a large farm due to labor-incentive problems. Ω is determined by the difference in total labor employment relative to effective labor input as measured by ω and the importance of labor as a productive input as measured by its output elasticity, β. Any decrement in effective labor input relative to nominal labor input, i.e., $\omega < 1$, is magnified the more important is labor as a productive input. If $\Omega < 1$, then $\Omega^{\frac{1}{1-\varepsilon}} < 1$, and $r^* < \alpha\sigma^{\frac{1}{1-\varepsilon}}\left(\frac{\varepsilon}{v}\right)^{\frac{\varepsilon}{1-\varepsilon}}$ and $w^* < \beta\sigma^{\frac{1}{1-\varepsilon}}\left(\frac{\varepsilon}{v}\right)^{\frac{\varepsilon}{1-\varepsilon}}$. This means, the loss of labor efficiency on large farms depresses the wage rate and the land rental rate in equilibrium.

Net income of a household that rents out its land and supplies its labor to a large commercial farm is

$$\pi_L^* = r^* + w^* = (1-\varepsilon)(\sigma\Omega)^{\frac{1}{1-\varepsilon}}\left(\frac{\varepsilon}{v}\right)^{\frac{\varepsilon}{1-\varepsilon}}.$$

Straightforward to see that $\frac{\partial\pi_L^*}{\partial\Omega} > 0$, meaning that household income from working on large farms decreases in the extent of moral hazard problem for hired labor and the relative importance of labor in generating farm outputs, because both equilibrium wage rates and land rental rates are depressed by this inefficiency. Further, $\frac{\partial\pi_L^*}{\partial\sigma} > 0$; household income increases in the marketing advantage of large farms. Price premiums for farm outputs achieved by large farms transmit in part to land and labor providers, given competitive land rental and farm labor markets.

To compare household incomes under the two scenarios, we define their relative magnitude as R, where

$$R(\sigma, \Omega, \gamma, \varepsilon) = \frac{\pi_L^*}{\pi_S^*} = (\sigma\Omega\gamma)^{\frac{1}{1-\varepsilon}} \frac{1-\varepsilon}{\gamma-\varepsilon}. \tag{2}$$

$R > 1$ implies $\pi_L^* > \pi_S^*$, namely, a household earns more by renting out land and working on large farms than from operating its own farm. It is easy to see that $\frac{\partial R}{\partial \sigma} > 0$ and $\frac{\partial R}{\partial \Omega} > 0$, and, because $\gamma \geq 1$ and $\varepsilon < 1$,

$$\frac{\partial R}{\partial \gamma} = -(\sigma\Omega)^{\frac{1}{1-\varepsilon}} \gamma^{\frac{\varepsilon}{1-\varepsilon}} \frac{\varepsilon(1-\gamma)}{(\gamma-\varepsilon)^2} > 0.$$

Each comparative static makes intuitive sense in that π_L^* is more likely to be larger than π_S^*, the greater are the advantages of large farms in terms of market price and access to capital relative to small farms, and the smaller is the loss in efficiency of hired farm labor.

3. Simulation Model

We seek not to apply this model to any single crop or developing-country setting, but to consider such settings broadly and utilize the literature to gain an understanding of plausible magnitudes for the key parameters that determine *R*. The key question concerns crops, production conditions, and local-economy environments where $R > 1$. These settings represent cases where household income is improved through facilitating the consolidation of farms into commercial operations. Further, we discuss the related question of conditions when large-scale commercial operations increase total food output relative to smallholder agriculture, considering the importance of generating sufficient food production as we move forward in the 21st Century.

3.1 Output Elasticities: Estimates for α and β

Much empirical work has addressed production relationships in developing-country settings using Cobb-Douglas specifications or its second-order Taylor series generalization, the translog function. The parameter estimates vary widely depending on the location of farms and the crops grown. To make sure that estimated output elasticities were comparable, we focused on two broad crop types: a staple, rice, wherein we selected 19 papers studying rice farming in developing countries in Asia and Africa, and specialty or cash crops, wherein we selected 16 papers focusing on vegetable production in Asia, Africa, and Latin America. The full list of these papers is found in the online appendix.

Table 1: Output Elasticities of Land and Labor for Rice Farms

Output elasticity of	No. Obs.	Mean	Std. Dev.	25%	75%
Land (α)	42	0.57	0.20	0.47	0.74
Labor (β)	41	0.24	0.19	0.14	0.27

Notes: Summary of studies developed by the authors. One paper may provide multiple estimates of output elasticities for farms in different regions, so the number of observations exceeds the number of papers.

The rice production papers were published from 1986 to 2011 in a variety of journals including *Agricultural Economics*, *American Journal of Agricultural Economics*, *Journal of Agricultural Economics*, and *Journal of Development Economics*. Summary statistics for the estimated output elasticities are shown in table 1. On average, land has the largest output elasticity, followed by labor, and then by other inputs. We estimate the value of ε based on values of the labor and land output elasticities under the CRS assumption. The mean output elasticity for land is 0.57 and for labor is 0.24, thus implying a mean value of ε equal to 1- 0.57 - 0.24 = 0.19.

