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What Can We Learn from the Formal Agricultural Sector? Trends, Scale, and Governance of Agriculture and Fishery Establishments in the Philippines

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Abstract

The Philippines' Agriculture and Fisheries Modernization Act (AFMA) identifies one of the modernization objectives as "to encourage horizontal and vertical integration, consolidation, and expansion of agriculture and fisheries activities, group functions and other services through the organization of cooperatives, farmers' and fisherfolk's associations, corporations, nucleus estates, and consolidated farms" (Section 3.d). Consolidation is an issue in developing countries, including the Philippines, where agriculture is dominated by small family farms. Consolidation will also entail formal recognition of farm enterprises, in any of the possible modalities of landholding, from sole proprietorships, to partnerships, corporations, cooperatives, and other private institutions. Organizing and registering smallholders offers access to capital, government programs, business services, and markets.

Based on official Census of Philippine Business and Industry data for 2006, 2012, and 2018, the study finds the following: Over time, the size of the formal agricultural sector has been increasing, as well as that of Crops and Animal raising. likewise, formal establishments have been showing increasing output per worker, but not profitability, nor innovation. Government support for privately-owned establishments is insignificant with no clear trend over time nor preference for legal organization. Based on production function analysis, there exists economies of scale in the operation of agricultural establishments. There is however insufficient evidence to show that cooperatives exhibit larger size, greater inclusiveness, and similar economic performance such as profitability. The study concludes with some implications for policy.

Keywords: Formal economy, family farm, economies of scale, increasing returns, economic organization, agricultural development

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1. Introduction

1.1. Context of the study

The Philippines' Agriculture and Fisheries Modernization Act (AFMA) identifies one of the modernization objectives as "to encourage horizontal and vertical integration, consolidation, and expansion of agriculture and fisheries activities, group functions and other services through the organization of cooperatives, farmers' and fisherfolk's associations, corporations, nucleus estates, and consolidated farms." This mandate is reflected in the National Agriculture and Fisheries Modernization and Industrialization Plan (NAFMIP), currently under review within the Department of Agriculture (DA), which envisions consolidation of family farms towards modernization and inclusive growth in agriculture.

Consolidation is an issue in developing countries, including the Philippines, where agriculture is dominated by small family farms. Over 90 percent of the world's farms are operated as family farms; these farms cover about three-fourths of the word's agricultural land. Hence, family farms are the likely the major source of the world's food production (Lowder et al, 2016). The term "family farms" covers a vast range of landholdings. It overlaps with "small farms", with areas of under 2 ha, which account for 84 percent of all farms. However, in contrast to family farms, small farms account for only 12 percent of all farmed area.

These global proportions mask large differences across countries. In the Philippines, the 2012 Census of Agriculture and Fisheries (the most recent available), found a total of 7.3 million ha of agricultural land, divided into by 5.6 million farms, for an average of just 1.3 ha per farm. The data suggest that small family farms are the dominant modality in the country: farms under household or individual holding account for 99.1 percent of all landholdings, covering 6.8 million ha. Farms under household/individual holdings have an average size of just 1.2 ha (PSA, 2020).

A few large family farms function like commercial enterprises; on the opposite end are miniscule holdings, where the bulk of household production is devoted to subsistence. In between these extremes are small and medium size farms that have the potential of becoming economically viable and environmentally sustainable; however, many such farms are only weakly linked into effective innovation systems (FAO, 2014). Given these realities, it is natural to infer that consolidation is needed to accelerate innovation in the small family farming system.

Moreover, consolidation will also entail formal recognition of farm enterprises, in any of the possible modalities of landholding, from sole proprietorships, to partnerships, corporations, cooperatives, and other private institutions. Organizing and registering smallholders offers access to capital, government programs, business services, and markets.

1.2. Policy issues and evaluation questions

Information about the small family farm abounds in the Philippines owing to numerous household surveys covering this sector (see Briones, 2022). Systematic information for the formal sector in agriculture is relatively sparse. Such a lacunae is not unique to Philippines: "[A]s a result, the agricultural and development economics profession relies mostly on household surveys, which, despite being a rich source of detailed information, do not include larger commercial or government owned, non-household farms" (Lowder et al. 2016, p.28). This paper seeks to address this information gap by carefully analyzing establishment level data collected by the Philippine Statistics Authority (PSA) covering the formal agricultural sector. This consists of a series of Census of Establishments for 2006, 2012, and 2018 (PSA, 2022a).

Gaining better understanding about the formal agricultural sector is critical to understanding the role and potential of access to markets and technology, networking, and formalization, in modernizing the country's family farms. The key policy issue addressed by this study is the transition from agriculture based on small, informal family farms, to one based on formal farms. The overall objective of the study is to characterize the formal agricultural sector in the country, to assess the potential for assimilating the small family farm system into the modern organized fam system. The following evaluation questions may be posed:

i. How large is the formal farm sector? Has it been growing over time?
ii. What are the economic characteristics of formal establishments in agriculture, forestry, and fisheries?
iii. How are these characteristics related to indicators of establishment size? How strong is the evidence for economies of scale?
iv. How are these characteristics related to form of legal organization? In particular, what is the potential for cooperatives as a means for smallholders to benefit from formality?
v. How much support is being provided by government to formal establishments? How may such support be designed in view of the characteristics and potential of formal establishments?

The study of the formal sector in agriculture is most relevant to government for providing empirical analysis in support of consolidation and clustering in agriculture, a key program of DA. The Department of Agrarian Reform (DAR) is also keen in promoting development of agrarian reform community clusters by the deployment of agricultural value chains, such as in the Convergence on Value Chain Enhancement for Rural Growth and Empowerment (ConVERGE) Project. Finally, the Department of Trade and Industry (DTI) is also closely engaged in agricultural value chains and development of rural micro and small enterprises, such as in the Rural Agro-Industrial Partnership for Inclusive Development (RAPID) Growth Project. The study will firm-up empirical evidence on the formal agricultural sector. As such it will support the development of strategies, result areas, and monitoring and evaluation systems towards farmer consolidation.

2. Related Literature

In characterizing the formal sector in agriculture, three clusters of issues arise: a) the contrast with family farms; b) the role of formality in development; c) the role of alternative governance structures in agriculture, such as producer organizations. Each of these issues is reviewed in turn.

2.1. Family farms in development

A "family farm" refers to farms that are partially or entirely owned, operated and/or managed by an individual, together with his or her relatives. A "farm" is more precisely defined by PSA in Box 1. Stylized features of the family farm are discussed in the following.

A family farm typically relies heavily on family labor rather than hired labor.

The average number of permanent hired workers on family farms is very small (fewer than one per farm). In traditional agriculture, family labor makes more economic sense than hired labor, given its lower supervision costs (FAO, 2014).

Box 1: PSA definition of "farm"

A farm is a parcel or parcels of land that satisfies any of the following conditions:

a. aggregate area of at least 1,000 square meters devoted to crops;
b. regardless of crop area but with:
    - at least ten (10) head of large animals like carabao, cattle, etc., or 20 head of small animals like goat, hog, sheep, etc., or 50 head of rabbit, or 100 birds such as chicken, duck, turkey, etc., regardless of age and kind;
    - a combination of large and small animals in (a) equivalent to 10 agricultural units, where one agricultural unit (for livestock and poultry) satisfies any of the following conditions: a head of large animals (carabao, cattle, etc.)
    - regardless of age and kind; two head of small animals (hog, goat, sheep, etc.) regardless of age and kind; five head of rabbit; or ten birds regardless of age and kind.

Source: Lifted in full from PSA (2013a, p. 106)

A small family farm may have higher land productivity, but lower labor productivity, than a large farm.

Representative survey data compiled by Rapsomanikis (2014) cover farms in several developing countries distinguished by farm size. A "small" farm is defined as one belonging to the bottom half of farms ordered by area in ha. His review found that land productivity in small farms exceed those of large farms. By the same token, labor productivity is relatively low: smallholders use more labor inputs per ha. Lastly, analyses of technical efficiency also tend to show that smallholders manage to obtain output closer to the production frontier for a given quantity of input, compared with large farms. Households cultivating smaller farms tend to have lower incomes and higher poverty than those cultivating larger farms.

Most farm households earn income from diversified sources, with smaller farms being more dependent on nonfarm employment.

Rapsomanikis (2014) also found that, for households who own more productive assets, including land, the share of agricultural production in total income is larger, compared with smallholder households. In many countries, the latter obtain below 40 percent of their income from agriculture.

Smallholders seek to diversify their crop choices even as many of them opt to produce the main staple for home consumption.

While the common view is that smallholders are mainly subsistence producers, in fact survey data show that farm household tend to diversify crops and sell off surplus harvest. Poor farmers produce their main staple as well as other products for a more varied diet; diversification of production also serves to reduce risk exposure, such as that induced by price drops. Larger farms can afford to specialize more intensively in fewer crops (Rapsomanikis, 2014).

Land fragmentation, combined with land market rigidity, reduces agricultural productivity.

