"Technological Change and Population"

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ABSTRACT

The following paper is a short note on the relationship between Technological Change and population size.   .

All technological changes involve human knowledge being created.[1]

Technological change is a human activity, the execution of which depends on the characteristics embodied in the person who engages in it.

There exists for any given technological change, a set (or sets) of characteristics an individual must possess in order to execute that change.

Each technological change effects each and every person in an economy, regardless of the size of the population.

The qualities that human beings possess are normally distributed across the population.

So, the proportion of the population who possess the characteristics to engage in any given act of technological change is a fixed proportion of the population regardless of population size.

We will call this proportion, 'ρ.'[2]

So, as population increases, the number of individuals who can create a technological change increases.

So, the number of acts of technological change will increase as population size increases.

So for a given population size, the number of acts of technological change should have a strong central tendency over time.

This, however, is not sufficient to define the rate of technological advancement over time since not all acts of technological change are equal to each other in their economic impact.

There are two aspects to this economic impact. First, there is the pace of the diffusion of the innovation[3] through the economy. Second, there is the magnitude of the resource saving per unit of product that the innovation creates.

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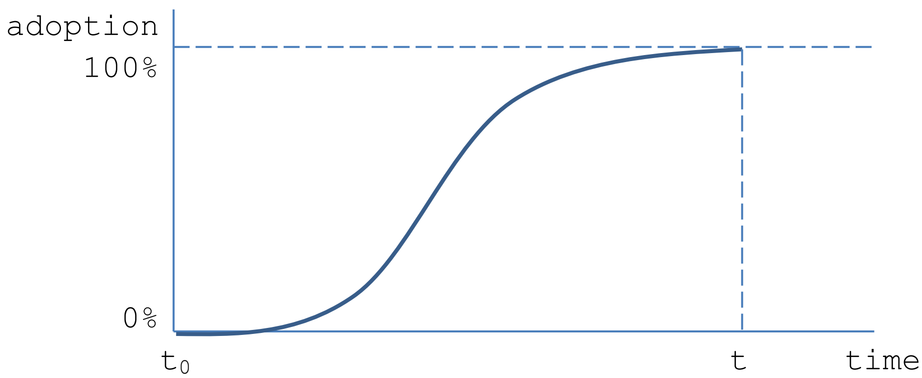
[1] It is assumed that to execute a technological change will require a certain level of received knowledge.

[2] ρ, is, of course, a stochastic variable with a probability distribution. And when we discuss ρ, we will usually mean the E(ρ). The distribution would have a range from 0 to 1 and would be extremely skewed to the left and I would expect it to be uni-modal and as population size increased, its variance would decrease. The distribution would also differ depending on social conditions such as education and social mores.

[3] For the purposes of this paper, an innovation is defined as an act of technological change.

The process of diffusion should be well behaved with time being the most important parameter.

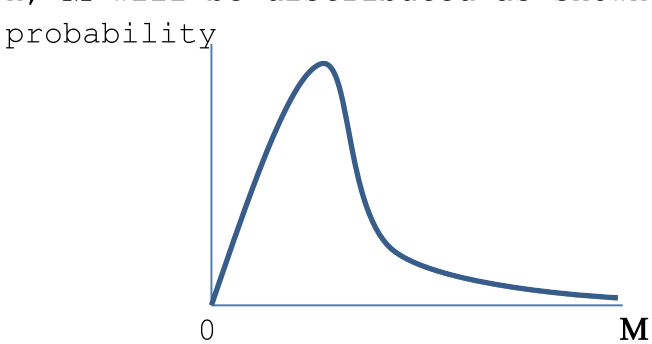
The process would likely have the classic shape as shown below,



, with the relevant parameters being the time until complete adoption and the inflexions of the curve.

Questions of the economic magnitude,[4] **M**, of the effects of each individual innovation are much less clear. There is no particular reason to think of those magnitudes as stochastic or to believe they possess central tendency. So, we are left to making assumptions.

Given that, we could assume that **M** for a given innovation will usually be smaller than the **M** for any other given innovation. This is an arbitrary assumption, but if we make this assumption, **M** will be distributed as shown below.



And it would have central tendency.

[4] How do we define this economic magnitude? Once the innovation is completely adopted, it will increase our ability to produce a given good. If all of the economy's resources are used to produce that good, the ratio of the new output to the old output, $((q_1/q_0)-1)$, would tell us the magnitude of the effect in terms of that good. Taking a weighted average of these magnitudes over all goods would tell us its effect on the economy as a whole. The appropriate weighting scheme would be an empirical question, not a theoretical one. We will denote this magnitude by the symbol, **M**.

So, if an economy has converged to its long-run capital to labor ratio,[5] and has a given stable population size, **N**, and the times until complete diffusion are finite, and the inflexions in diffusion curve are normally distributed, then the average growth rate over time of aggregate product would be shown by the equation:

$$E(\Delta Y_{t+1}) = E(\rho) \times N \times (E(M)/2) \times Y_t$$

[5] As in Robert Solow, 1956, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*, 70: 65-94.