The papers on specialty-crop production in emerging economies were published from 1983 to 2017 in a similar set of journals. Output elasticities are summarized in table 2. The labor output elasticity for such crops is closely comparable to the results for rice, but these crops have a lower output elasticity for land and a commensurately higher output elasticity for other inputs. The corresponding mean value of ε is 1- 0.38 - 0.30 = 0.32.

Table 2: Output Elasticities of Land and Labor for Specialty-Crop Farms

Output elasticity of	No. Obs.	Mean	Std. Dev.	25%	75%
Land (α)	26	0.38	0.20	0.23	0.45
Labor (β)	26	0.30	0.23	0.17	0.34

Notes: Summarized by the authors. One paper may provide multiple estimates of output elasticities for farms in different regions.

3.2 Price Premiums and Discounts: Estimates for σ

The literature on prices and markets for smallholder production is extensive and encompasses a wide range of topics including market information, transactions costs, integration of prices across space and between farm and wholesale markets, and presence of market power by downstream buyers. Many authors recognize the importance of these factors in affecting smallholder prices and income, but, as Barrett (2008) and others have noted, most do not attempt to quantify the impact which is necessary for our simulation model. We focus here on studies that were able to estimate the aforementioned factors' impacts on farmer prices. Studies examining impacts on farmer incomes or return on investment from participation in programs that provide training on production practices, marketing, etc. (e.g., Godtland et al., 2004; Davis et al., 2010) are not considered.[5]

Table 3 presents estimates of price premiums and price discounts from the literature. The listing is not comprehensive, but we regard it as representative. We denote the price effect with a plus symbol when it represents a premium due (e.g., to high quality or improved information) and

[5] Another literature measures farm-wholesale margins and studies the integration of prices between farm and wholesale markets. The price spread in these settings is due to traders' costs and profits. A common finding is that wholesale price changes asymmetrically to farm price, with price increases transmitted slowly and incompletely relative to price decreases (Fafchamps and Hill 2008; Kopp et al., 2017). The most common explanation is that, while traders are aware of price changes downstream, producers are not. Traders exploit the informational asymmetry and increase their profit margins during periods of higher prices. This explanation requires, however, an absence of robust competition among the traders, because otherwise farm prices would be bid up to reflect higher wholesale prices even if farmers themselves were not aware of the price increase.

with a minus symbol when it represents a discount (e.g., due to buyer power). Our point in all cases is that large commercial farms are in a better position than smallholder farms to capture the available price premiums and avoid the price discounts, although we cannot, of course, claim in any instance that a larger farm could achieve 100% of the available premiums and avoid 100% of the price discounts.

Table 3: Price Premiums and Price Discounts for Smallholder Farms

Study	Year pub.	Area/Region	Market factors	Crop(s)	% Δ in price[a]
Abebe et al.	2016	Ethiopia	Direct selling to wholesale	Potatoes	+15%
Ahsanuzzaman & Zilberman	2018	Pakistan	Quality premium	Bt Brinjal	+32%
Courtois & Subervie	2015	Northern Ghana	Price information	Maize Groundnuts	+10% +7%
Gupta	2019	Tanzania	Buyer power	Cotton	-28%
Kopp & Brümmer	2017	Jambi, Indonesia	Buyer power	Rubber	-29%
Lopez & You	1993	Haiti	Buyer power	Coffee	-18%
Mitra et al.	2018	West Bengal, India	Price information	Potatoes	+12%
Negi et al.	2018	India	Information; Bargaining power	Paddy Wheat	+15% +9%
Osborne	2005	Ethiopia	Buyer power	Grain	-2.5% to -4%
Subervie & Vagneron	2013	Madagascar	GlobalGap certification	Lychee	+16%
Vakis et al.	2003	Peru	Price information	Potatoes	+77%

Notes: We utilize a + symbol to denote studies that document a price premium due to the indicated market factor and a – symbol to denote studies that find a price discount associated with the indicated market factor.

The table shows the presence of substantial price premiums and discounts. Reduced prices due to buyer power range from 2.5-4% found by Osborne (2005) to much higher values of 18%, 29%, and 33-45% estimated by Lopez and You (1993), Kopp and Brümmer (2017), and Gupta

(2019), respectively.[6] Improved price information generally leads to price premiums in the range of 7-15%, while Vakis et al. (2003) find even larger percent gains for Peruvian potato farmers. Similarly, empirical evidence shows quality premiums ranging from 16% to 32% for avoidance of pest damages, obtaining certifications, or engaging in specific post-harvest practices.

We note in closing this discussion that, while premiums and discounts for different market factors cannot be aggregated in any straightforward manner, it is plausible that large farms could achieve premiums and avoid discounts based on multiple considerations. The individual estimates in table 3 need not be seen as upper bounds to the market advantages that might accrue to large farms in these settings.

3.3 Loss in Effective Labor: Estimates for Ω

We considered two strategies for estimating Ω. One relies upon studies that estimate impacts on yield due to the inverse size-productivity relationship (e.g., Barrett et al., 2010; Larson et al., 2014), which might allow converting the estimates to implied values for Ω. This proved exceedingly difficult to do, given the variety of empirical methods and implied production relationships utilized by the various authors. We, thus, examine empirical studies that directly estimate productivity differences between family and hired farm labor.