In 2012, over half of agricultural holdings in the Philippines fell under 1.0 ha, while 32 percent fell between 1.0 and 2.9 ha. Land fragmentation within this system has reduced agricultural productivity; Adamopolous and Restuccia (2020) have found that land reform, by splitting up holdings and then preventing transfers of the smaller holdings, reduced average farm size by 34 percent, and agricultural productivity by 17 percent.

Empirical test reveal market segmentation in rural areas, specifically in labor allocation.

Within agricultural economics, the standard model for understanding agricultural production in developing countries is the "agricultural household" (Singh, Squire, and Strauss, 1986). This model offers a theoretically coherent account of observed behaviors such as subsistence production and reliance on family labor. An important conclusion of the model is **separability**: in the presence of competitive markets, the agricultural household first acts to maximize profit, and then allocates the resulting income to maximize utility. A testable prediction of separability is the independence of production choices from household endowments; this implies household's labor endowment should not be predictive of labor demand on the farm.
Rejection of separability implies some departure from integrated and competitive markets. For example, there may be persistent discrepancy between marginal product of family labor and hired labor, the latter being priced too high compared with opportunity cost of the former. Data from five Sub-Saharan countries finds strong evidence to reject separability; market failure seem to be a fairly general finding, rather than being specific to labor sub-markets distinguished by gender, geography, human capital level, or quality of land (Dillon and Barrett, 2017).

2.2. Formality in development

ILO (2018) had estimated that 61.2 percent of employed workers (15 and older) are in the informal economy; likewise, 81 percent of economic units (own account workers and employers) are informal. The sector with the highest level of informal employment is agriculture at 94 percent; in contrast, the share of informal employment in total was 57.2 percent for industry and less than half (47.2 percent) for services.

Various schools of thought have emerged offering contrasting perspectives on the informal economy. The "dualist" approach equates the informal economy with the "traditional" sector while the formal economy corresponds to the "modern" sector. The former is devoted to activities peripheral to the mainstream formal sector, functioning to absorb surplus labor, provide income for the poor, and serve as safety net in times of crises in the formal sector. Meanwhile, "structural" approach views the informal economy as a means to reduce input and labor cost for large capitalist firms. Lastly, the "legalist" approach associated with de Soto (1989), views informality as a strategy of microentrepreneurs to reduce cost, time, and effort of formal recognition (Chen et al, 2004).

The legalist approach overlaps with the "neoclassical" perspective in which the rational entrepreneur chooses to operate informally to maximize profit, i.e. to save on taxes or the cost of labor code compliance (Dell'Anno, 2021). Of course, this comes at the loss of potential benefit from going formal (Floridi et al, 2021), such as larger markets, better access to credit and formal sector services, and so forth. Currently the literature on informal economy has reconciled these alternative explanations by noting these are not mutually exclusive accounts for informality, and that successful promotion of formality requires a clear set of benefits such as access to training, development finance, and markets (Urban and Ndou, 2021).

2.3. Producer organizations in agriculture

Beyond discussions of formality, a key feature of formal economy in agriculture are organizations of agricultural producers, in the form of cooperatives, corporations, or worker associations. In particular, the *cooperative* offers a potential advance over the family farm as represented by the agricultural household model.

2.3.1. Rationale for cooperatives

A "cooperative" refers to "an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise." (International Cooperative Alliance, 2022). The democratically controlled firm (DCF) interpretation of the cooperative distinguishes it from the investor-controlled firm (ICF). In the neoclassical theory of the firm, the ICF is seen as a monolithic decision-making entity with the goal of maximizing profit. Earlier models of the cooperative mirror this neoclassical approach by positing as well an objective of that the cooperative organization is supposedly addressing. For example, Helmberger and Hoos (1962) interpret a producer cooperative as an organization for maximizing the price paid to producers (who are also members), subject to the downstream enterprise (owned by the cooperative) breaking even. Alternative specifications of the cooperative objective are compiled by Royer (2014) as follows:

i. Maximization of net earnings of the cooperative;
ii. Minimization of net price charged by cooperative to its members;
iii. Maximization of member returns, including patronage refund;
iv. Maximization of quantity purchased from members.

A firm however is a much more complex entity, better seen as a "governance structure" coordinating actions of agents, each with their individual motivation and constraints. In a seminal paper, Alchian and Demsetz (1972) posited a firm as an economic organization that emerges to solve asymmetric information arising from teamwork. Teamwork is characterized by individisibilities in production, ownership of factors of production distributed across different agents, and transaction costs in measuring and rewarding the marginal contribution of team members (e.g. the level of effort of the owner of labor). One solution is to settle on a *monitor* specialized in the task of contracting resource owners, as well as metering and rewarding marginal contributions; the appropriate incentive mechanism for such a monitor is the residual claim, also known as "profit".

This theory of the firm may be seen as one of "complete contracts". However, in real world firms, the role of asset owner is typically combined with the role of the residual claimant and team monitor. The explanation for these multiple roles is that contracts in the real world can never completely in specify contingencies over all possible states. The "incomplete contract" theory of the firm points to the ability of integrated ownership to address the "holdup" problem under such conditions (Grossman and Hart, 1986).

Similarly, a cooperative may emerge as solution for farmers to remedy information and holdup problems when collective action is advantageous along the value chain. Indeed, a cooperative may be seen as an extension of the family farm, in that it minimizes transaction costs, realizes scale economies, and asserts bargaining power (Candemir et al, 2021).

Empirically, Grashuis and Su (2018) have shown that farmers who are members of cooperatives realize higher price, yield, income, and other indicators, compared with farmers who are not members of a cooperative. Similarly, Jimenez et al (2018) have found that *calamansi* farmers who are members of a cooperative realize higher household expenditures. Against these advantages are some difficulties of maintaining formality, e.g. maintaining proper and updated financial records (Quilloy, 2015).

2.3.2. Agricultural cooperatives in the Philippines

Formal recognition of cooperatives in the Philippines by registration with the Cooperative Development Authority (CDA), in accordance with the Cooperative Code. In 2015, the CDA issued "Guidelines for the Registration of Agriculture Cooperative". These Guidelines defined an agriculture cooperative as one "whose members are involve/engage in raising/culture of plants, animals, fungi, and other living organisms for productive and economic purpose and in related activities that lead to the reduction of cost and/or value addition of outputs." (CDA Memorandum Circular 2015-05, Section 5)

Songco (2022) summarizes data made available by CDA regarding agricultural cooperatives, i.e., those classified as agriculture, agrarian reform, dairy, fisherman; or classified as multipurpose, marketing, producer, or service, but indicates in its registration a sub-set activity as agriculture or farmers. In 2021, there were 5,721 agricultural cooperatives, 5,684 of whom were primary cooperatives (members are natural persons), and 37 are secondary (members are primary cooperatives. The most common type of agri-coop is multi-purpose at 46%, followed by agriculture at 24%, then agrarian reform at 13.1%. Most agricultural cooperatives fall in the micro to small category, based on the size measure of membership or enterprise assets. More than half (55 percent) of agricultural cooperatives have 100 members or fewer; meanwhile 68 percent have assets totaling Php 3 million or below (equivalent to a micro-enterprise scale).

3. Methodology

3.1. Data source

The data is derived from the Agriculture, Fisheries, and Forestry Division of the Census of Philippine Business and Industry (CPBI). Anonymized data files were shared by PSA with PIDS, covering 2006, 2012, and 2018.

The Census covers *establishments*, defined as "an economic unit under a single ownership or control, i.e., under a single legal entity, engaged in one or predominantly one kind of economic activity at a single fixed location" (PSA, 2020). The CPBI covers formal, i.e. registered establishments of 20 or more workers, or of any number of workers but with multiple branches. The types of legal organization covered under "formal establishment" are as follows:

> Single proprietorship - a form of legal or business organization organized, owned, and managed by one person, who alone assumes the risk of the business enterprise.
>
> Partnership - refers to an association of two or more individuals for the conduct of a business enterprise based upon an agreement or contract between or among them to make financial or in-kind contributions towards a pooled fund with an expectation of dividing the resulting profits.
>
> Government corporation - a private corporation organized for private aim, benefit or purpose and owned or controlled by the government.
>
> Private corporation - a corporation organized by private persons.
> Cooperative - is an organization composed primarily of small producers and/or consumers who voluntarily join together to form a business enterprise which they themselves own, control and patronize.
>
> Others – refers to private associations, foundations, non-government organizations or other forms of legal organization not classified in any of the above.

The sampling frames of the CPBIs were their respective List of Establishments, (2006, 2012, and 2018). In 2006, establishments in the Division with 100 or more workers were completely enumerated; proportional allocation was used in allocating the number of samples for total employment of less than 20 by industry domain and employment stratum to the regions. However, for the 2012 CPBI, all establishments in the formal sector were enumerated. Lastly, for the 2018 CPBI, establishments with 20 workers or more were completely enumerated. Those with fewer then 20 workers were grouped according to the same 5-digit industry code and size group (1-9, 10 – 19), which were then sampled proportionately. Given the presence of a non-certainty stratum, sampling weights are provided in the 2018 Census.

