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Give a Man a Fishpond: Modeling the Impacts of Aquaculture in the Rural Economy

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ABSTRACT

The rapid growth of fish farming over the past three decades has generated heated debate over the role of aquaculture in rural development and poverty reduction. Central to these debates is the question of whether and how aquaculture impacts local incomes and employment, yet little empirical evidence exists on the issue. To address this question, we propose a Local Economy-wide Impact Evaluation (LEWIE) model which nests fish farm models within a general-equilibrium model of their local economy. The model is calibrated using primary data collected from 1102 households in Myanmar's main aquaculture zone, representative of 60% of the country's aquaculture farms. Using this model, we examine the impact of aquaculture on the incomes and labor market outcomes of fish farming households, but also crop farms and non-farm households in the cluster. Simulating one-acre increases in pond/plot surface we find that: (1) aquaculture generates much higher incomes per-acre than agriculture; (2) aquaculture generates larger income spillovers than agriculture for non-farm households by way of retail and labor markets; (3) small commercial fish farms generate greater spillovers than large fish farms. These results bolster the notion that fish-farming, and in particular small-scale commercial aquaculture, may have a significant role to play in rural development and poverty reduction.

"Give a woman a fish and you feed her for a day. Give her a fishpond, and you may generate income spillovers for the whole village."

1. Introduction

Aquaculture (fish farming) has been the world's most rapidly growing food production subsector for the past three decades, and now generates more than half the fish destined for direct human consumption (FAO, 2016). The aquaculture sector's rise to global significance has seen an explosion of interest in its potential to stimulate economic growth and reduce poverty in developing countries, where most fish farming is concentrated. However, the literature lacks both a consistent theoretical framework and a compelling body of empirical evidence evaluating the contributions of aquaculture to rural economic development (Arthur, Béné, Leschen, & Little, 2013; Béné et al., 2016). This article's objective is to address this gap, using a rigorous empirically grounded evaluation methodology (Local Economy Wide Impact Evaluation) founded on a well-established body of economic literature (Filipski, Taylor, Thome, & Davis, 2015; Taylor and Filipski, 2014; Taylor, 2013; Thome, Filipski, Kagin, Taylor, & Davis, 2013), to estimate the economic impacts of aquaculture in a rural economy, including indirect impacts through input and factor markets.

Two main 'strands' are evident in the literature linking aquaculture with poverty reduction. We call the first the "small-scale" narrative. This emphasizes the direct benefits that resource-poor farming households may gain by producing fish for home consumption using simple low input technologies, and selling surplus to earn supplemental income. This narrative is present in the earliest work linking aquaculture and poverty (eg. Ahmed & Lorica, 2002; Edwards, 1999; Edwards, Little, & Demaine, 2002). It has been the dominant theme in the literature since this time (e.g. Bondad-Reantaso & Subasinghe, 2013) and continues to be widely espoused (eg. Golden et al., 2016).

We label the second strand the "SME" (Small and Medium Enterprise) narrative. This diverges from the small-scale narrative on two empirical observations: (1) aquaculture's rapid growth in

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Asia (and more recently Africa) has been driven overwhelmingly by the investments of commercially oriented farmers and supporting off-farm enterprises, employing a mix of capital intensive, productive, and increasingly sophisticated technologies (Belton & Little, 2011; Brummett, Gockowski, Pouomogne, & Muir, 2011; Hernandez, Belton, Reardon, Hu, & Ahmed, 2017; Belton, Bush, & Little, 2017); (2) the poorest households in communities where fish farming occurs rarely have sufficient resources to participate in aquaculture directly as producers, but are able to obtain benefit from the sector through employment linkages (Belton, Haque & Little, 2012).

Unlike the small-scale aquaculture literature, which emphasizes the direct benefits derived from small-scale, semi-subsistence fish farming by producers, the SME narrative infers that a large part of aquaculture's contribution to poverty reduction is indirect; resulting from business opportunities and employment created both on- and off-farm. Though not always explicitly framed in such terms, the SME narrative reflects the idea (well-established in agricultural and development economics), that rural growth linkages are a key mechanism by which poverty is reduced (Haggblade & Hazell, 1989; Mellor, 1986).

Growth linkages occur when growth in one segment of the economy generates spillovers to other segments via the interconnectedness of production, consumption, and employment markets, in what Dorward, Poole, Morrison, Kydd, and Urey (2003) refer to as a 'virtuous circle'. In the context of agriculture, spillovers happen when profits or wages earned from farming or related work are spent on productive investments or consumption. This creates demand for additional goods, services and labor, which in turn create further cascading demand for goods, services and labor.

For instance, farms often demand services and intermediate inputs produced by non-farm enterprises ('production linkages'). In addition to generating income for their owners, these enterprises can provide employment and income-earning opportunities for the poor (Haggblade & Hazell, 1989). Similarly, demand created when farm households or workers spend profits and incomes on consumption goods (food, clothing, transport, leisure activities, etc.) creates 'consumption linkages'. These linkages tend to strengthen as agricultural income grows (Haggblade, Hazell, & Dorosh, 2007).