We find only a handful of such studies, despite an extensive theoretical literature on supervising and designing incentives for hired labor on and off the farm (Hölmstrom, 1979; Key and Runsten, 1999). Deolalikar and Vijverberg (1983; 1987) find mixed evidence as to whether family and hired laborers are perfect substitutes for different Asian countries. Using data of

[6] Price discounts due to buyer market power are determined jointly by the extent of buyers' power and the inelasticity of farmers' supply functions. Even modest buyer power, e.g., such as represented by a handful of Cournot buyers, can result in substantial price decrements to farmers if their supply functions are highly inelastic (Sexton, 2000).

Indonesian farmers, Benjamin (1992) tests whether family and hired laborers are equally efficient and fails to reject the null hypothesis. Frisvold (1994) provides a most direct estimation of an *effective-labor ratio* which equals the effective amount of hired labor without supervision over the amount of family labor for 174 rice plots in semi-arid tropical areas of India. He adopts the Cobb-Douglas functional form for farm production and finds a mean of the ratio to be 0.52. This ratio is ω in our equation (1).

In a recent study of sugarcane farmers in Ethiopia, Wendimu et al. (2017) find that the marginal productivity of family labor was 2.6 times as large as that of hired labor, which would imply $\omega = \frac{1}{2.6} = 0.38$. Tsiboe et al. (2018) find the shadow wage of family labor to be 1.7 times that of hired labor, implying $\omega = 0.59$ for Ghanaian cocoa farmers.[7] With estimated values for ω, we can obtain the corresponding Ω by exponentiating ω to the output elasticity of labor, β.

3.4 Shadow Interest Rates: Estimates for γ

Finally, we can interpret γ as the shadow interest rate for smallholders who are faced with credit constraints relative to the market interest rate. Several papers provide estimates of the shadow interest rates all of which are fairly large. Regarding a rural credit market in Peru, Guirkinger and Boucher (2008) find shadow marginal return to capital input for credit-constrained households to be 7.8%, or 186-205% as large as the interest rate charged by formal financial institutions. In Kenya, the shadow interest rate is over 300% larger than the market rate for farms smaller than 5

[7] Only Frisvold (1994) explicitly considers the effect of supervision labor on effectiveness of hired labor. Productivity of family labor estimated by other authors contains working and supervisory labor. Thus, Frisvold's estimation of ω matches our definition of this parameter most closely.

acres (Carter and Wiebe, 1990). Sial and Carter (1996) study smallholders in Pakistan and find that the shadow marginal net return to loans to be 5.7 times as large as the market interest rate.

4. Simulation Results

Based on the empirical literature summarized in section 3, we develop plausible ranges for σ, Ω, and γ values. We consider σ in the range of (1, 1.35), i.e., zero to a 35% price premium earned by large farms. To be conservative, we set a lower support for ω at 0.38, the lowest estimated effective-labor ratio for hired labor that we found in the literature and set the range for Ω from 0.38^{β} to 1, with the upper support reflecting equal labor efficiency on both farm types. Given values for ε, σ, and Ω, we can find the corresponding range of values for γ such that households earn more by renting out land and working on large farms than from farming their own plots. Values of γ that define $R = 1$, given values for σ and Ω, can then be compared to the small set of values estimated in the literature.

4.1 Household Income under Small- and Large-Farm Scenarios

We use *Wolfram Mathematica* to draw hyperplanes which indicate sets of σ, Ω, and γ values that yield $R = 1$. Any combinations of σ, Ω, and γ above such a hyperplane imply an R value greater than 1 and greater household income from supplying inputs to large farms than operating smallholder farms. Figure 1 depicts the hyperplane for rice farms with $\varepsilon = 0.19$, and figure 2 depicts specialty-crop farms where $\varepsilon = 0.32$.

If $\sigma\Omega \geq 1$ and $\gamma > 1$, then necessarily $R > 1$. Thus, $\sigma\Omega = 1$ is where the hyperplanes intersect with the horizontal plane $\gamma = 1$ on the "floor" in both figures. That means, if the relative increase in output price is larger than the relative loss in output contribution of labor, households earn more income by supplying land and labor to large farms, regardless of credit constraints.

If $\sigma\Omega < 1$, then $\gamma > 1$ is necessary to achieve $R > 1$. In the extreme case where $\sigma\Omega$ reaches its smallest value in the simulation, namely, $\sigma\Omega = 1 \times 0.38^{0.24} = 0.79$ in figure 1, $\gamma > 7.7$ is required to make smallholders better off by supplying their land and labor to a large farm. This gap between shadow and market interest rates is even larger than the largest gap of 5.7 identified in section 3.4. In this scenario, despite facing highly inefficient credit markets, smallholders may not earn more by working on large farms, because the effective ratio of hired-to-family labor is so low and the price premium obtained by large farms is trivial. As soon as σ increases to 1.06, though, $\gamma = 5.7$ is sufficient to attain $R = 1$ given the lowest $\Omega = 0.79$.