The Census data provides comprehensive information on revenues, expenses, and assets, all in peso valuation; there is little physical input information (except number of workers). This raises some problems with the empirical analysis, discussed below.

3.2. Theory

3.2.1. Returns to scale and economies of scale

According to the standard economic theory of the firm, technology is described by a production function, which, in simplified form, is as follows:

$$Q = f(K, L) \tag{1}$$

Here Q is output per period, f a production function given factors of production, namely K for capital, and L for labor, corresponding to flows of services per period. The theory of the firm further posits behavior based on profit maximization, and as a corollary, cost minimization, as follows:

$$\begin{aligned} &\min C = P_K K + P_L L \\ &s.t \quad Q = Q_0 \end{aligned}$$

Here Q_0 is an arbitrary given level of output, and P_K, P_L are factor prices for capital and labor services, respectively, deemed given under competitive markets. Assuming the conditions of the implicit function theorem hold, then we can define a cost function as follows:

$$C = C(Q; P_K, P_L)$$

Suppressing factor prices, the cost function can be expressed simply as $C = C(Q)$. Assuming differentiability, average and marginal cost, respectively are expressed as follows:

$$\begin{aligned} &AC = C(Q)/Q \\ &MC = \partial C(Q)/\partial Q = C_Q^{'} \end{aligned}$$

Returns to scale is defined in terms of the production function as follows:

$$f(tK, tL) > tQ; t > 1$$

Note that $f(tK, tL) = tQ$ implies constant returns to scale, while $f(tK, tL) < tQ$ implies decreasing returns to scale.

Once a functional form is specified, one may inspect the parameters directly to check for the presence of increasing returns. For instance, the Cobb-Douglas technology is given by:

$$Q = \beta_0 K^{\beta_1} L^{\beta_2}$$

Here $\beta_0, \beta_1, \beta_2$ are function parameters or constants. Note that:

$$\beta_0 \left(tK\right)^{\beta_1} \left(tL\right)^{\beta_1} = t^{\beta_2 + \beta 2} Q\,.$$

Hence, $\beta_1+\beta_2>1$ implies increasing returns to scale. ($\beta_1+\beta_2=1$ implies constant returns, while $\beta_1+\beta_2<1$ implies decreasing returns.)

Original theory is that *Q, K, L* measured by physical inputs. However, suppose the data source only provides value of output, value of assets, and number of workers, so only *L* is measurable in physical units. However, assuming price of output and of assets are fixed with respect to enterprise actions, then Equation (1) can be equivalently represented by

$$R = PQ = f(A, L)$$

Here *R* = revenue, and *P* is output price, while *A* is asset value.
Increasing returns to scale has an important consequence for average cost. Consider an initial output level Q_0 and the minimum cost at that initial level:

$$AC(Q_0) = \frac{P_K K + P_L L}{Q_0}$$

With no optimization, i.e. simply adhering to the linear expansion path, consider a *t*-fold increase in factors, $t > 1$, and assume factor prices remain fixed. This leads to a *t*-fold increase in cost; let $Q_1 = f(tK, tL)$. Then:

$$\frac{tC(K_0, L_0)}{tQ_0} = AC(Q_0) > \frac{t(P_K K + P_L L)}{f(tK, tL)} \geq \frac{C(Q_1)}{Q_1} = AC(Q_1)$$

Hence, $AC(Q_0) > AC(Q_1)$. This corresponds to *declining average cost with output*, otherwise known as *economies of scale*. In short, increasing returns technology implies economies of scale in production.

3.2.2. Legal organization and the firm

The interpretation of the cooperative as similar to a conventional for-profit enterprise but solves a set of problems related to transaction cost, information access, and bargaining power of smallholders, suggests that indicators related to financial viability of a cooperative should be broadly identical with a for-profit enterprise. On the other hand, an interpretation of a cooperative as different from a for-profit enterprise suggests that the cooperative solves a different problem from that of a for-profit enterprise.
From our review of literature, a simple problem addressed by the cooperative may be to maximize net returns (revenue less opportunity cost of capital) subject to a profit constraint $\pi_C \geq 0$. The problem is set up as follows:

$$\max PQ - rK \text{ s.t } \pi_C - PQ - wL - RK \geq 0$$

Setting up the Lagrangian, and assuming the constraint is binding, i.e. $\lambda > 0$:

$$\Lambda = PQ - rK + \lambda\left[\pi_C - \left(PQ - rK - wL\right)\right]$$

The first order conditions imply the following:

$$PQ_K^{'} = r \tag{2}$$

$$PQ_L^{'} = w\left(\frac{\lambda - 1}{\lambda}\right) \tag{3}$$

Equation (3) is the standard profit-maximizing condition for utilization of labor, with an extra bracketed term; this bracketed term is less than 1. Hence, compared with the profit-maximizing condition for utilization of labor, $PQ_L^{'} = w$, the right hand side of (3) is smaller. Hence marginal product must fall further, i.e. labor utilization is greater, which matches intuition. In other respects however, the cooperative behaves like a profit-maximizing firm, e.g. Equation (2) is just the same profit-maximizing condition for the utilization of capital.

3.3. Empirical approach

3.3.1. Scope of CPBI analysis and study hypothesis

The evaluation questions posed in Section 1 is translated specifically into the following tasks to define the scope of CPBI analysis.

Task 1: **To characterize the formal agricultural sector over time**, in terms of its sales, costs, number of workers, assets, net income, nationality, and legal organization.

Task 2: **To determine the relation of cost to production,** in particular whether there are **economies of scale**.

Task 3: To **examine issues of organization in the formal agricultural sector**, **comparing economic indicators of cooperatives vis-à-vis other organizational forms**, e.g., proprietorships/partnerships, private stock corporations, other corporations, and other forms (e.g., rural worker associations).

Based on the theoretical framework and related literature, we posit the following hypothesis:

Hypothesis 1: Over time, the size of the formal agricultural sector has been increasing, based on various measures, namely sales, cost, number of workers, and asset value.

Hypothesis 2: Over time, formal establishments have been showing increasing productivity, profitability, and innovation, based on several indicators (value added per worker; net revenue per peso asset; share of export and e-commerce in sales; share of R&D in total expense).

Hypothesis 3: Over time, formal establishments have enjoyed increasing government support, based on the growing share of subsidies in gross revenues.

Hypothesis 4: There exists economies of scale in the formal agricultural sector.

Hypothesis 5: The average number of workers for cooperatives tends to be larger compared with for-profit establishments.

Hypothesis 6: Cooperatives exhibit similar levels of productivity and innovation as for-profit establishments.

Hypothesis 7: Cooperatives exhibit a similar production behavior as for-profit establishments.

Hypothesis 1 to 3 corresponds to the view that the formal sector is dynamic, progressive, and has been drawing state support. Hypothesis 4 is is to be confirmed by analytical techniques discussed below. The remaining hypotheses pertain to organizational form. Hypothesis 5 is consistent with the model of the cooperative as a wage payment maximizer, in turn based on the view that the cooperative is a more inclusive legal organization compared with for-profit establishments. Hypothesis 6 assumes that economic viability is similar between for-profit enterprises and the cooperative; Hypothesis 7 follows in the same vein this time for production options.

3.3.2. Economies of scale

A simple empirical test therefore of economies of scale/increasing returns technology is to examine over a cross-section of firms whether larger firms (in terms of output) produce at lower average cost. Note however that this simple average-cost test requires physical measurement of output. The CPBI data unfortunately have no physical output quantities, only sales, or *P* (for price) multiplied by quantity. Instead of average cost, what can be computed is the cost share:

$$\frac{C(Q)}{PQ} = \frac{AC}{P} = g(Q).$$

The involvement of price leads to two cases: the competitive case, where $P'(Q) = 0;$ and the market power case, where $P'(Q) < 0.$ For the latter we define:

$$MR = \frac{dR}{dP} = \frac{dP}{dQ}Q + P.$$

Hence, $P > MR.$
Under the the competitive case, the following holds:

$$\frac{dC}{dR} = \frac{1}{R}\left(\frac{MC - AC}{P}\right) < 0\,.$$

The inequality sign holds owing to the fact that, under economies of scale, *AC* is declining, hence $MC < AC;$ therefore *C* is likewise declining with *R*.

Meanwhile under the market power case, the expression becomes more complicated:

$$\frac{dC}{dR} = \frac{1}{R}\frac{1}{P}\left(\frac{MC}{MR/P} - AC\right)$$

In this case there is no way to unambiguously sign the derivative, even in the case of economeis of scale; though $MC < AC$, we also have $MR < P$. However, even in the case of market power, if market power is moderated by competition such that $MR/P \approx 1$ then we still have $dC/dR < 0$.

