



Measurement, Farm Size and Productivity

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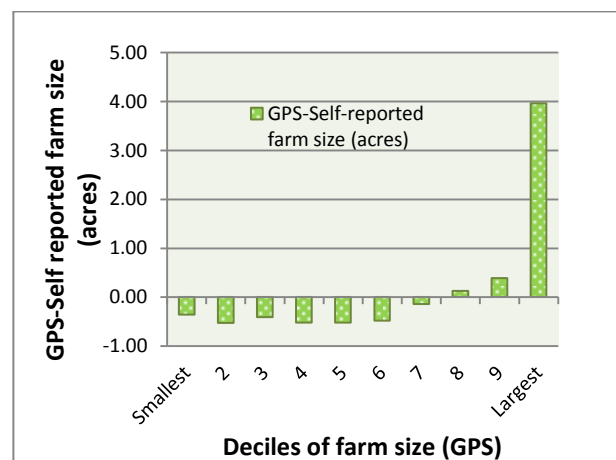
Agricultural economists have long debated the efficiency and viability of smallholder agriculture. While much research has shown that small farmers in developing regions are often more efficient than larger farmers, some have challenged the validity of that evidence, citing potential problems that come with farmers' self-reporting of land size. If smaller farmers systematically under-report the size of their plots, one would observe higher levels of production per unit of land that are not linked with efficiency in the production process, but to a failure to properly account for the quantity of land they actually use.

In this paper, measurements of land size collected via Global Positioning System (GPS) devices are used alongside farmers' estimates to test the validity of that critique. The main result of the analysis is that more accurate measurement of farmers' plots if anything reinforces, rather than weakening, the existing evidence of an inverse farm size-productivity relationship.

Fact or Artifact?

Starting with the seminal work of Sen in the 1960's, who observed an inverse relationship (IR) between farm size and output per hectare in Indian agriculture, a large number of empirical studies have presented evidence that appears to corroborate that hypothesis. A smaller set of studies has challenged the validity of that evidence, however, claiming that the observed IR is in fact a mere statistical artifact stemming from the failure to control for unobserved differences

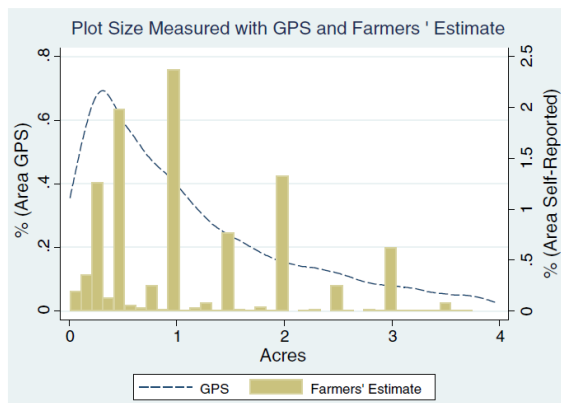
in land quality attributes, or from systematic errors in land measurement. The land quality argument was debunked in a 2010 article by Chris Barrett using laboratory soil testing to control for land quality attributes. This paper revisits the land measurement aspect of the controversy by working with data from the 2005 Uganda National Household Survey to compare farmers' own estimates to land measurements taken using GPS devices. For the IR to be partially or fully explained by errors in land measurement, smaller farmers would have to systematically over-report land area with respect to larger farmers.



However, contrary to the expectations implicit in the 'measurement error' criticism of the inverse farm-size productivity relationship, we find that small farmers tend to systematically under-report the size of their plots, and it is only among the top three landholding deciles that farmers tend to over-report farm size. This is clearly shown above, where the difference between the GPS measure and the farmers' self-reported farm size is plotted against 10 deciles of farm size, from the smallest to the largest.

One additional issue in our data is the considerable tendency of respondents (or

enumerators) to round their reported plot size to the nearest acre or half acre. This 'heaping' in the response pattern is not uncommon but it may be particularly important in the case of land measurement, since it is bound to matter proportionally more to the left of the distribution, as the same amount of rounding represents a larger percentage of the actual size.



Source: Authors' calculations based on UNHS 2005

The figure above also shows how the means are not very different, but at specific points the distributions deviate considerably, in a way that appears to be driven by heaping in the self-reporting distribution as opposed to a smooth curve for the GPS measure. Finally, the comparison of the two distributions lends support to the case for treating the GPS measure as the more accurate of the two.

How Does Using GPS Affect Yield Estimates?

The systematic patterns in the difference between land measurements we have observed above have the potential to introduce a bias in the estimation of agricultural/land productivity. If small farmers report to be cultivating more land than they actually are, their 'true' yields are actually even larger than what one would compute using self-reported land quantities.

Output Per Acre and Farm Size

	Yields		Bias
	GPS	Self-reported	(GPS minus self-report)
	US\$/acre	US\$/acre	%
Small	236	170	28%
Medium	208	193	7%
Large	77	100	-30%

The above table summarizes level of output per acre computed using GPS and self-reported land

areas. Farms are categorized as small, medium or large. Small farms, those cultivating landholdings smaller than 1.45 acres, exhibit systematically higher yields when area cultivated is measured via GPS as compared to self-reporting. The difference is reduced for medium farms, whereas large farms have lower yields measured with GPS than those obtained through farmers' estimates.

To go beyond these simple, yet telling, descriptives we estimated two versions of a standard model used to estimate the farm-size productivity relationship, one using GPS and the other one with the self-reported land measure. Both estimates supported the IR hypothesis. When more accurate land measures are used thanks to the introduction of GPS devices, the estimated slope of the function becomes steeper, indicating an even stronger IR than what one would conclude based on similar estimates performed using farmers' self-reporting.

Key Messages

The hypothesis according to which the IR would be a statistical artifact due to small farmers under-reporting their farm size is strongly rejected by the data. In our sample, small farmers in fact over-report land size, and it is the large farmers who are actually more likely to underestimate their holdings, which results in artificially higher yields.

This has clear practical implications for policymakers, as it suggests that: (1) policies that enable the small farm sector to realize its full potential may be justified by efficiency, as well as equity considerations; and (2) it is unlikely that the small-farm sector will rapidly disappear because of the inefficiency claims alleged by some analysts. The study also shows that the GPS technology clearly holds promise for improving the accuracy in the collection of land size measures in the context of large household surveys.

This brief is based on: Carletto, Calogero, Sara Savastano and Alberto Zezza (2013). Fact or artifact: The impact of measurement errors on the farm size-productivity relationship. *Journal of Development Economics*, Vol. 103, pp. 254-261.

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