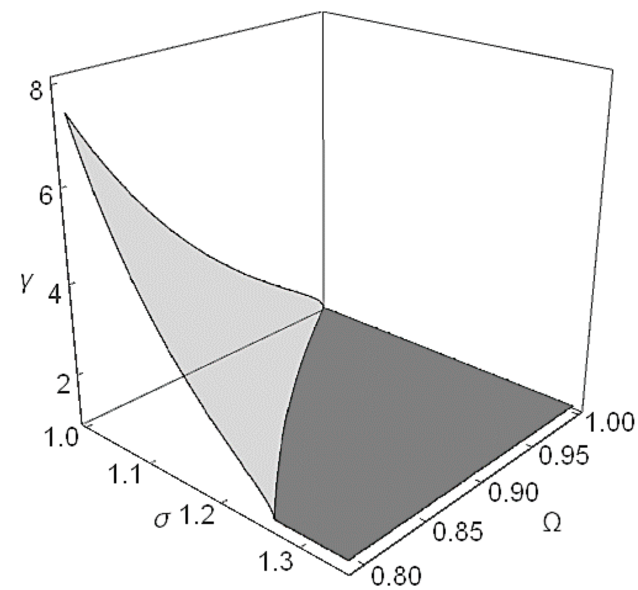

Fig 1. Hyperplane for $R = 1$ with $\varepsilon = 0.19$

Notes: Authors' calculation. R is defined in equation (2). All combinations of (σ, Ω, γ) that lie above the hyperplane denote settings where the household income is higher as an input supplier to large farms than as an independent farm.

For specialty-crop farms, the largest threshold value of γ required to make $R = 1$ is lower. It is below 5 even with the smallest $\sigma\Omega = 1 \times 0.38^{0.30} = 0.75$ (see figure 2) and within the range of estimated shadow interest rates reported in section 3.4. Thus, credit-constrained smallholders growing specialty crops may earn more by supplying their land and labor to large farms even if the effective rate of hired labor and the price premium obtained by large farms are both set at the lowest values.

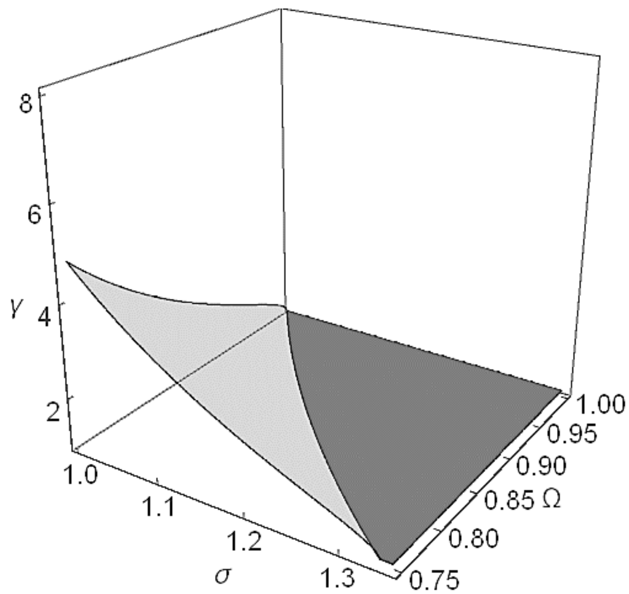

Fig 2. Hyperplane for $R = 1$ with $\varepsilon = 0.32$

Notes: Authors' calculation. Notations and interpretation follow figure 1.

For further comparison of the first two hyperplanes, we trace the threshold γ (i.e., γ value making $R = 1$) for all values of $\sigma\Omega \in [0.79,1]$ for $\varepsilon = 0.19$ and $\sigma\Omega \in [0.75,1]$ for $\varepsilon = 0.32$, respectively. Figure 3 shows that, for any $\sigma\Omega$ in these ranges, a smaller shadow credit price is required for smallholders to earn more from supplying inputs to large farms, when the output elasticity of capital is relatively large. Intuitively, ε measures the relative importance of capital in the production funciton. With an increase in ε, the advantage of large farms in securing optimal use of market inputs is magnified. As long as ε does not become too large, hosueholds would be more likely to earn higher income by supplying land and labor to large farms even if credit market inefficiency is relatively small.

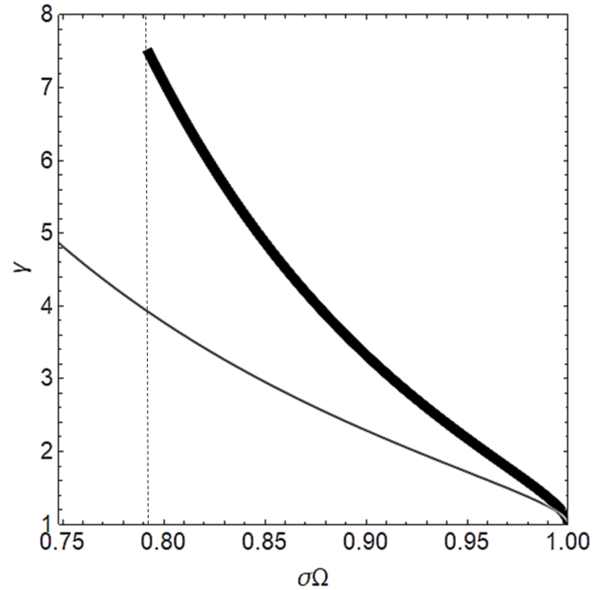

Fig 3. Curves of γ for $R = 1$ with $\varepsilon = 0.19$ and $\varepsilon = 0.32$