3.3.3. Returns to scale

For enterprise *i*, define a production function of a Cobb-Douglas form as follows:

$$R_i = P_i \beta_0 K^{\beta_1} L^{\beta_2} \exp(\varepsilon_i)$$

The variable ε_i is an error term with the usual properties. A convenient way to estimate this form is to take natural logarithms:

$$\ln R_i = \ln P_i + \ln \beta_0 + \beta_K \ln K_i + \beta_L L_i + e_i \qquad (2)$$

The estimation works only in the competitive case, where the term $\ln P_i + \ln \beta_0$ can be subsumed under a constant intercept term. Allowing for other control variables $z_{ij}, j = 1, 2, ..., n$, the estimating equation is:

$$\ln R_i = b_0 + b_1 \ln K_i + b_2 \ln L_i + \sum_{j=1}^{n} a_j z_{ij} + e_i \qquad (4)$$

The terms $b_0, b_1, b_2, a_j, j = 1, 2, ...n$ are parameters to be estimated. As written, the model can be estimated by ordinary least squares (OLS). However, the model is a pooled time series cross section involving Census years 2006, 2012, and 2018; in this case it is appropriate to insert a period term *t* to capture fixed effects. After the regression, one may check the sum of coefficients b_1, b_2 to see if they total a number greater than one. Increasing returns to scale is confirmed when the sum exceeds unity and a Wald linear restriction test for the null $b_1 + b_2 = 1$ results in a test-statistic within the rejection region.

4. Profile of formal agricultural enterprises

4.1. Trends for agricultural establishments

4.1.1. Financial indicators

Revenue, expenses, and net revenue have been expanding at the sector level but shrinking at the establishment level.

The first two data rows of Table 1 shows both sample (unweighted) and weighted number of agricultural establishments. Note that weights were available only for the 2018 Census. Sample size increased by 146 percent between 2006 and 2012, but shrank between 2012 to 2018; however, applying weights, the number of establishments nationwide actually increased by 34 percent.

Table 1: Number and financial indicators of agricultural establishments, 2006 - 18

	At current prices			PPP-adjusted Php (2012 = 1.00)		
	2006	2012	2018	2006	2012	2018
Number of enterprises						
Sample number	830	2,039	1,344	--	--	--
Weighted number	830	2,039	2,733	--	--	--
Financial indicators (Php millions)						
Revenue						
Mean	64.6	63.6	71.8	84.0	63.6	61.0
Median	9.6	7.9	11.8	12.5	7.9	10.0
Maximum	4,100.0	7,890.0	11,600.0	5,330.0	7,890.0	9,860.0
Minimum	0.0	0.0	0.0	0.0	0.0	0.0
Sector total	53,600.0	129,000.0	196,000.0	72,360.0	129,000.0	166,600.0
Expense						
Mean	51.0	63.8	63.5	66.3	63.8	54.0
Median	5.8	7.2	9.6	7.5	7.2	8.1
Maximum	2,330.0	8,830.0	11,400.0	3,029.0	8,830.0	9,690.0
Minimum	0.0	0.0	0.0	0.0	0.0	0.0
Sector total	42,300.0	130,000.0	173,000.0	57,105.0	130,000.0	147,050.0
Net revenue						
Mean	13.6	-0.3	8.3	17.7	-0.3	7.0
Median	2.4	0.3	0.7	3.1	0.3	0.6
Maximum	1,770.0	324.0	2,510.0	2,301.0	324.0	2,133.5
Minimum	-84.1	-943.0	-1,280.0	-109.3	-943.0	-1,088.0
Sector total	11,300.0	-620.0	22,600.0	15,255.0	-620.0	19,210.0

Source: PSA (2022).

At the sector level, total revenue has been increasing over time, as has been total expenses, whether valued at current prices, or 2012 prices, using the purchasing power of the peso (PPP) estimate of PSA (2022b). The increase translates to a rising share of formal sector revenue in total value of production of agriculture, that is, from 6.1 percent in 2006, to 9.2 percent in 2012, and further to 10.9 percent in 2018 (PSA, 2022b).

Average revenue per establishment (whether measured by mean or median), has been increasing in nominal terms, from a mean of Php 64.6 million per establishment, to Php 71.8 million in 2018. However, in real terms, revenue per establishment has on the contrary, declined, by 27 percent over a span of 12 years. Note however that there is tremendous skewness in the sample data, as the median is far below the mean, although the range is also very wide, from 0 to Php 5.33 billion in 2006, up to 0 to Php 9.86 billion in 2018, in 2012 prices. (Henceforth, peso values will be reported in real terms, unless otherwise stated). The net entry of establishments has risen faster than industry output, resulting in smaller output per establishment. Related to this, the skewness has been slightly declining over time, with the median-to-mean ratio increasing from 14.9 percent in 2006 to 16.4 percent in 2018.

A similar trend can be observed for expenses at the sector level (rising) and establishment level (declining, in real terms). The net revenue though shows some disturbing patterns. At the sector level, there was an increase over the period 2006 to 2018. However, between 2006 to 2012 there was a drastic decline, with aggregate sector net revenue dipping to Php 620 million. On the establishment level, mean net revenue has also been declining in both real and nominal terms; the average establishment registered a net loss of Php 0.3 million in real terms in 2012. Note however that the median establishment posted a net revenue of Php 0.3 million in 2012; that is, the negative value on average is the result of a small number of establishments posting large losses.

4.1.2. Size and other indicators

Number of workers, and asset size has been increasing at the sector level but declining at the establishment level; share of female workers in total has been increasing slightly.

The PSA classifies enterprises based on size category as follows: **Micro** - 1 to 9 employees; **Small** - 10 to 99 employees; **Medium** - 100 to 199 employees; and **Large** - 200 or more employees (PSA, 2022c). Based on the mean, the average agricultural establishment fell in the Medium category in 2006, but declining in 2012, and shrinking further in 2018, but remaining in the Medium category (Table 2). Female workers have increased as a share in total, but with only a small movement, from 20 to 24 percent at the mean (18 to 20 percent at the median). Male workers remain predominant in the sector (76 percent in 2018). However, the total number of workers in formal agriculture has been increasing, from 108 thousand in 2006, up to 141 thousand in 2018, equivalent to a 30 percent increase. From 2012 to 2018, the number of workers has been declining, consistent with the trend for agriculture as a whole, including formal and informal workers (Briones, 2017).

The total asset size of the formal sector in 2018 at the sector level has also increased, but by a far larger degree, that is, a 214 percent increase between 2006 to 2018, i.e. capital stock has been increasing at a much faster pace than number of workers. There has been hardly any change in mean asset value, in real terms. The median value though has been declining between 2006 and 2018.

Table 2: Size and other indicators of agricultural establishments, 2006 - 18

	2006	2012	2018
Number of workers			
Mean	130	73	52
Median	30	20	14
Maximum	11,650	9,775	11,339
Minimum	1	1	1
Total	107,898	148,092	140,827
Share of female workers in total (%)			
Mean	20.4	20.8	23.6
Median	18.2	16.7	20.0
Maximum	100.0	100.0	100.0
Minimum	0.0	0.0	0.0
Size of assets (Php '000 , 2012 = 1.00)			
Mean	41,080	28,100	41,140
Median	5,569	4,035	3,613
Maximum	1,586,000	2,610,000	5,746,000
Minimum	0	0	0
Total	34,060,000	56,400,000	107,100,000

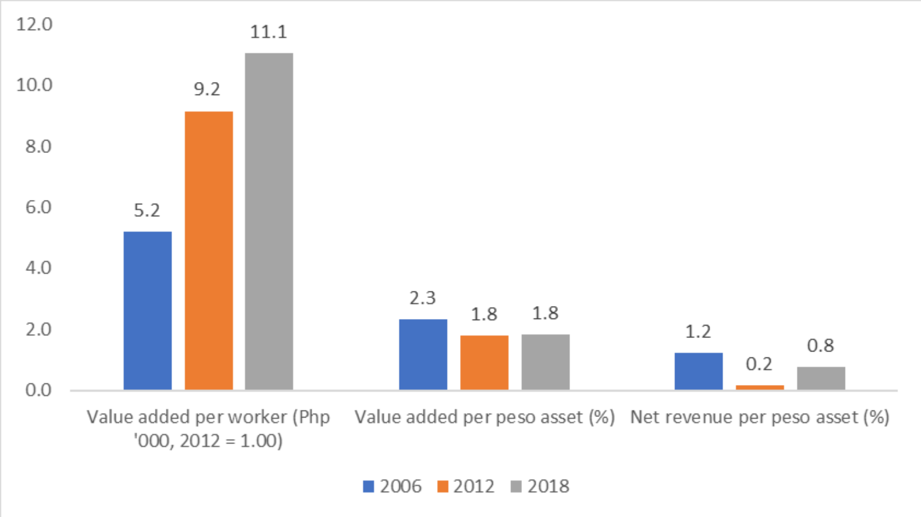
Source: PSA (2022a).

4.1.3. Productivity indicators

Productivity has been increasing on per worker basis, although rate of return has been declining.

Figure 1 presents summary indicators for the mean establishment (in real terms). Based on **value added** per worker, productivity per establishment has been increasing, notwithstanding the declining gross output per establishment. However, based on output per unit asset, productivity per establishment has been falling between 2006 to 2018, consistent with expanding investments into the sector shown in Table 2. The rate of return (net revenue per peso asset) has also been declining between 2006 to 2018 (though increasing from 20012 to 2018). The value is very small, dipping to 0.8 percent in 2018.

