

Researcher

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How Substitutable Are Fixed Factors in Production? Evidence From Preindustrial England

The extent to which fixed factors of production, such as land, constrain per capita income growth has historically been a widely discussed topic in economics since Malthus (1798). Whether fixed factors limit growth critically depends on two variables: the substitutability of fixed factors in production, and the extent to which innovation will be biased toward land-saving technologies. However, there are few estimates of either variable, and most models assume this elasticity of substitution is unity out of convenience. This paper attempts to fill that gap in the literature. Using the timing of plague epidemics as an instrument for labor supply, this paper estimates the elasticity of substitution between fixed factors and nonfixed factors in preindustrial England. I find that the elasticity of substitution between land and other factors during this period was significantly less than one, which implies that the Malthusian effects of population on income were stronger than current models predict. In addition, I am able to estimate the direction and magnitude of induced innovation. I find evidence that denser populations—and hence less availability of land—induced innovation toward land-saving technologies. Specifically, I find that a doubling of population density in England from its year-1500 level increases the difference in the growth rates of land-enhancing and labor-enhancing productivity by 0.22 percent per year.

Country where the research will take place

England

How does the research describe the impact of population/reproductive health on poverty reduction and/or economic growth?

The extent to which land can be substituted in production with other factors such as labor, capital, and fertilizer directly affects how large the negative effect of population growth will be on income per capita. For example, if it is difficult to substitute other factors of production for land, then output per person will be almost directly linked to the quantity of land used to produce output. In light of population growth, land per person must decrease, and production per person must also decrease. If land is easily substitutable, then production can be easily increased to its previous level by adding capital, fertilizer, or other productive factors. This paper quantifies this land substitutability in a closed, agricultural economy.

How will the research address a policy need, and what kind of policy lesson is expected?

Knowing the elasticity of substitution between land and other factors will be critical for policymakers to understand the extent of the negative effect of population growth on income per capita. High substitutability will mean that pro-

grams which lower population growth (such as interventions to reduce fertility) will have a small effect on income, while a low substitutability will mean that such programs can potentially increase income per capita by a large amount.

Methods used

I use an instrumental variable regression approach to estimate the elasticity. From a simple constant elasticity of substitution production function, I derive a regression equation with the ratio of factor rents (wages and land) as the dependent variable and the land-to-labor ratio as the independent variable and solve the problem of endogeneity. An instrument for the land-to-labor ratio is needed, and so I use the timing of plague epidemics.

Data used

I use data on factor rents in preindustrial England (years 1200 to 1750) from Clark, and data on population from Wrigley and Schofield.

Research results

I find that the elasticity of substitution is less than one, lower than currently estimated. Insofar as my results are valid in today's developing world, the implication is that policies that reduce population growth have the potential to increase income per capita more than is believed.