Notes: Authors' calculation. The black thick curve is obtained for $\varepsilon = 0.19$ and the gray thin curve for $\varepsilon = 0.32$. Given the corresponding output elasticity of labor, $\sigma\Omega \in [0.79,1]$ for $\varepsilon = 0.19$, while $\sigma\Omega \in [0.75,1]$ for the other case. All combinations of $(\sigma\Omega, \gamma)$ that lie to the right of a curve denote settings the household income is higher as an input supplier to large farms than as an independent farm. The dotted vertical line meets the horizontal axis at $\sigma\Omega = 0.79$.

4.2 Farm Production under Small- and Large-Farm Scenarios

We now consider the total production under the two farming systems. The debate regarding smallholder *versus* commercial farming is important not only for its effects on household incomes, but also in terms of food security issues in developing countries. For smallholder farming, the total production in the local economy equals

$$Q_S = Nf_s(h_s^*, l_s^*, k_s^*) = N\left(\frac{\varepsilon}{\gamma v}\right)^{\frac{\varepsilon}{1-\varepsilon}}.$$

For *M* large farms, the total production is

$$Q_L = Mf_L(h_L^*, l_L^*, k_L^*) = N\Omega^{\frac{1}{1-\varepsilon}}\left(\frac{\sigma\varepsilon}{v}\right)^{\frac{\varepsilon}{1-\varepsilon}}.$$

The relative magnitudes of Q_L and Q_S again depend on σ, Ω, and γ. Impacts of hired-labor inefficiency and smallholder capital constraints on Q_L is clear. Perhaps less obvious is that price premiums earned or price discounts avoided by large farms also increase farm production.

The ratio of Q_L and Q_S is

$$R' = \frac{Q_L}{Q_S} = \Omega^{\frac{1}{1-\varepsilon}}(\sigma\gamma)^{\frac{\varepsilon}{1-\varepsilon}} = \frac{(\sigma\Omega\gamma)^{\frac{1}{1-\varepsilon}}}{\sigma\gamma}. \quad (3)$$

R' increases in σ, Ω, and γ. Taking the prototype rice farm ($\varepsilon = 0.19$) as an example. We have $Q_L > Q_S$ or $R' > 1$, when the set of σ, Ω, and γ values are above the hyperplane shown in figure 4. When both R and R' are greater than one, households earn more by supplying inputs to large farms, and more farm outputs are produced as well, namely, the objectives of enhancing household income and expanding the food supply are both achieved. For $\varepsilon = 0.19$, corresponding combinations of (σ, Ω, γ) that yield both $R > 1$ and $R' > 1$ are found in the space that lies above both hyperplanes, as depicted in figure 5.

By cutting through the space along $\Omega = 0.79$, we present a two-dimensional surface of the space drawn in figure 5. The dark gray area in figure 6 contains all (σ, γ) values that make both R and R' greater than 1. There are also nontrivial areas where $R > 1$ but $R' < 1$ (the light gray area) and where $R < 1$ but $R' > 1$ (the medium-dark gray area to the left of the dark gray area). Both areas represent scenarios where a trade-off exists between enhancing income of smallholder households and increasing food production when transforming smallholder farms to large commercial farms. Large price premiums reflected in high values of σ and low values of large-farm labor efficiency (γ) can lead to situations when $R > 1$, but the total output decreases. Conversely, low price premiums and high values of γ can create situations where output increases from the conversion to large-scale farms, while household incomes do not.

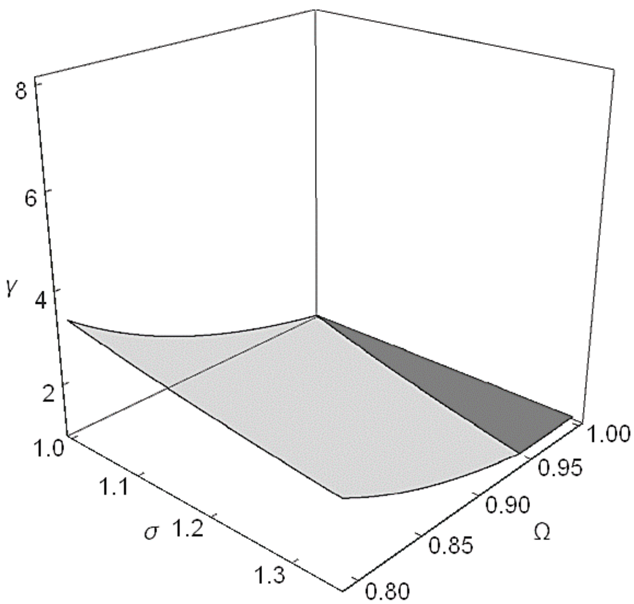

Fig 4. Hyperplane for $R' = 1$ with $\varepsilon = 0.19$

Notes: Authors' calculation. R' is defined in equation (3). All combinations of (σ, Ω, γ) that lie above the hyperplane denote settings where the total farm production of large farms is higher than that of smallholders.