Figure 1: Productivity and profitability indicators for the mean agricultural establishment, 2006 – 2018



Source: PSA (2022a).

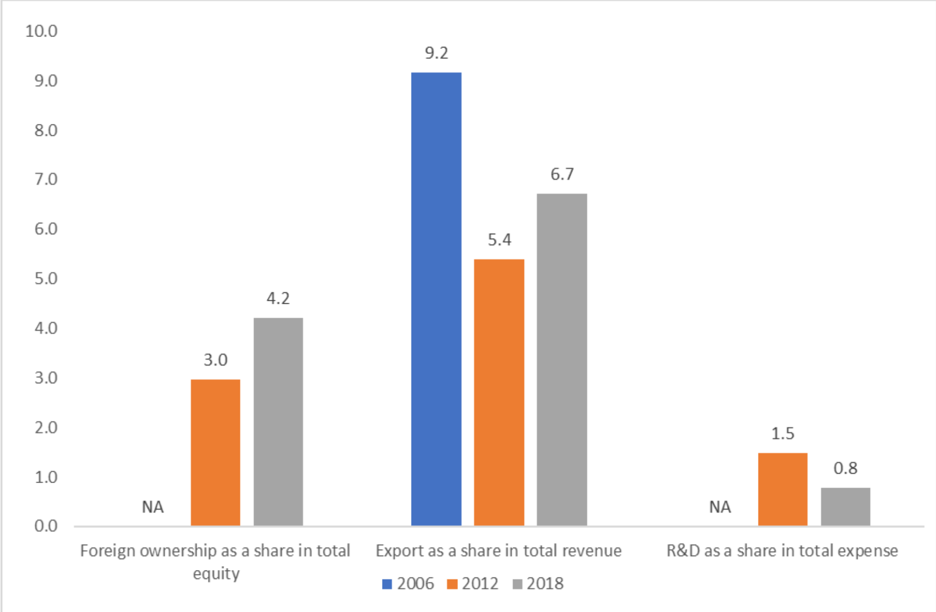
4.1.4. Innovation indicators

Innovation outcomes have not been improving over time among agricultural establishments.

Figure 2 presents some innovation indicators for agricultural establishments.[1] Foreign investment (measured by the share of foreign-owned equity in total equity) increased only slightly, reaching just 4.2 percent in 2018, up from 3 percent in 2012 (no data is reported for 2006). Likewise, no data is reported for R&D expenses in 2006; from 2012 to 2018, the share of R&D in total expense **decreased** from 1.5 percent in 2012, down to under 1 percent (0.8 percent) in 2018. Finally, export revenue share in total revenue also declined, from 9.2 percent in 2006, to just 6.7 percent in 2018.

[1] The E-commerce indicator has been omitted as the CPBI reports zero E-commerce sales for agricultural establishments from 2006 to 2012.

Figure 2: Innovation indicators for the mean agricultural establishment, 2006 – 2018 (%)



Source: PSA (2022a).

4.2. Trends by industry of agricultural establishments

4.2.1. Distribution by industry

Growing of crops, is the most common type of agricultural establishment, although the share of this sub-class has been declining while that of Animal raising has been increasing.

The preceding tables and charts pertain to sectoral averages, which may conceal large differences within sub-sectors. Table 3 shows the distribution of agricultural establishments by industry. Over time, the share of crops establishments has been declining dramatically, whereas that of animal raising establishments has been increasing. As for fishery establishments (capturing both aquaculture and capture fishery), data was not available in 2006, though available data (2012 to 2018) shows a declining share.

Among the various crops, shares in total establishments has also been declining, with the largest changes in percentage points observed for Growing of Palay and Growing of Sugarcane. Meanwhile, among the Animal raising industries, the largest percentage point increase was observed for Chicken, followed by Hogs; establishment shares are stable for Egg production, but declining for Ruminants. Lastly, between 2012 – 18, the share of Prawn aquaculture has been stable, even as the share of establishments in aquaculture and marine capture had fallen. The majority of fishery establishments are still engaged in Marine capture.

Table 3: Distribution of agricultural establishments, by industry, 2006-18 (%)

	2006	2012	2018
Growing of crops	55.4	34.6	31.0
Palay	11.2	1.7	1.6
Corn	0.4	0.5	1.4
Sugarcane	21.7	15.2	9.9
Other annual crops	2.4	3.1	5.0
Banana	10.1	8.0	7.6
Other permanent crops	7.6	5.8	4.8
Plant propagation	2.1	0.4	0.7
Animal raising	44.6	44.8	54.6
Hog	18.7	19.5	21.9
Chicken	15.5	18.2	23.3
Egg production	7.8	5.5	7.9
Ruminants	2.5	1.7	1.5
Fishery	NA	20.6	14.5
Marine aquaculture	NA	0.7	0.5
Prawn aquaculture	NA	1.5	1.5
Freshwater aquaculture	NA	5.6	4.3
Marine capture	NA	12.8	8.1
Total	NA	100.0	100.0

Source: PSA (2022a).

4.2.2. Financial indicators

By industry group, revenue and expenses have been increasing in real terms, together with net revenue (except fishery in 2012-18).

Fishery establishments were not included in the sample in 2006; for the remaining establishments (in Crop growing and Animal raising), net revenue has been increasing between 2006 and 2018. Meanwhile that of fishery also increased from 2012 to 2018.

Table 4: Financial indicators for the mean agricultural establishment, by industry group, 2006 – 2012

	2006	2012	2018
	In Php '000 (2012 = 1.00)		
Revenue			
Crop growing	77,044	108,000	89,844
Animal raising	49,028	39,362	65,206
Fishery	NA	41,895	58,013
Expense			
Crop growing	58,476	112,700	78,023
Animal raising	41,689	36,735	57,315
Fishery	NA	40,207	55,439
Net revenue			
Crop growing	18,600	-5,081	11,600

	2006	2012	2018
Animal raising	7,339	2,473	7,892
Fishery	NA	1,688	2,574

Source: PSA (2022a).

Expenses followed the same trend. Net revenue turns out to have been increasing for Animal growing starting 2006, and for Fishery starting 2012; the decline is noted for Crop growing from 2006 to 2018, with mean net revenue turning negative in 2012.

4.2.3. Size and other indicators

Consistent with sector trends, number of workers and share of female workers has been declining at the establishment level; however, assets per establishment have been growing for Animal raising and Fishery.

For the mean establishment, in 2012 the number of workers was largest for Crop growing, followed by Fishery, then Animal raising. Over time, the number of workers fell by more than half for Crop growing; declines were there but proportionately more moderate for Animal raising and Fishery. The share in female workers in total has been increasing for Animal raising and for Fishery, but with hardly any difference for Crop growing. Sharp differences in trend are also noted for assets; Animal raising and Fishery has experienced a rising asset build-up, consistent with overall sector trends, but contrary to investment trends for Crops, where asset size has been falling.

Table 5: Size and other indicators for the mean agricultural establishment, by industry group

	2006	2012	2018
Number of workers			
Crop growing	206.8	147.2	100.9
Animal raising	34.5	25.4	24.5
Fishery	-	50.0	47.7
Share of female workers (%)			
Crop growing	24.7	27.7	28.6
Animal raising	15.0	18.3	20.0
Fishery	NA	12.2	20.0
Value of assets (Php '000, 2012 = 1.00)			
Crop growing	55,502	48,364	30,043
Animal raising	23,077	15,061	51,004
Fishery		22,414	26,269

Source: PSA (2022a).

4.2.4. Productivity indicators

Productivity and profitability indicators trend upward for Growing of crops, but in the contrary direction for Animal raising.

Growing of crops has been experiencing a rising productivity over time based on value added per worker; however, based on value added per peso asset, and return on asset, Growing of crops has been suffering a declining trend. The opposite holds for Animal raising. Fishery has no baseline figures for 2006, though it has followed a similar trend as Animal raising for 2012 to 2018.

Table 6: Productivity and profitability indicators, by industry group of agricultural establishments, 2006 - 2018

	2006	2012	2018
Value added per worker (Php '000, 2012 = 1.00)			
Crop growing	5.37	4.75	10.5
Animal raising	9.1	12.19	10.56
Fishery	-	8.27	2.21
Value added per peso of assets			
Crop growing	9.69	8.20	7.72
Animal raising	4.03	2.55	13.10
Fishery	-	3.80	6.75
Net revenue per peso of assets			
Crop growing	1.80	0.17	0.44
Animal raising	0.48	0.15	1.24
Fishery	-	0.14	0.22

Source: PSA (2022a).

4.2.5. Innovation indicators

Crop growing exhibits relatively the highest innovation indicators compared with Animal raising and Fishery.

Exports accounted for 16.5 percent of revenue for the mean crop growing establishment in 2006; the share declined somewhat to 14.7 percent in 2018. Meanwhile the share of foreign in total equity reached 5.5 percent in 2018, up from 3.9 percent in 2012.

