PROJECT POLICY BRIEF

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Nutrition Demand, Subsistence Farming, and Agricultural Productivity

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In many of the poorest countries, agriculture is unproductive and subsistence farming is widespread. I propose nutrition demand as a mechanism that can explain what subsistence farmers in low-income countries choose to consume and grow on their land, and that ultimately contributes to keeping the productivity of the whole agricultural sector low. I use Malawian household-level data to document that the smallest farmers focus their consumption and subsistence production on obtaining calories, medium farmers diversify both their diet and their subsistence production, and the largest farmers commercialize their farms. Next, I build a quantitative model where farmers face explicit caloric needs. The model reproduces the new facts and suggests that allowing farmers to even partly leave subsistence and commercialize would raise the productivity of Malawi's agricultural sector by over 40%.

Introduction

Some of the poorest countries in the world are still dominated by agriculture, which tends to be extremely unproductive. In Malawi, for example, 76% of workers labor in the agricultural sector, yet they produce only 23% of the nation's GDP (World Development Indicators). The low agricultural productivity in low-income countries is puzzling but crucial in understanding the enormous income differences across countries (Gollin, Lagakos, and Waugh 2014). A frequent feature of unproductive agricultural sectors is the prevalence of subsistence farming: severe market frictions forcing households to rely on their own production, not the market, for the food they need. In this project, I explore whether the production decisions of subsistence farmers are relevant for understanding the aggregate agricultural productivity level of low-income countries.

Malawi is one of the poorest countries in the world. Most of its population is engaged in agriculture, and 79% of all households operate their own farm. The median farm is only 1.2 acres large: compare it to the median US farm's 45 acres (MacDonald, Korb, and Hoppe 2013). Malawian households operate farms on a tiny scale, but despite their size, they are of significant economic relevance to the families that operate them. Using the survey data described below, I find that, on average, 36% of the calories consumed by a household were grown on its on own farm. And, in fact, serving the family's table tends to be the primary purpose of the farm: more than half of all farmers sell none of their agricultural output. While Malawi may be a particularly severe case, subsistence farming is common to most low-income countries, especially in Sub-Saharan Africa and South-East Asia.

Data and methodology

For the empirical analysis, I use the Fourth Integrated Household Survey 2016/17, conducted by the National Statistical Office of the government of Malawi with assistance from the World Bank. It is a nationally representative survey that covers many aspects of household economic behavior. Of the 12,447 Malawian households surveyed, 9,799 (79%) reported producing agricultural goods on their own farm in the past year: it is this sample of farm-operating households that I use for my analysis. I construct measures of household consumption and production of individual agricultural goods. Merging this data with the Malawian Food Composition Table (van Graan et al. 2019), the Tanzanian Food Composition Table (Lukmanji et al. 2008), the FAO/INFOODS Density Database (Charrondiere, Haytowitz, and Stadlmayr 2012), FAO's Human Energy Requirements (FAO 2004), and the Dietary Guidelines for Americans (USDA and HHS 2020), I am able to construct household-level calorie and nutrient requirements as well as household-level calorie and nutrient intakes. I conduct a series of empirical exercises in this Malawian data to explore the relationship between a household's farm production behavior and its food consumption behavior.