Households operating small to medium-sized farms have favorable expenditure patterns for promoting growth in the local non-farm economy because they typically spend higher shares of incremental income gained on locally produced 'non-tradable' goods and labor-intensive services than large farms (Diao, Hazell, & Thurlow, 2010). Commercially oriented forms of aquaculture often require significant inputs of labor and other production inputs and are capable of generating much higher returns than staple crops such as rice (Belton, Ahmed, & Murshed-e-Jahan, 2015). Together, these facts suggest that small- and medium-scale commercial aquaculture has the potential to create denser rural growth linkages than either traditional crop agriculture or large scale aquaculture. This hypothesis informs all subsequent analysis in this paper.

A handful of previous studies have attempted to analyze indicators of the extent and size of production, consumption and employment linkages associated with aquaculture. Taken together, their results suggest the following points: (1) The indirect poverty impacts of aquaculture tend to be larger than the direct impacts (Belton, Haque, & Little, 2012; Kassam & Dorward, 2017); (2) Commercial aquaculture can create employment linkages that are greater than those associated with crop farming (Belton, Ahmed et al., 2015; Belton, Hein et al., 2017), and these employment linkages can be poverty and income inequality reducing (Irz, Stevenson, Tanoy, Villarante, & Morissens, 2007); (3) Small commercial fish farms may create larger multipliers of all types than small non-commercial or large commercial farms (Belton et al., 2012; Kassam & Dorward, 2017).[1]

However, the generalizability and comparability of results from these studies is limited by their deployment of varied methodologies, limitations in the size, representativeness and quality in the data utilized, the context specificity of the cases selected, and differences in the way in which growth linkages are conceived, evaluated or inferred. Béné et al. (2016) provide a similar critique of the broader literature linking aquaculture and poverty reduction. As Allison (2011) notes, "there is little direct quantitative evidence of the size of growth-multiplier effects from fisheries and aquaculture development" – this article provides some.

The present paper makes a methodological and empirical contribution to the literature by modelling production, consumption and employment linkages within the boundaries of a clearly defined rural economy[2] in Myanmar, using a large dataset (n = 1102) collected specifically for this purpose and statistically representative of nearly half of all aquaculture ponds in Myanmar (42%). We construct a local economy-wide impact evaluation (LEWIE) model of the areas surveyed, delineating how fish farms and crop farms interact with each other and with other local economic actors (Taylor, 2013; Thome et al., 2013). We use the model to perform simulations that evaluate the full economic contributions of crop farms, and fish farms of different sizes. This approach allows us to: (1) quantify growth linkages associated with aquaculture, and compare these with linkages created by crop agriculture; (2) analyze differences in the size and type of linkages created by small-scale and large-scale aquaculture farms, and; (3) assess shifts in income (in) equality associated with the growth of each of these activities.

By simulating a one-acre increase in the land (or pond) holdings of different types of household, we find that aquaculture: (1) produces higher overall incomes than agriculture on a per-acre basis; (2) generates higher income spillovers in the local economy. Fish ponds generate spillovers that are large relative to their direct impact (being of equal or slightly greater monetary value). We also find that small fish farms (defined as under 10 acres) generate higher spillovers than large fish farms (>10 acres), and that an increase in small fish farm area reduces local income inequality, while large farm growth raises inequality. These results highlight the importance of using an economy-wide lens when examining the role of fish-farms in rural development and poverty reduction, and resonate strongly with the SME narrative on aquaculture development.

The findings also contribute to ongoing policy debates in Myanmar. Myanmar's agricultural policy has historically favored the establishment of very large fish farms by granting land concessions. At the same time, strict regulations governing agricultural land use have slowed smallholder-led fish farm development. As a result, the majority of farm area and output in Myanmar is concentrated among large farms (Belton, Hein et al., 2017). Shifting policy priorities following Myanmar's democratization in 2016 mean that agricultural diversification beyond the staple rice is now encouraged, but restrictions on the conversion of agricultural

[1] (Stanley 2003) presents evidence suggesting that export-oriented aquaculture may generate relatively small backward production linkages and large forward production linkages, though this is beyond the scope of our analysis in this paper.

[2] Although the aquaculture cluster is close to Yangon as the crow flies, and the existence of water transport links to the city play an important role in its location (Belton et al. 2017), it possesses few of the characteristics of commonly associated with *peri*-urban areas (Little and Bunting 2005). For example, research on which this paper is based showed that there is little in the way of mixed land use (agricultural, industrial, commercial, leisure) that characterizes the *peri*-urban zones surrounding most major Southeast Asian cities. In addition, infrastructure and connectivity is very limited; the average distance from surveyed villages to the nearest paved road is 3.1 miles, 68% of surveyed communities could not be reached by road during monsoon season, and 88% had no electricity connection.