



Human capital and the switch from agriculture to industry

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Abstract

Endogenous technological change explains the transition from agriculture to industry. Initial production is agricultural. Human capital accumulation causes the economy to switch from agriculture to industry. The model explains slow growth in population and income before a switch to a balanced growth path of higher population growth and rapid income growth. Introducing a human capital externality in the total factor productivity of agriculture and industry allows for the reproduction of the previous outcomes and generates better per capita incomes in 200 and 3000 BC, the onset and duration of an agricultural revolution, time varying market size and modern income differentials. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

From 200 BC to 1850 AD, the rate of population growth in Europe averaged barely one tenth of one percent per year.¹ The rate of growth of

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¹ Kremer (1993b) presents European population estimates from 200 BC to 1975. I will use the West (or Western) to cover both Europe, Canada and the United States. Prior to the Western Industrial Revolution, which I date at 1850, the population of the West grew at an annual rate of 0.108 percent. From 1850 to 1996, Western population grew at an annual rate of 0.829 percent, or over 7.5 times larger! Even excluding the Black Death from the pre-industrial data, the annual rates of growth of population from 600 AD to 1300 AD and from 1500 to 1600 are 0.15 and 0.17 percent, respectively.

income was, perhaps, even lower.² After the onset of industrialization, both population growth and income growth accelerated. Between 1850 and 1996, the rate of population growth in Europe averaged 0.8 percent per year—more than seven times its prior rate. The rate of growth of per capita income from 1800 to 1996 increased by an even larger amount, from essentially no growth to 1.8 percent per year.

This paper models the transition from agriculture to industry endogenously. Researchers have taken a variety of approaches to modeling these events (Laitner, 2000; Galor and Weil, 2000; Hansen and Prescott, 1999; Jones, 1999; Tamura, 2001). However, virtually all models to date rely on exogenous forces to generate the transition. Such features are understandable, for endogenous growth models quickly lose analytic tractability when they are extended to complex environments. Such models are, however, solvable using numerical methods.

In this paper, I develop a model of economic and population growth that generates a transition between agriculture and industry endogenously. The model is similar to that of Lucas (1998), and embodies elements from the models of a number of other authors, including Kremer (1993a, b), Rosen (1982) and Tamura (1992, 1995). The model assumes the existence of two highly stylized methods of producing a single final output. As in Lucas (1998), output is produced in autarky using a fixed factor, called land, and labor, and is labeled the agricultural method. As in Rosen (1982) and Tamura (1992, 1995), in the second, output is produced using labor along with intermediate services that are acquired through trade, and is labeled the industrial method. Trade, however, incurs a coordination cost that is inversely related to the level of human capital. In the model, individuals start out having low levels of human capital and specializing in agricultural production in autarky. In Lucas (1998) the precipitating event moving an economy away from a classical steady state in income and population is an exogenous increase in the rate of return to human capital investment. Here, however, human capital accumulates because individuals care about the incomes of their children, and human capital is productive even in agriculture. Eventually the coordination costs of trade are sufficiently low so as to make the switch from agriculture to industry profitable. In addition, the accumulation of human capital has implications for fertility. When specialized in agriculture, rates of both population growth and income growth are low. Both growth rates increase

² Cameron (1993) states that the typical English worker of the 1850 earned no more than the typical Roman citizen.

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