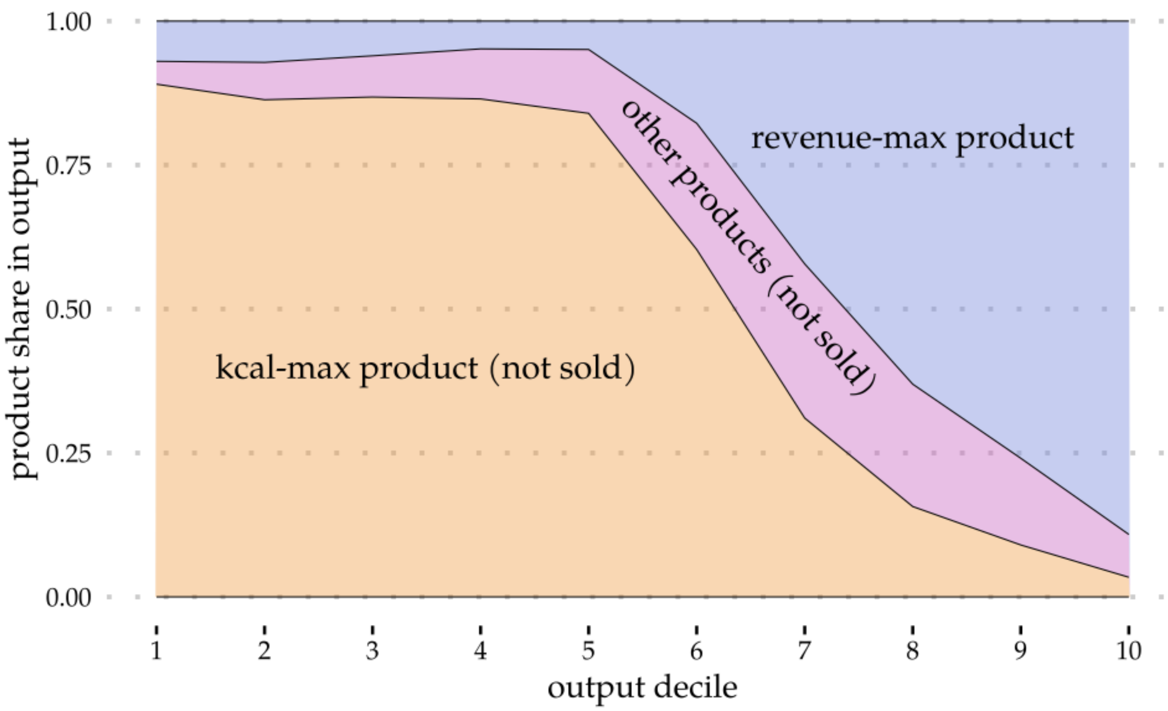
The main contribution of the paper is in the quantitative model I develop. Its objective is twofold: to explain the observed behavior of Malawian farmers with economic mechanisms and to provide an estimate of the importance of this behavior for the aggregate productivity of the whole agricultural sector. The model is populated with households that operate their own farms, face costly trade with other farmers, and have explicit caloric needs, which is the main novel feature of the model. Each household can engage in farming and jointly makes consumption, production, and trading decisions over many agricultural goods, which differ in their productivity and caloric content.

Results

First, I document that the consumption, production, and selling behavior of farmers is dependent on the scale of their farms. Smallest farmers specialize their consumption in obtaining calories and specialize their production in subsistence production of maize: they usually sell none of their harvest. Medium farmers diversify their diets among a broader selection of foods , and likewise they diversify their subsistence production among a broader selection of agricultural products grown for the family's table. Finally, large farmers commercialize their production: they tend to specialize in a single product (often a cash crop like tobacco) that they mostly sell on the market. This is visually represented in Figure 1 below.

I find that the quantitative model I develop is able to explain these findings. The explicit caloric needs that model farmers face make their consumption behavior depend on their nutritional situation. Furthermore, the fact that trade between farmers is costly makes the nutritional situation of the household relevant for what it ends up producing on its farm. The combination of these two features reproduces the observed scale dependence and provides an economic explanation for it.

Figure 1: Farm size and product choice model



NOTE. Products are split into groups at farm level. "kcal-max product (not sold)" is the $\arg\max_i k_i z_{h,i}$ good, unless it's the same as the $\arg\max_i p_i z_{h,i}$ and is sold. "revenue-max product" is the $\arg\max_i p_i z_{h,i}$ good, unless it's the same as the $\arg\max_i k_i z_{h,i}$ and is not sold. "other products (not sold)" are all other goods. Product shares are the output value shares of each product group in the decile-level output value. Farms are grouped into deciles by output market value relative to caloric requirement.