Table 7: Innovation indicators by industry of agricultural establishment, 2006 – 2012

	2006	2012	2018
Foreign ownership as a share in total equity			
Crop growing	-	3.9	5.5
Animal raising	-	3.2	2.2
Fishery	-	1.9	1.6
Exports as a share of revenue			
Crop growing	16.5	13.8	14.7
Animal raising	0	0.1	0
Fishery	-	4.1	1.9
R&D as a share in total expense			
Crop growing	-	1.7	1.1
Animal raising	-	0.8	0.2
Fishery	-	2.1	0.1

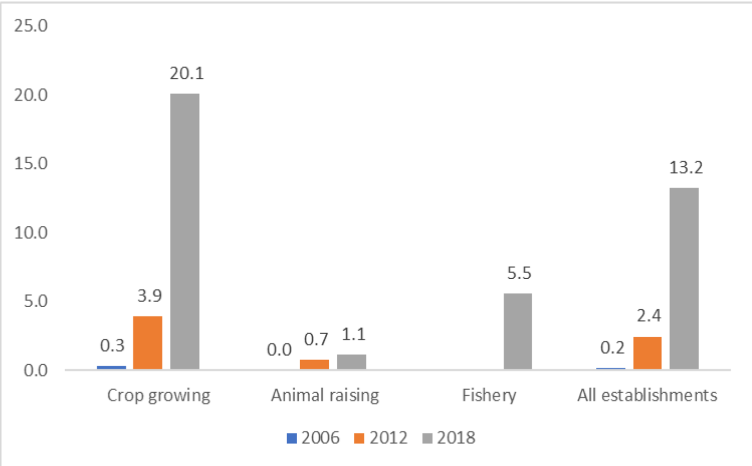
Source: PSA (2022a).

4.2.6. State support indicator

State support in the form of subsidies has been increasing over time, with a heavy concentration on growing crops.

Figure 3 displays the indicator of state support for formal establishments, namely subsidies (normalized to total expenses). Starting from miniscule levels in 2006, support escalated reaching 13.2 percent for all establishments in 2018, with up to 20 percent of average expenses subsidized for crop growing in 2018, followed at a distance by fishery expenses at 5.5 percent. Note however that the mean subsidies is accounted for by only a few establishments, with only 1.1 percent of establishments reporting any subsidy at all in 2018, down from 9.4 percent in 2006. The Census does not break down the subsidy by type (i.e. tax expenditure, input-based payment, etc.).

Figure 3: Subsidies as a share in total expenses for the mean agricultural establishment, by industry group, 2006 – 2018 (%)



Source: PSA (2022a).

4.3. Trends by legal organization of agricultural establishments

4.3.1. Distribution of legal organizations

The most common form of legal organization is the stock corporation, followed by the single proprietorship, with cooperative a distant third.

Table 6 shows the distribution of establishments using the weighted sample observations. Among the legal organizations: across all years, the dominant form is the Stock corporation, followed by Single proprietorship. The cooperative form is third most common; despite its increasing share, the cooperative accounted for only 6.6 percent of formal establishments in agriculture in 2018. The least common form is composed of “Others” (many of which are rural worker associations, which are registered legal entities but with very limited functions).

4.3.2. Financial indicators

Revenue and expense has been decreasing for the average establishment but not for cooperatives and single proprietorships; net revenue has generally been on a decline.

The increasing trend of revenues and expenses per establishments has been carried over only for Single proprietorships and Cooperatives; for the most common form of legal organization, namely the Stock corporation, both indicators have trended downward (Table 9). In common with the average establishment, net revenue has been falling across the various legal organizations, with Cooperatives observing one of the sharpest declines in profitability. Cooperatives on average have smaller revenues, expenses, and net revenues compared with Stock corporations (except net revenue in 2012), but larger than those of single proprietorships.

Table 8: Distribution of establishments, by legal organization, 2006 – 2018 (%)

	2006	2012	2018
Single proprietorship	35.5	32.2	42.7
Partnership	0.6	2.8	0.5
Government corporation	0.1	0.0	0.0
Stock corporation	58.3	57.9	48.4
Other corporation	0.6	0.8	1.2
Cooperative	4.8	5.5	6.6
Others	0.0	0.8	0.7
Total	100.0	100.0	100.0

Source: PSA (2022a).

Table 9: Financial indicators for the mean agricultural establishment, 2006 – 2018 (Php '000, 2012 = 1.00)

	2006	2012	2018
Revenue			
Single proprietorship	10,880	9,406	11,685
Partnership	73,306	5,320	14,151
Government corporation	20,692	-	122
Stock corporation	132,340	100,300	109,140
Other corporations	-	17,279	31,460
Cooperative	34,094	37,647	41,539
Others	46,074	16,038	14,464
Expenses			
Single proprietorship	8,691	8,564	9,945
Partnership	63,053	4,625	13,513
Government corporation	18,338	-	74
Stock corporation	104,976	101,400	96,390
Other corporations	-	16,904	29,647
Cooperative	8,787	33,900	39,350
Others	31,781	15,906	12,569
Net revenue			
Single proprietorship	2,189	830	1,740
Partnership	10,253	628	638
Government corporation	2,354	-	47

	2006	2012	2018
Stock corporation	27,300	-1,350	12,665
Other corporations	-	375	1,813
Cooperative	25,350	3,457	2,189
Others	14,300	132	1,895

Source: PSA (2022a).

4.3.3. Size and productivity indicators

Again consistent with sector trends, number of workers and asset size has been decreasing across various legal organizations; the exception is the rising asset trend for Stock coprorations and Single proprietorships. Among the legal organizations, the share of female workers has increased most among Cooperatives.

Table 10: Size and other indicators for the mean agricultural establishment, by industry sub-group and legal organization, 2006 – 2018

	2006	2012	2018
Number of workers			
Single proprietorship	27.5	33.6	17.7
Partnership	151.4	19.4	13.7
Government corporation	49.0	-	20.0
Stock corporation	190.9	96.2	82.9
Other corporation	93.6	38.6	25.1
Cooperative	152.8	89.0	51.4
Others	-	43.9	15.3
Share of female workers in total			
Single proprietorship	21.8	17.8	22.8
Partnership	21.8	17.6	36.9
Government corporation	26.5	-	50.0
Stock corporation	19.4	21.2	22.6
Other corporation	8.0	23.4	23.1
Cooperative	22.8	29.4	34.0
Others	-	42.6	24.5
Asset value (Php '000, 2012 = 1.00)			
Single proprietorship	5,419	5,788	8,810
Partnership	20,902	2,510	6,213
Government corporation	16,043	0	1,294
Stock corporation	61,992	41,278	73,542
Other corporation	15,688	12,776	10,293
Cooperative	56,698	35,637	18,433
Others	0	10,088	2,850

Source: PSA (2022a).

Productivity patterns and trends are mixed for single proprietorships, stock corporations, and cooperatives.

There is no clear relationship between productivity and legal organization. For instance, value added per worker is larger for Stock corporations than for cooperatives in 2012 and 2015, but not in 2006; the same indicator is smaller for single proprietorships in 2006, but not in 2012 and 2018.

For cooperatives, value added has been increasing, whether on a per worker basis, or per peso asset; however, rate of return on assets has been declining. Meanwhile for Stock corporations, value added has been increasing (whether normalized per worker or per peso), but profitability has been falling. Lastly, for Single proprietorships, value added per worker, and rate of return on assets, has been increasing, but value added per peso asset has moved in reverse direction.

Table 11: Productivity and profitability indicators for the mean agricultural establishment, by legal organization, 2006 - 2018

	2006	2012	2018
Value added per worker (Php '000, 2012 = 1.00)			
Single proprietorship	368.58	175.35	395.28
Partnership	578.16	279.70	229.64
Government corporation	199.53	-	9.44
Stock corporation	790.09	144.59	1210.28
Other corporation	-	56.37	245.24
Cooperative	922.83	142.01	310.91
Others	710.03	-81.82	368.87
Value added per peso asset (%)			
Single proprietorship	6.80	3.03	4.49
Partnership	2.77	11.14	3.70
Government corporation	1.24	-	0.73
Stock corporation	1.27	0.35	1.65
Other corporation	-	0.44	2.38
Cooperative	1.63	0.40	1.69
Others	-	-0.81	12.94
Net revenue per peso asset (%)			
Single proprietorship	1.10	0.24	1.51
Partnership	0.78	0.28	-0.01
Government corporation	0.13	-	0.63
Stock corporation	0.69	0.08	0.23
Other corporation		0.52	0.43
Cooperative	8.00	0.25	1.26
Others	4.25	0.03	0.33

Source: PSA (2022a).

4.3.4. Distribution by industry group

By 2018, the most common legal organization of Crops and Animal raising establishments are Stock corporations, followed by Single proprietorships; Cooperative account for signficant (above 10 percent) share only for Crops.