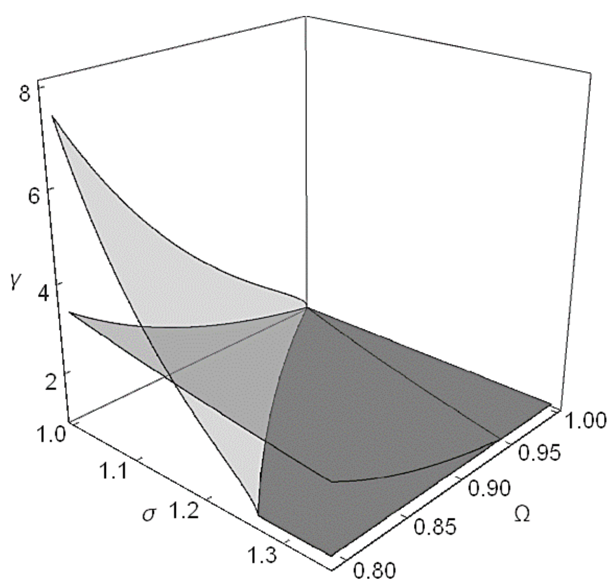

Fig 5. Hyperplanes for $R = R' = 1$ with $\varepsilon = 0.19$

Notes: Authors' calculation. R is defined in equation (2), and R' is defined in equation (3). Combinations of (σ, Ω, γ) that lie above both hyperplanes denote settings where the total farm production of large farms is higher than that of smallholder farms, and the household income is higher as an input supplier to large farms than as an independent farm.

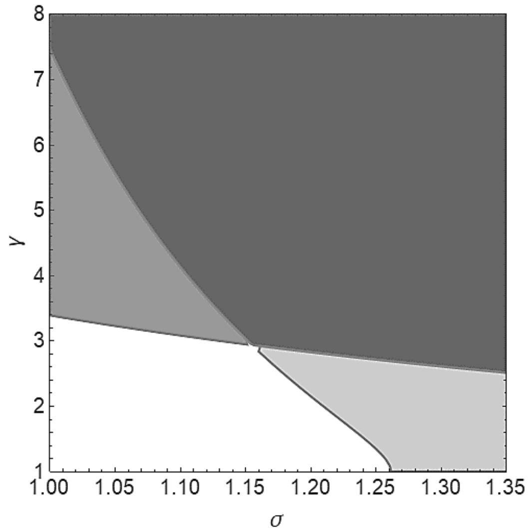

Fig 6. Regions of σ and γ for $R > 1$ and $R' > 1$ with $\varepsilon = 0.19$ and $\Omega = 0.79$

Notes: Authors' calculation. R is defined in equation (2), and R' is defined in equation (3). Given $\Omega = 0.79$, the dark gray area contains combinations of (σ, γ) that make both R and R' larger than one. The medium-dark gray area contains combinations of (σ, γ) such that $R < 1$ and $R' > 1$. The light gray area contains combinations of (σ, γ) such that $R > 1$ and $R' < 1$.

Overall, simulation results show that smallholders can earn more from renting out land and labor into competitive factor markets for a wide range of plausible conditions based on the empirical literature. The higher the price premium commanded by large farms, the tighter the credit constraints on smallholders, and less the loss in effective labor on large farms, the greater is the smallholder income advantage from supplying inputs to large farms compared to operating independent small farms. Importantly, an advantage in total food production also accrues to large farms under similar, although not identical conditions.

5. Alternative Strategies: Contract Farming and Marketing Cooperatives

We have compared rural households' incomes and total farm production from smallholder farming *versus* a hypothetical conversion to commercial-scale farms, with rural households supplying land and labor to large commercial farms. One might argue that the analysis considers two polar organizational structures, and that less drastic re-organizations of agricultural production could achieve much of the benefits associated with large-scale farming operations. Here we briefly discuss the benefits and limitations of two other often-discussed options for smallholders to participate in high-value supply chains: contracting with downstream buyers and organizing marketing cooperatives.[8]

5.1 Contract Farming

The emergence of large supermarket chains and the establishment of high-value supply chains for dairy, sugar, horticultural, and other products in developing countries has caused a rapid expansion of contract farming in these settings. The developments have attracted widespread interest. Documentation of the "supermarket revolution" within emerging economies includes Latin America (Reardon and Berdegué, 2002), Central America (Berdegué et al., 2005), Africa (Reardon et al., 2003), and Asia (Reardon et al., 2003; Hu et al., 2005). The establishment of export supply chains for horticultural products has been well documented, with key papers by Maertens (2009) and Maertens et al. (2012), and by Reardon et al. (2009), introducing a special issue of *World Development* devoted to studying this transformation.