The poorest farmers struggle to satisfy their most basic need for dietary energy, consequently specializing both their consumption and production in the most efficient sources of calories. Farmers that are able to cover most of their caloric needs can afford to diversify their diet to satisfy their love of variety in food, which they partly achieve by diversifying their production. Finally, the largest farmers easily satisfy their caloric needs, permitting them to increase the share of purchased non-food goods in their consumption, which requires growing and selling the product that can fetch them the highest price on the market. Therefore, I contribute to the literature by showing that farmers' nutritional needs in the presence of costly domestic trade can explain several salient patterns in farmer food consumption, product choice, and selling behavior that commonly used existing models are unable to reproduce simultaneously.

After establishing the caloric needs model's ability to explain the observed behavior of individual farmers, I use this model to test the importance of nutrition demand-driven product choice by subsistence farmers for keeping the agricultural productivity of Malawi low. The model suggests that a reduction in trade costs sufficient to allow Malawian farmers to increase the average share of farm output sold from the currently observed 16% to a counterfactual 50% (an intermediate point between full subsistence and fully commercial farming) would raise the output of Malawi's agricultural sector by 42%. Just over half of this gain happens because falling trade costs allow farmers to grow and sell products they are best at to buy products their family wants to eat – rather than having to grow most of what the family wants to eat on their own land. The productivity and the consumption of the smallest farmers, who are the most calorically constrained, respond the most to falling trade costs. The remaining half of the agricultural sector's output gain is caused by a mechanical reduction in trade cost losses happening between the harvesting of a crop and its ultimate consumption (if the two do not take place on the same farm). Thus, the model suggests *that the limited extent of agricultural trade between Malawian farmers is a significant drag on the productivity of the agricultural sector, and the misalignment between what farmers currently grow and what they are good at growing is a big contributor to that.*

Policy impact

The project reinforces the importance of facilitating market access for smallholder farmers. According to the mechanism explored in the project, allowing farmers better access to agricultural markets would permit them to exploit the strengths of the technology and land available to them, and would let the economy produce significantly more agricultural output using the same agricultural technology.

A follow-up project I am planning to undertake next will lead to more actionable and specific policy implications, and will involve direct interactions with policymakers. The model I developed in the current project is well suited for analyzing the nutritionally sensitive policies targeting smallholder farmers, which are at the center of the welfare programs in many low-income countries, including Malawi. For instance, much of Malawi's agricultural policy has revolved around supporting smallholder farmers in the production of staples or, to a lesser extent, tobacco (Levy 2005; Chibwana et al. 2014). Meanwhile, some researchers argue that promoting biodiversity can be a more effective way of bolstering the food security of smallholder farmers (Jones 2017; Pingali and Sunder 2017).

Since the model this project developed combines explicit nutritional needs with farm product choice that aims to fulfill those needs, it can be used to predict and compare the effects of encouraging staples, cash crops, or biodiversity. Because the model captures the trade-off between calories, dietary diversity, and commercial production, it would be able to say which farmers are likely to benefit from a given policy and which are likely to be harmed, covering not only economic, but also nutritional outcomes. I anticipate this follow-up project to involve significant interactions with policymakers: both in soliciting their input on the representation of existing policies in the model and in mapping the model's predictions to concrete policy recommendations.

Moving forward

In addition to the policy-oriented follow-up project described above, there are two fruitful extensions of this paper's analysis.

The first is allowing farmers in the model to choose how to allocate their time between working on the family farm, working for wages on someone else's farm, or working for wages in the non-agricultural sector. This extension would make the model useful for studying structural transformation (the reallocation of economic activity between sectors with economic development) both within the agricultural sector and across sectors on the path of development, potentially adding nuance to both dimensions. The extended model's predictions can then be compared to empirical observations and used to derive lessons on the structural transformation of low-income economies.

The second extension is modeling risk. Making harvests and market prices in the model volatile would permit the study of the interaction of riskiness and nutritional concerns in driving the product choice of farmers. This should allow the model to better fit the data: currently, the model overpredicts the degree of specialization of the smallest farmers and the contrast in commercialization between small and large farmers. Adding risk would make the smallest farmers averse to putting all of their eggs into one basket (due to the risk of starvation if a single crop's harvest fails) and would give sellers incentive to reserve some of their farm for subsistence production (due to the risk of a large drop in cash crop market prices): both of these effects would bring the model closer to what's observed in the data, making the model's predictions even more reliable.

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