The share of Stock corporations has been rising over time, across industry groups; similarly the share of Single proprietorships. Cooperatives have not enjoyed similarly signifcant gains in share for Crops and Animal raising, but only for Fisheries (between 2012 and 2018).

Table 12: Distribution of agricultural establishments by industry group and legal organization, 2006 – 2018 (%)

	2006	2012	2018
Crops			
Single proprietorship	33.7	21.3	33.9
Partnership	1.1	2.0	0.0
Government corporation	56.1	-	0.1
Stock corporation	8.3	62.8	49.7
Other corporation	0.9	0.9	0.7
Cooperative	-	12.2	14.2
Others		1.0	1.4
Animal raising			
Single proprietorship	37.8	33.4	46.6
Partnership	0.3	2.2	0.8
Government corporation	61.1		0.0
Stock corporation	0.5	61.3	49.0
Other corporation	0.3	0.8	1.7
Cooperative	-	1.5	1.7
Others		0.9	0.2
Fishery and aquaculture			
Single proprietorship	NA	48.0	46.6
Partnership	NA	5.5	0.3
Government corporation	NA	42.5	-
Stock corporation	NA	0.7	43.0
Other corporation	NA	2.9	0.3
Cooperative	NA	0.5	8.6
Others	NA		1.3

Source: PSA (2022a).

4.3.5. Innovation indicators

Innovation indicators remain low across the various legal organizations; cooperatives have seen a decline in export share and share of R&D expense.

Low levels of innovation for the mean agricultural establishment also characterize the various legal organizations, based on indicators of foreign ownership share, export share, and R&D share (Table 13). Highest foreign equity shares are observed, obviously, for stock corporations; this category also showsn the highest export shares in 2018, although in 2012 it was cooperatives that had the highest export share.

Table 13: Innovation indicators for the mean agricultural establishment, 2006 – 2018 (%)

	2006	2012	2018
Foreign ownership as a share in total equity			
Single proprietorship	NA	0.4	0.5
Partnership	NA	3.2	0.0
Government corporation	NA	0.0	0.0
Stock corporation	NA	4.7	6.0
Other corporation	NA	0.0	0.0
Cooperative	NA	0.6	0.1
Others	NA	0.0	0.0
Exports as a share in total revenue			
Single proprietorship	0.3	1.3	1.6
Partnership	12.5	3.6	0.0
Government corporation	0.0	0.0	0.0
Stock corporation	12.8	6.7	8.0
Other corporation	0.0	0.0	0.0
Cooperative	16.7	18.2	3.8
Others	0.0	0.0	0.0
R&D as a share in total expense			
Single proprietorship	NA	2.3	1.8
Partnership	NA	5.7	0.0
Government corporation	NA	0.0	0.0
Stock corporation	NA	1.0	0.5
Other corporation	NA	4.1	0.0
Cooperative	NA	2.3	1.4
Others	NA	0.0	0.0

Source: PSA (2022a).

4.3.6. State support indicator

State support for privately-owned establishments is insignificant throughout the period.

Figure 3 had already shown weak state support for formal establishments. It turns out that this is in fact concentrated among government corporations, with very little allocated for privately-owned establishments (Table 14). Subsidies as a share in expenses are reported by Government corporations only for 2018, and the share reaches as high as 69 percent. Meanwhile, Others also reaches a high percentage of 48.3 percent in 2018; but we know this legal organization accounts for less than one percent of total establishments throughout the period.

Table 14: Subsidies as a share of expenses, mean agricultural establishment, legal organization (%)

	2006	2012	2018
Single proprietorship	-	-	3.8
Partnership	-	-	
Government corporation	-	-	68.6
Stock corporation	0.0	1.2	0.4
Other corporation	-		
Cooperative	0.6	20.0	1.3
Others	18.8	-	48.3

Source: PSA (2022a).

5. Assessment of scale economies

5.1. Cost comparisons by industry and by size of establishment

There is no consistent relationship between cost share and size indicator of an establishment. Tables 15, 16, and 17 show the cost share of the average establishment by industry and size category based on number of workers. (Comparison was also made using other size indicators such as by category of asset size, and whether revenue is above or below the median, with similar results.) The asterisk marks industries for which cost share of the smallest category present exceeds cost share of the largest category present, consistent with economies of scale. This pattern is found for 7 out of 11 industries in 2006; 10 out of 15 industries in 2012; and only 2 out of 15 industries in 2018. Nor are they the same industries across years; for example, Banana shows economies of scale in 2006, but not in 2012 nor in 2018. Corn, Palay, Sugarcane, Egg production, Ruminants, and All establishments, exhibit scale economies in 2006 and 2012.

Table 15: Mean cost shares by number of workers and by industry, 2006

	0 – 9 (Micro)	10-99 (Small)	100-199 (Medium)	200 and greater (Large)
Banana*	0.85	0.75	0.73	0.75
Chicken	0.83	0.87	0.96	0.88
Corn*	.	0.77	.	0.61
Egg production*	0.95	0.73	0.72	.
Hog	0.62	25.99	0.84	0.88
Other annual*	1.03	0.88	0.78	0.92
Other permanent	0.40	0.55	0.65	0.54
Palay*	0.72	0.55	.	.
Plant propagation	0.50	0.53	0.67	.
Ruminants*	0.85	0.68	.	.
Sugarcane*	0.96	0.47	0.55	0.50
All establishments*	0.73	6.29	0.65	0.61

Source: PSA (2022a).

Table 16: Mean cost shares by number of workers and by industry, 2012

	0 – 9 (Micro)	10-99 (Small)	100-199 (Medium)	200 and greater (Large)
Banana	0.85	0.97	0.99	1.11
Chicken	0.93	0.90	0.95	.
Corn*	9.36	1.04	0.77	0.60
Egg production*	0.97	0.91	0.95	.
Freshwater aquaculture*	1.09	1.22	0.96	0.98
Hog*	1.02	1.88	0.96	0.88
Marine aquaculture	0.91	1.08	.	.
Marine fishing	0.95	0.93	0.98	0.97
Other annual*	2.12	1.15	1.12	0.97
Other permanent*	2.04	1.15	1.62	0.82
Palay*	1.00	0.71	0.87	.
Plant propagation*	1.11	0.55	.	.
Prawn culture	0.82	1.23	.	.
Ruminants*	4.81	1.06	2.64	.
Sugarcane*	1.27	0.92	1.01	0.93
All establishments*	1.37	1.15	1.04	0.98

Source: PSA (2022a).

Table 17: Mean cost shares by number of workers and by industry, 2018

	0 – 9 (Micro)	10-99 (Small)	100-199 (Medium)	200 and greater (Large)
Banana	0.83	0.96	0.97	0.95
Chicken*	1.12	0.84	0.75	0.94
Corn	1.12	0.78	0.99	.
Egg production	0.85	0.90	0.86	0.97
Freshwater aquaculture*	1.05	0.92	0.99	1.03
Hog	0.78	0.83	0.94	0.85
Marine aquaculture	0.86	0.80	1.29	.
Marine fishing	0.81	0.87	1.09	0.95
Other annual	0.87	0.91	0.97	0.87
Other permanent	0.87	0.92	0.79	0.94
Palay	0.83	0.94	.	0.55
Plant propagation	0.68	0.85	0.93	.
Prawn culture	0.92	0.94	0.96	0.98
Ruminants	0.79	0.84	1.00	0.97
Sugarcane	0.87	0.94	0.94	0.94
All establishments	0.91	0.87	0.95	0.93

Source: PSA (2022a).

5.2. Analysis of returns to scale

Among formal agricultural establishments, there is evidence of increasing returns to scale. Results of a least squares regression (with fixed effects by period) are shown in Table 18. The dependent revenue is (natural) log of revenue, whiile logs of workers and assets are among the explanatory variables. Also included are dummy variables for industry (with the category Other industry omitted; dummy variables for legal organization (with the category For-profit organization omitted), and year. The For-profit category covers Sole proprietorships, Partnerships, and Corporations; the dummy variable for Other legal organization codes for Government corporations and Others.

The R^2 and adjusted R^2 are both equal to 0.69, signifying a comfortably high goodness-of-fit. The regression also finds that coefficients for various industries are likewise statistically significant at 5 percent level (except Other annual crops, Ruminants, Marine aquaculture). Several industry coefficients are however negative, i.e. the crops (except Banana). Coefficients that are statistically significant at 5% level for Animal raising and Fisheries are positive. That is crops tend to have lower revenue, other factors constant, compared with the omitted Other industry, while Animal raising and Fisheries tend to have higher revenue.
The key result is that the sum of coefficients for worker and asset variables exceeds unity. The corresponding linear restriction test, that the sum of coefficients is one, yields an F-value of 70.48. The probability of exceeding the critical value is effectively zero, i.e. the null hypothesis that there is a linear restriction on coefficients is rejected. As discussed in Section 3, this implies the presence of increasing returns in the context of a Cobb-Douglas production function.