These changes have streamlined procurement systems for many crops and eroded the role of wholesale markets and traders in favor of direct marketing, increased vertical coordination, and implementation of private standards through vertical integration and contracts (Dries et al., 2004; Reardon and Timmer, 2012). Contracts in these settings often provide production support for farmers in the form of inputs, credit, information, technical assistance, etc. (Gow et al., 2000;

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[8] A referee noted another modest transformation in the spirit of our analysis, namely, the co-existence of smallholder farms and large commercial farms. Within this framework smallholders might supply some land and labor to large farms, while continuing to self-cultivate some land. Income earned through supplying inputs to commercial farms could ease smallholders' credit constraints. The framework may help smallholders address another problem that, though yields of small farms are high, households tend to over supply labor from an allocative efficiency perspective because of lacking outside employment opportunities (Barrett et al., 2008).

Berdegué et al., 2005; Hu et al., 2005; Swinnen and Vandeplas, 2010).

These value chains can be usefully analyzed within the model framework set forth in this paper. Credit and other inputs supplied by downstream buyers under resource-providing contracts can enhance resource-constrained farmers' ability to acquire and utilize the efficient amounts of market inputs. Solving the problem of $\gamma > 1$ increases the market surplus generated from transactions involving farmers and their downstream buyers.

The question that arises, however, is to what extent farmers will capture this additional surplus from producing and marketing high-value products. In the absence of competition among buyers to bid up contract prices, the downstream firm needs only to provide a return sufficient to meet a farmer's participation constraint, which, absent other considerations, would be farm income earned through traditional market channels. Indeed, market power concerns can be exacerbated if tailoring one's production to a buyer's specific needs results in the producer being "locked in" to that buyer.

The literature has brought up another question: whether the transactions costs of engaging small farmers in contract farming exceed the benefit to downstream buyers, thus leaving smallholders unable to participate in the higher value supply chain and exposed to greater buyer power in lower-value markets if these premium market outlets are foreclosed. A key aspect of these transactions costs highlighted by Swinnen and Vandeplas (2010; 2011) is farmer moral hazard including side-selling inputs provided by a buyer or selling outputs opportunistically outside of an agreed-upon selling arrangement. Resource-providing contracts cannot survive in this environment. To the extent that small farmers are more vulnerable to engage in this behavior, e.g., due to financial hardship, it makes them even less desirable as contract partners.

Crespi, Saitone, and Sexton (2012), Sexton (2013), and Adjemian, Saitone, and Sexton,

(2015) emphasize that vertical coordination, contract production, and lock-in between farmers and downstream marketers are inevitable consequences of the evolution of agricultural markets to what they term “modern agricultural markets.” Their work makes the fundamental point that, in environments where downstream buyers value the future and can internalize the benefits of supporting the profitability of suppliers of the agricultural-product input to their downstream processes, the buyers have no incentive to exercise buyer power. They argue that buyer power will reduce rates of return on farm investment below “normal” levels and over time cause producers to exit from producing the product, reducing overall supply to the buyer, and jeopardizing the downstream buyers’ own substantial sunk investments.

In this framework increasing buyer concentration can benefit farmers, because it better enables the buyers to internalize benefits from paying sufficient prices to insure profitability of upstream suppliers, e.g., by reducing opportunities for side selling. Modern agricultural markets can create conditions where a symbiotic relationship exists between a downstream buyer and its farm suppliers, and farmers earn at least the competitive rate of return on their investments, despite having few selling options. However, unless private contract enforcement mechanisms can be executed (e.g., Gow et al., 2000), farmer moral hazard is likely to prevent such arrangements from emerging.

In sum, contract farming may be a viable alternative strategy to the large-scale commercial farming model we consider, especially when certain public institutions are ineffective (e.g., underdeveloped credit markets). In the absence of conditions to support a symbiotic relationship between farmers and their downstream buyers, however, there is little basis to believe that farmers are able to capture much of the additional market surplus that emerge from these arrangements.

5.2 Marketing Cooperatives

Joint marketing through cooperatives is widely regarded as a potential tool to mitigate small farmers' competitive disadvantages in modern supply chains (Reardon et al., 2009; Ebata and Hernandez, 2016). Indeed, marketing cooperatives are prevalent in much of the developing world.[9] Cooperatives may enable small farmers to agglomerate production, capture the benefit of downstream scale economies, and reduce transactions costs, thereby facilitating their participation in value chains that are beyond the reach of individual producers (Holloway et al., 2000; World Bank, 2003, 2008; Soboh et al., 2009; Reardon et al., 2009). Marketing cooperatives also may enable farmers to collectively enhance bargaining power and avoid direct selling to buyers who may exercise oligopsony power due to limited access to outside selling options (Lele, 1981; Sexton, 1990; Ito et al., 2012). Cooperatives can provide input and technology services to members and hence also attempt to address the problem of $\gamma > 1$ (Ma and Zhu, 2019).

Thus, in principle, marketing cooperatives can address many of the limitations of smallholder farming discussed in this paper and allow a group of smallholders to enjoy price premiums similar to those obtainable by large commercial farms. Nonetheless, widespread concerns have been expressed that marketing cooperatives have not fulfilled their potential (e.g., Ito et al., 2012, Saitone et al., 2018). Reasons cited include lingering government interference, pressure by government and donor agencies for cooperatives to perform social as well as economic functions, undercapitalization, lack of member commitment, and poor management.

