



Population Genetics and Economic Growth

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Synopsis: This paper builds an age-structured model of human population genetics in which explicit individual choices drive the dynamics via sexual selection. In the model, agents are endowed with a high-dimensional genome that determines their cognitive and physical characteristics. Young adults optimally search for a marriage partner, work for firms, consume goods, save for old age and, if married, decide how many children to have. In accord with the fundamental genetic operators, children receive genes from their parents. An agent's human capital (productivity) is an aggregate of the received genetic endowment and environmental influences so that the population of agents and the economy co-evolve. After calibrating the model, we examine the impact of physical, social, and economic institutions on population growth and economic performance. We find that institutional factors significantly impact economic performance by affecting marriage, family size, and the intergenerational transmission of genes. The principal novel findings are that i) genetic diversity has a nonmonotone causal impact on population size and economic performance; ii) an endogenous population threshold exists which, absent frictions, causes societies with declining populations and output to reverse course and grow; and iii) that the emotion love substantially accelerates economic growth by increasing genetic diversity 'just enough', which we term '*The Goldilocks Principle*'.

Key words: growth, population biology, genetics, evolution, fertility, marriage, psychology

JEL classification: J12, J13, J24, O40

1. Introduction

For its implications throughout biology and the social sciences, no subject is intellectually more interesting [than the co-evolution of genes and environment].

(Edward O. Wilson, Consilience, 1998, p. 137)

It is well accepted that human capital is the source of long-run growth, as human capital engenders technological innovation (Lucas 1988, Romer 1990). This paper provides a biological foundation for the production of human capital by modeling the production of humans. Behavioral geneticists have shown that one's genetic endowment and early childhood experiences are the fundamental factors that beget adult cognitive skills (McClearn et al. 1997, Plomin & Petrill 1997, Plomin 1994). As a result, the way that

individuals meet and mate, and the post-mating household structure, fundamentally determine adult productivity. Put more simply, we follow Becker (1993) by modeling the nature *and* nurture constituents of human capital.

In this paper we seek to take nature and nurture seriously. We do this by endowing each agent in the model with a high-dimensional genome which is derived from the primary genetic operators acting on his or her parents' genes: recombination, linkage, and mutation. An agent's genome codes for baseline cognitive ability, physical appearance, and gender. To characterize where an individual's genetic material comes from, adults make two-sided marriage decisions, and, if married, choose how many children to have. Sexual selection occurs as some individuals are unable to find a mate with whom to reproduce. Indeed, this is a model of human sexual selection which is mapped into economic output via the intergenerational transmission of human capital.

Because the model includes the search for a marriage partner, we use findings from evolutionary psychology to identify the factors that lead individuals to marry, including a spouse's human capital, physical attractiveness, the ability to effect reproduction, and the value of companionship. In this way, the model seeks to integrate the biology and psychology of human mating and reproduction with the economic and social environments in which individuals find themselves. The model is therefore an exercise in population genetics (Ginzberg 1983, Emlen 1984, Keyfitz 1984, Little & Haas 1989, Takahata & Clark 1993), but departs from the biological literature by modeling the (boundedly) rational decision-making unique to humans. Such a research program has been advocated by E. O. Wilson (1984), who stated during a conference in 1981 that 'The optimization technique is, I think, very valuable for micro-evolutionary analyses, particularly when one [has] a thorough knowledge of the species and of its adaptive repertoires... Behavior and genetic distribution are then optimized over a small portion of the conceivable adaptive landscape.'

In terms of economic choices, viz. consumption and production, an agent's genetic endowment acts as a constraint on individual choices. For example, education raises an agent's human capital and labor income, but does so only given one's genetic endowment. As a result, genetics constrains achievable consumption, savings, and the ability to find a marriage partner. These in turn affect the economic landscape in the following generation. The population of agents and the economy therefore co-evolve.

Considering genetics and family structure as the building blocks of human capital stands in contrast with the literature that models human capital as purely education or experience with or without financing constraints (Lucas 1988, 1993, Stokey 1996, Galor & Zeira 1993, Galor & Tsiddon 1997a, b). Rather, the model in this paper is grounded in behavioral genetics (see Zak 2000), extending the analysis of human capital to the level of the genome. The model is driven by marriage and fertility, and thus is related to the seminal analysis of fertility decisions by Becker & Tomes (1976), and subsequent work by Becker & Barro (1988), Becker et al. (1990), and Tamura (1996), as well as the literature on marriage matching (Becker 1973, 1974, Lam 1988, Burdett & Coles 1997, Weiss 1997). The primary point of departure of this paper is the inclusion of explicit biological factors for mating and reproduction that underpin the creation of human capital.