Table 18: Parameter estimates for model of log revenue, least squares regression

Variable	Coefficient	$P(t>t_{critical})$	95% confidence interval	
			Lower limit	Upper limit
Log Workers	0.850	0.017	0.000	0.816
Log Assets	0.278	0.009	0.000	0.260
Palay	-1.578	0.202	0.000	-1.973
Corn	-0.563	0.265	0.033	-1.082
Sugar	-0.749	0.184	0.000	-1.110
Other annual	-0.334	0.201	0.097	-0.728
Banana	0.424	0.189	0.025	0.053
Other permanent	-0.559	0.191	0.004	-0.934
Ruminants	-0.047	0.219	0.829	-0.477
Hogs	0.822	0.182	0.000	0.465
Chicken	0.709	0.183	0.000	0.350
Egg	0.408	0.189	0.031	0.038
Marine fish	-0.740	0.187	0.000	-1.107
Freshwater fish	0.141	0.199	0.477	-0.249
Marine aquaculture	-0.136	0.281	0.628	-0.688
Prawn aquaculture	0.697	0.239	0.004	0.229
Cooperative	-0.250	0.082	0.002	-0.411
Other legal orgs.	-0.437	0.150	0.004	-0.731
Year 2012	0.318	0.050	0.000	0.220

Variable	Coefficient	P(t>t$_{critical}$)	95% confidence interval	
			Lower limit	Upper limit
Year 2018	0.764	0.053	0.000	0.659
Constant	8.622	0.214	0.000	8.202

Source: Author's regression.

The Breusch-Pagan heteroscedasticity test however finds a value of 210 for the Chi-squared statistic; the probably of exceeding this critical value is also effectively zero. That is the null of constant variance is strongly rejected, rendering the standard error estimates suspect. Table 19 therefore implements the so-called "robust" regression. The coefficient values are identical but the standard errors, confidence intervals, and *P*-values are adjusted by using the Hubert-White "sandwich" estimator for the standard errors. The coefficients for Log workers and Log assets are both still statistically significant at 5 percent level; The same linear restriction test now corresponds to an F-value of 57.6, which is still effectively zero, i.e. the null of equality with one is still strongly rejected.

Table 19: Parameter estimates for model of log revenue, robust regression

Variable	Coefficient	P(t>t$_{critica}$l)	95% confidence interval	
			Lower limit	Upper limit
Log Workers	0.850	0.025	0.000	0.801
Log Assets	0.278	0.019	0.000	0.240
Palay	-1.578	0.233	0.000	-2.034
Corn	-0.563	0.392	0.151	-1.331
Sugar	-0.749	0.194	0.000	-1.129
Other annual	-0.334	0.209	0.110	-0.744
Banana	0.424	0.201	0.035	0.030
Other permanent	-0.559	0.205	0.007	-0.961
Ruminants	-0.047	0.231	0.838	-0.501
Hogs	0.822	0.193	0.000	0.444
Chicken	0.709	0.195	0.000	0.327
Egg	0.408	0.197	0.038	0.022
Marine fish	-0.740	0.199	0.000	-1.130
Freshwater fish	0.141	0.215	0.510	-0.279
Marine aquaculture	-0.136	0.337	0.686	-0.798
Prawn aquaculture	0.697	0.216	0.001	0.274
Cooperative	-0.250	0.101	0.013	-0.447
Other legal orgs.	-0.437	0.187	0.019	-0.803
Year 2012	0.318	0.049	0.000	0.221
Year 2018	0.764	0.054	0.000	0.658
Constant	8.622	0.302	0.000	8.030

Source: Author's regression.

There is little evidence that being a Cooperative matters for generating output from inputs. In the robust regression, the Cooperative dummy has a negative sign, i.e. tends to generate **less** output from a given set of inputs, compared with the omitted for-profit organizations. However, the 95% confident interval goes from -0.447 to 0.019, hence at 5-percent threshold, the hypothesis of a nonzero coefficient cannot be rejected.

6. Conclusion

6.1. Summary

To summarize: based on recent rounds of the CPBI, the study finds:

Hypothesis 1: **Not rejected** - *Over time, the size of the formal agricultural sector has been increasing*, *as well as that of Crops and Animal raising*. However, the average agricultural establishment has been shrinking, implying the sector expansion is the result of entry of new establishments; however, based on average asset size, Animal raisinng and Fishery establishments have been growing.

Hypothesis 2: **Rejected** - *Over time, formal establishments have been showing increasing output per worker, but not profitability, nor innovation*.

Hypothesis 3: **Rejected** – *Government support for privately-owned establishments is insignficant* with no clear trend over time nor preference for legal organization, However, technically, formal establishments as a whole have enjoyed increasing government support, which is heavily concentrated among government corporations.

Hypothesis 4: **Not rejected -** *There exists economies of scale in the formal agricultural sector.* The evidence for this however is not obtained by simple cross-tabulation of cost-to-output indicators by establishment size, but rather by production function analysis.
Hypothesis 5: **Rejected** – *The average number of workers is smaller for cooperatives compared with stock corporations*. However, cooperatives tend to be larger than single proprietorships. Over time, sales and expenses of cooperatives have been increasing, but not number of workers and asset size.

Hypothesis 6: **Rejected** – *No clear patterns around found either for productivity or innovation indicators by legal organization of establishment; for cooperatives, innovation indicators have been declining.*
Hypothesis 7: **Not rejected** –*Cooperatives show a tendency to generate lower output for a given level of factors, but the evidence for this is not firm.*

6.2. Policy implications

1. Government should relax constraints to registration of farm and fishery enterprises as formal establishments.

The study confirms that formal establishments in agriculture have been a growing sector. However, given the persistence of a vast informal family farm and fishery sector, there needs to be a faster transition from informal to formal enterprises. It is possible that cumbersome registration process and requirements is preventing a faster transition. The 2020 Ease of Doing

Business ranked Philippines 171st out of 190 countries in terms of Starting a business. Reforms in business registration is one of the reasons why the Ease of Doing Business law was passed and is now being implemented.

One reason why business registration is low is that the cost of operating a registered business may be relatively high, e.g. tax payment (versus zero for unregistered), and compliance with labor regulations. Currently, retail establishments with 10 or fewer workers, as well as MSMEs affected by pandemic or natural calamity, may apply for exemption from increased minimum wages.[2] However further exemptions for agricultural establishments should be explored.

2. Government should relax constraints to expanding scale of operations in crop cultivation, animal raising, and aquaculture.

Formal establishments in agriculture encounter a number of constraints in expanding their operations, thereby realizing economies of scale. In crop cultivation, a major constraint to expanding farm operations are regulations on the agricultural land market. Several restrictions are imposed by Republic Act (RA) 6657, the Comprehensive Agrarian Reform Law, namely:

- a ceiling on agricultural landholdings of 5 ha;
- redistributed lands are to be amortized for 30 years, during which land is under encumbrance with the Land Bank of the Philippines;
- within ten years of redistribution, land may not be transferred or sold except to an heir or to another agrarian reform beneficiary.

Meanwhile for animal raising, zoning regulations of local government units (LGUs) tend to restrict operation and expansion of livestock enterprises (Briones and Espineli, 2021). Lastly for brackishwater aquaculture, the Bureau of Fisheries and Aquatic Resources (BFAR) is responsible for providing fisheries lease agreements (FLAs), hence the ability of operators to expand is limited by the liberality or strictness of BFAR bureaucrats. Address credit issues to finance fixed and working capital.

Another constraint to operation is difficulty in accessing credit. It is well known that commercial banks in the Philippines are conservative in their risk assessment of agricultural operators; this may prevent them from obtaining the requisite finance for expanding their fixed and working capital.

3. Government should explore provision of performance-based subsidies in support of economies of scale.

The study has found that, notwithstanding pronouncements of state support for agri-fishery enterprises, such as expressed in the Sagip-Saka Act (RA 11321), support in the form of subsidies is nearly absent. Obviously, the provision of wasteful doleouts should be avoided;

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[2] https://www.dole.gov.ph/news/micro-in-retail-service-biz-pandemic-hit-firms-may-apply-for-exemption-from-wage-hike/

what is needed rather are performance-based subsidies, conditional on modernization, professionalization, and ultimately expansion of the business.

4. Deeper study on the correlates of productivity, innovation, and profitability of agricultural cooperatives should be conducted.

The study has admittedly failed to support hypothesis related to the favorable role of cooperatives in facilitating inclusion of smallholders in modern agriculture. However the study can only lump together cooperatives as a whole, whereas there may be distinctions among cooperatives that may qualify this negative finding. The AFMA itself (Section 3) posits that cooperatives should be enabled to benefit from "a stronger negotiating position, pursue more focused, efficient, and appropriate research and development efforts and enable them to hire more professional managers." The importance of professional management is also highlighted in Songco (2021) as an essential trait for cooperatives to participate in modern agricultural value chains. This links as well to the presence of economies of scale; a professional management team involves a significant overhead cost, which can only be paid for by a sufficiently large scale of operations. It may well be that cooperatives with professionalized management, functional management systems, and other related indicators, will exhibit the favorable productivity, innovation, and profitability indicators predicted in this study.

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