Human Capital, Technology, and Economic Development

Eric Scott, Andrews University/Sante Fe Institute

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Abstract

Information-led development envisions information technology as the prime driver of growth in a developing economy. Sustaining a technologically advanced society, however, requires significant human capital for skilled labor which does not tend to be available in such economies. The co-evolution of technology corporations and education distributions in a developing community will be investigated via agent-based modeling, with the goal of trying to answer questions about optimal strategies for economic development.

As the rest of the world's GDP per capita (GDPh) exploded in the 20th century, the average GDPh for Africa (including the Magreb, Egypt, and South Africa) only increased by an average of 1% per year, and has actually fallen since 1980, as economic growth is unable to compete with high fertility rates.[1] "Knowledge-based development,"[2] "Information and Communication Technologies for Development" (ICT4D),[3] "Information-led development", and other such buzzwords have emerged recently as heuristics for development strategies, its proponents hoping that technology can catalyze the closure of the gap between Africa and the rest of the world. For technology to gain a foothold, however, expertise and education is requisite.

[1]Maria-Carmen Guisan and Pilar Exposito, "Human Capital and Development in Africa: Econometric Models and Evolution, 1950-2002," *Applied Econometrics and International Development*, 5(1), 2005, 129-142.

[2]Robin Mansell, Uta Wehn, *Knowledge Societies: Information Technology for Sustainable Development* (United Nations, 2000).

[3]http://www.ict4d.org.uk/

Brian Arthur uses the term *deep craft* to denote the cultural, experience-based component of technology which, going beyond only book-knowledge, makes the growth of a sector possible. Not quite equivalent to education, it is specific to a technological domain – but also reasonably fungible, as demonstrated by the retooling of Silicon Valley from wireless telegraphy, to electronics, to computing, and most recently to biotechnology and nanotechnology.[4]

Arthur has not incorporated the idea of deep craft into a model. In addition, he stays with the simple case in which knowledge is universal, i.e all innovators have access to a vast "bulletin board" listing all current technologies.[5] This could be a reasonable assumption for advanced centers such as Silicon Valley or even the diverse economy in a city like Chicago. However, when we start to think about technology companies emerging in poorly educated regions of the developing world, the bounded rationality of the local climate becomes accentuated. Take, for example, Kano, Nigeria – which, as the second largest economic center in the country after Lagos, has comparable population to Chicago, but less than 3% its GDP.[6] In Kano, the adult literacy rate is 52% (70% for men and 30% for women) – not the sort of place that draws entrepreneurs from the tech sector.[7]

Both knowledge and deep craft are local in nature. Collectively these can be seen as *human capital* ("capital" hereafter), which is necessary and arguably sufficient for a technologically advanced economy. Figure 1 provides a more comprehensive, high-level view of the social dynamics involved in building such an economy, with human capital at the center. Capital is determined by several factors: demand, cultural contagion, formal education, and bounded rationality (the availability of knowledge and craft in the culture to begin with). The effect of culture on capital is influenced by social network