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[9] Develtere et al. (2009) discuss the role of marketing cooperatives in Africa. Lou (2013) reported 689,000 registered cooperatives in China at the end of 2012, with one or more cooperatives present in over 90% of Chinese villages. Marketing cooperatives are also widely prevalent in Indian dairy and sugar sectors, (Banerjee et al. 2001), and also in Central America (Ebata and Hernandez 2016).

But even if cooperatives manage to raise the collective selling price to what large commercial farms can achieve, members may not benefit fully from it. Saitone et al. (2018) report several instances from the literature of cooperatives paying price premiums relative to traders that ranged as high as 22-24% for pigeon pea in Kenya (Shiferaw et al., 2009). However, farmers were often dissuaded from participating in cooperatives due to substantial delays in receipt of the payment and the corresponding risk of payment default inherent in the delays.

Furthermore, being able to countervail buyer power does not imply that a co-operative has balanced power among members. When bargaining for shares of collective economic surplus generated by a cooperative, smallholder members are often at a disadvantageous position relative to members who are major providers of assets and capital, given underdeveloped credit markets in rural areas of most developing countries. “Elite-capture” has long been a problem for cooperatives in developing countries where heterogeneity among members in the contribution of equity and production is generally substantial (Banerjee et al., 2001, Sukhtankar, 2012). Members providing the most assets and capital are likely to make decisions on behalf of the cooperative and capture large portions of economic surplus in those organizations, while the majority of smallholder members contribute large portions of production but only acquire minimum shares of incremental economic surplus achieved collectively.

In sum, marketing cooperatives have potential to help small farmers achieve economies of scale in input procurement, output processing, storage, and selling and also to countervail buyer power, so that credit constraints on smallholders can be relaxed and net selling prices can be increased. Other factors, however, may prevent cooperatives from achieving their full potential. Delayed payments and imbalanced distribution of cooperative benefits usually mean that smallholder members only partially benefit from the increased surplus achieved by the cooperative relative to producing and selling individually.

6. Conclusions and Policy Implications

We have addressed the efficacy of small-scale farming in developing countries as a means to raise smallholders from poverty and contribute to food security, given rapid changes in agricultural value chains across the world. Many scholars, developing country governments, NGOs, and international agencies consider improving efficiency of smallholder farming as the best short-to-medium term path forward. Substantial resources have been allocated for this purpose, and policies sustaining smallholders and impeding consolidation of farmland have been implemented. Our work raises challenges to these development strategies. We have argued that, even if smallholder farms have a labor efficiency advantage relative to large commercial farms, they are likely to face capital constraints on accessing market inputs and, for a variety of reasons, receive discounted prices for outputs relative to larger operations. Most of these reasons are likely to increase as worldwide trends towards increasing concentration, vertical coordination, and product differentiation within the food system continue apace.

Working within the standard framework of Cobb-Douglas production with constant returns to scale, we compared household income from operating their small farms with the hypothetical alternative of supplying land and labor to large farms that could emerge if institutions supporting systematic land transfers were in place. The key determinants for the comparison included magnitudes of price premiums achievable by large farms, loss in effective labor on large farms due to incentive problems, and extent of credit constraints for smallholders. Based on estimates from prior research, we calibrated the conceptual model and compared household income and total farm output under the two farming systems.

Given competitive factor markets, results showed that smallholders, especially those growing specialty-crops, can earn more from renting out land and labor for a wide range of plausible conditions based on the empirical literature. The higher the price premium commanded by large farms, the tighter the credit constraints on smallholders, and less the loss in effective labor on large farms, the greater is the income advantage for households supplying land and labor to large-scale operations.

Achieving food security has become an increasing concern moving forward amid challenges caused by rising populations and incomes, climate change, pest resistance, and slow productivity growth. Our comparison of total food production from smallholder farming relative to commercial farming revealed that conditions where household income increased through selling inputs to large farms need not result in higher total output. Yet, the percentage of “win-win” settings wherein commercial farming yielded both higher household incomes and greater output tended to be large. Although not a formal part of this analysis, these on-farm gains are likely to be augmented by industrialized sectors of packing, processing, distribution, and retailing due to reductions in transactions costs and improvements in product quality and quality uniformity (e.g., Maertens, 2009, Maertens et al., 2012; Reardon and Timmer, 2012).

Our bottom-line conclusion is that the support for smallholder farming systems has focused too narrowly on yield advantages of small farms, historical successes of small farms that are partly sustained by institutions and less applicable in today’s agricultural value chains, and failures of some mega farms organized in a top-down manner. The confluence of forces that comprise modern agricultural markets (Sexton, 2013) are likely to place smallholder farms at an increasing disadvantage moving forward.

The rapid transformations that have occurred in high-value export sectors have shown that, if supportive institutions are in place, transformations to commercial, large-scale agriculture can occur relatively quickly and to the betterment of local populations. In these settings, expending substantial resources to sustain smallholder farming or keeping policies that impede the emergence of large farms is detrimental to the goal of improving households' welfare and food security even in the short-to-medium run. Resources could be better expended by executing reforms to enable the endogenous consolidation of smallholder farms and the emergence of competitive land and labor markets.

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