Report on "The role of land in temperate and tropical agriculture", MS#9485

Summary of Paper

This paper neatly blends simple theory and empirics to provide a new approach to estimating the elasticity of agricultural output with respect to land. The authors show that, provided the agricultural production function is fixed within a province, capital and labour mobile, and the aggregate agricultural production function has constant returns to scale in capital, labour and land, the elasticity of agricultural output can be estimated on within-"province" data by regressing the ratio of labour to land on agricultural TFP.

To obtain estimates of agricultural TFP, the authors use GAEZ data on crop productivity to estimate the calorific potential of the land in each district following Galor and Ozak (2016), albeit using a different subset of crops. Estimates of population are obtained from a variety of sources. The authors estimate separate elasticities of agricultural output with respect to the supply of land for tropical and temperate areas (as defined by the type of crops grown, or whether an area is frost free), finding that the elasticity of agricultural output is higher in temperate areas than tropical areas. They go on to use a two-sector model to show that an implication of this is that output per capita should respond more strongly to changes in population or technology in areas with lower elasticity. Lastly the authors estimate country specific elasticities of agricultural output with respect to land and use them to show that - as predicted by their model - the negative impact of the epidemiological transition on the living standards of survivors is larger in countries with a stronger elasticity of agricultural output to land.

Comments

1. Are returns to capital and labour really equalised across space? Because the analysis in the paper is primarily cross-sectional - based on the correlation between population density and agricultural productivity - it relies heavily on theory to give meaning to the results. As discussed above, this theory relies on the assumption that wages and returns to capital are equalised across space, however, a body of recent literature strongly indicates that this may not be the case either for labour markets (e.g. Bustos et al., 2016; Gollin et al., 2013; Munshi & Rosenzweig, 2016) or for capital markets (e.g. Bustos et al., 2017; Marden, 2017) in developing countries. It is unclear to me what the implications of allowing the real wage and cost of capital to vary over space for the results of the paper. It seems plausible that we would still expect a stronger correlation between population density and agricultural productivity in areas with a higher elasticity of output with respect to land – and this is consistent with the authors panel results - but it seems unlikely that this elasticity is would still be the estimated coefficient. It's possible that a richer model could bound and or sign the degree of bias from this type of misallocation, which would help generalise the results.

An empirical analysis restricted to countries and regions where capital and labour markets worked effectively could allay these concerns. Unfortunately, the lack of a material number of tropical regions in developed countries limits the scope for such an exercise. Moreover, the

elasticity of agricultural output with respect to land is surely of greater interest in developing countries.

2. Population data. The authors main source of population data is HYDE data which interpolates population data to provide a global gridded population data set. The authors use this data to create a global dataset of "district" level population using 2nd level administrative boundaries map of administrative boundaries.

As the authors make clear, the interpolation algorithm used to construct the HYDE data uses land-productivity as an input. To avoid estimating the interpolation algorithm, the authors conduct their analysis not at the grid-cell level but at the district level. This is only sufficient, if the data population data underlying HYDE is also at the district level, but this doesn't appear to be the case. Popustat, the input to HYDE cited in Goldwijk et al. (2011), often provides population data for higher level administrative regions than those used in the paper, so at the level of aggregation used in the paper, the authors may still be "estimating the algorithm" – exactly as they were attempting to avoid doing. In practice, it may be that this issue is mitigated for more recent periods by HYDE's use of Landscan population density patterns (which I am not familiar with), but this issue deserves further consideration.

The authors also present results result based on two other population data sources. Gridded "GRUMP" data and non-gridded IPUMS census data. I don't know enough about GRUMP to comment on its suitability for the authors purpose and the extent to which similar issues of "estimating the algorithm" are likely to arise. However, the use of IPUMS data seems clearly preferable to the use of interpolated data where possible, and unless the case for the use of interpolated can be made much more convincingly, using the IPUMS data as the principle data-set would make the results more convincing. The drawback would be to limit geographic coverage, but GRUMP and HYDE used to validate the results for the rest of the world.

When the authors use the IPUMS data, they obtain quite different results – there is no relationship between agricultural population density and productivity in the tropics if the IPUMS data is used (although the differential with temperate regions remains). The sample of districts in IPUMS is quite different so it is unclear whether this difference is due to the sample or the data source. The authors could reassure the reader as to the validity, or not, of the interpolated data by using the same sample for all data sources.

4. Panel Estimation. Given the necessarily small sample of countries, the evidence from the panel analysis, which interacts the elasticity of land to agricultural output and shows, is interesting but hardly determinative. The set of countries, and their associated elasticities, should be provided so as to help the reader assess the extent, or not, that other factors could plausibly be driving this relationship.

4.Appendix. The paper makes references to an Appendix that was not supplied with the paper and I have not been able to review as it was not obviously available on the authors websites. This means I have not, for example, reviewed the algebra feeding in to section 4.1. It may be that this was lost in the editorial system.

5.Standard errors. As a robustness check, standard errors should be clustered by country as an alternative to Conley errors as, in my experience, clustered errors tend to be a bit more conservative when specified at an appropriate geographic unit. This seems unlikely to affect the results, so could simply be flagged on page 8 (rather than providing an additional set of tables).

6. Visual Aids. I would have found it helpful to have more visual aids to help understand where the variation in productivity and population density that exist were to be found, and where in the world high elasticities of agricultural output with respect to land would be found.

7. Ruggedness. Slope and elevation are inputs to the GAEZ data, with more rugged areas tending to have lower agricultural productivity. Because ruggedness also impacts trade costs, it has the scope to affect the population-to-land ratio independently of its affect through land productivity (less rugged areas may be more intensively farmed holding productivity constant). The relationship may vary by crop and by region, so the authors should include an additional robustness check controlling for ruggedness.

8.Typos. The equation number identifying the wage definition at the bottom of page 5 should say (2) not (3). There is a “see: that should read “seen” at the top of page 24. (This is probably not a complete list.)

Bibliography.

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