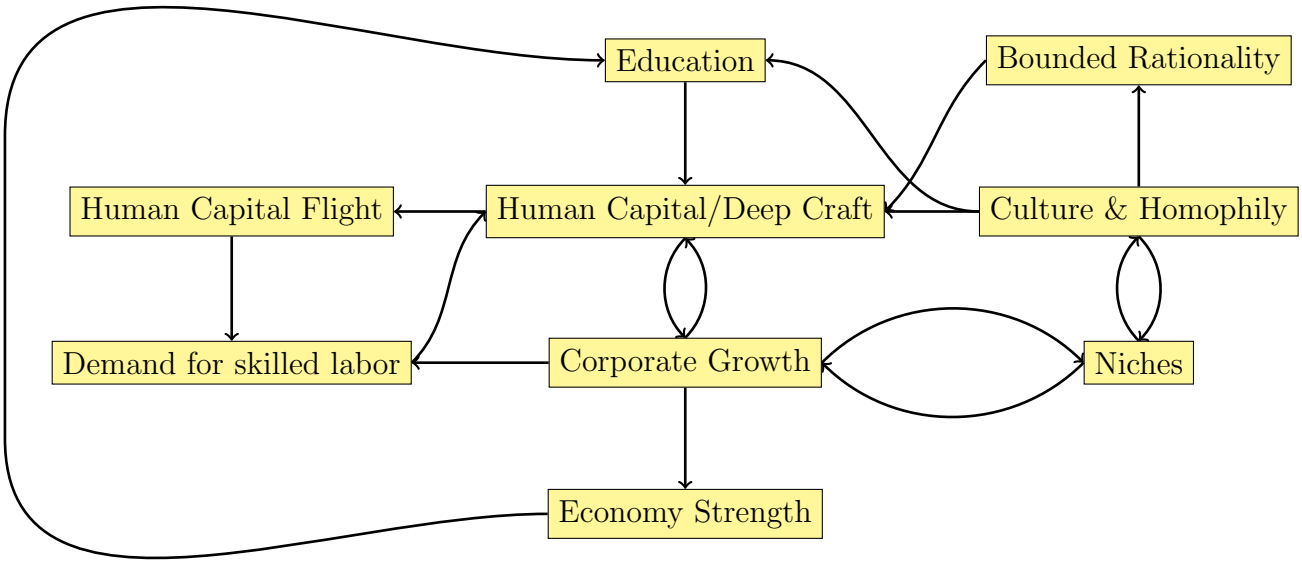
[4]Brian Arthur, *The Nature of Technology: What It is and How It Evolves* (New York, NY: Free Press, 2009), 159-163.

[5]Ibid, 177.

[6]As of 2008, Chicago's GDP is estimated at $574 billion USD (John Hawksworth, Thomas Hoehn and Anmol Tiwari, "Global City GDP Rankings 2008-2025," *PricewaterhouseCoopers UK Economic Outlook*, November, 2009.) The GDP of the entire state of Kano is less than $13 billion USD (Wikipedia, "Kano State"). Note that the Chicago metro area actually has twice the population of Kano's.

[7]Sabo A. Indabawa, "Educational access for girls: the case of Kano State of Nigeria," in Akpovire Oduaran and H.S. Bhola, *Widening Access to Education as Social Justice* (The Netherlands: Springer, 2006).

Figure 1:



factors such as topology and homophily.[8] Capital growth must be paralleled by industrial growth, or else flight occurs (Educated persons migrating to more highly developed localities). Demand for skilled labor affects whether an individual invests in human capital. A corporation's growth is only possible if there is demand niche for their goods/services. Niches influence culture and thereby capital, but culture also defines niches.

Clearly, the feedback inherent in this model implies that it can be difficult for technology companies to penetrate a poorly educated society. Niche and human capital are prerequisites for industry, but industry is a prerequisite for niche and capital. Ergo the "poverty trap."

Araújo and St. Aubyn have developed a simple agent-based model that incorporates some of these factors.[9] They arrange an array of individuals in

[8]Miller McPherson, Lynn Smith-Lovin, and James M. Cook, "Birds of a Feather: Homophily in Social Networks," *Annual Review of Sociology*, 27(1), 414-444.

[9]Tanya Ara'ujo and Miguel St. Aubyn, "Education, Neighborhood Effects and Growth:

a circular network, in which each agent decides whether or not to invest in an education based on 1) the education level of their nearest neighbors and 2) the expected payoff of becoming a skilled worker in the future as opposed to entering the unskilled workforce young. Furthermore, skilled workers produce *ideas* which increase the productivity of the unskilled workers. Skilled workers receive wages proportional to the improvement in productivity their ideas induce. A variety of equilibrium scenarios are observed, including the "poverty trap" and "over education collapse."

Several components of their model could stand improvement. First, real social networks do not have a circular structure, but are rather small-world and scale-free. Second, it is oversimplistic to consider skilled workers as only producing *ideas*, and to consider them implemented by unskilled workers. The more sophisticatd an idea, the more education it takes to implement it. In the case of IT companies, software engineers and network specialists require a great deal of training. Third, innovation increases linearly in their model, which does not correspond to real-world experience curves in industry.

An Agent Based Model Approach," *Advances in Complex Systems*, 11(1), 2008, 99-117.