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A CAPITAL-BASED THEORY OF SECULAR GROWTH: REPLY TO ENGELHARDT

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Lucas Engelhardt[1] does not point out anything incorrect in my "Capital-Based Theory of Secular Growth" (2009). Rather, he implicates me in a violation of Occam's razor. My discussion of nonrivalry, external effects, and intangible capital contains, but obscures, the fundamental ingredient for secular growth: *nondepreciating capital*. Engelhardt purports to demonstrate how nondepreciating capital is sufficient for secular growth in a simple Crusoean economy. With appreciated wit, Engelhardt begins his comment by quoting Murray Rothbard ([1962] 2009, p. 11): "*The distinguishing feature of a recipe is that, once learned, it generally does not have to be learned again*." At once, Rothbard (and Engelhardt) recognize the importance of nondepreciating capital and chide me for trying to reinvent the wheel.

Unfortunately, Engelhardt's analysis implicitly assumes away the presence of diminishing returns. Diminishing returns have long been at the heart of growth theory—from Thomas Malthus's ([1803] 2003) prediction of starvation as the result of population growth to Robert Solow's (1956) conclusion that technological change is a necessary condition for secular growth. An account of secular growth in the presence of diminishing returns is featured prominently in both my critique of Roger Garrison's (2001) theory of growth through capital accumulation and my alternative theory based on intangible, nonrivalrous capital.

Consider the numerical example provided by Engelhardt (2009, p. 1):

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[1]See Engelhardt, Comment on "A Capital-Based Theory of Secular Growth," in this issue, pp. 60–62.

> Suppose Robinson Crusoe has 24 hours a day in which to fish. With his current state of knowledge and with items that are freely available on his island, he can catch 1 fish per hour – giving a total income of 24 fish per day. . . . Also, his time preference implies that he saves 12.5% of his income, and this "saving" is in the form of spending time working on some sort of investment. Consider two different investments: one in depreciating capital (a net), and one in nondepreciating capital (an idea for a more efficient fishing method).

Given the above, Engelhardt summarizes the two scenarios over two periods as follows.

DEPRECIATING CAPITAL	NONDEPRECIATING CAPITAL
Before Capital is Complete	*Before Capital is Complete*
Total income: 24 fish	Total income: 24 fish
Savings Rate: 12.5%	Savings Rate: 12.5%
Savings: 3 fish	Savings: 3 fish
Result: 3 hours work on a net	Result: 3 hours thinking of a new idea
After Capital is Complete	*After Capital is Complete*
Total income: 48 fish	Total income: 48 fish
Savings Rate: 12.5%	Savings rate: 12.5%
Savings 6 fish	Savings: 6 fish
Result: 3 hours work on a (replacement) net	Result: 3 hours thinking of a new idea

So, says Engelhardt, if capital depreciates then secular growth is not possible. Investing in the net results only in a *level effect* on income. Given the same savings rate, the need to replace the net (which has depreciated fully by the next period) leaves Crusoe with a steady-state flow of 48 fish. On the other hand, when Crusoe comes up with a *new* idea (intangible capital) it does not depreciate (unless Crusoe is forgetful) so he can "spend" his next-period savings coming up with *another new idea*.

The careful reader will, upon examination of Engelhardt's numbers, wonder: *What's Crusoe doing with the additional 3 units of savings in the later period?* Apparently nothing, for if he was putting it to use (in thinking up a new idea or making an additional net), Crusoe's income would grow further. In the case of nets, Crusoe would use his savings of 6 fish to make 2 nets (in place of the one worn-out net), raising his catch of fish to 72. In the case of ideas, Crusoe would be able to think up 2 new ideas

(to bring his total to 3) and bring his total catch to 96 fish. *There would be secular growth in either case.*

The implicit assumption making secular growth possible in either case is that there are no diminishing returns. To demonstrate this, consider the nondepreciating capital case. Crusoe initially "spends" his 3 saved fish by taking time to come up with a new idea. Having done so and applied the idea, Crusoe now, with the same savings rate, saves 6 fish (12.5 percent of 48 fish) and spends them coming up with 2 new ideas (bringing the total available ideas to 3). This is what Engelhardt would have us believe. *However, the law of diminishing returns tells us a subsequent savings of 3 fish will not yield the same number of—or quality of—ideas that the previous savings of 3 fish yielded.*

To see this, first assume that, subsequent to the first idea, Crusoe is forced to work under the initial state of knowledge (i.e., that he was constrained by before his first idea existed). For concreteness, assume that Crusoe's first idea was a *rod & reel*. Given the same state of knowledge under which the rod & reel were developed, and given the same savings, Crusoe must settle for an incomplete and/or lower quality idea. Why? Because, given that state of knowledge (which did *not* include knowledge of a rod & reel), Crusoe previously came up with the best idea that he could. Coming up with the same idea would be redundant; an inferior output of intangible capital is the alternative. This is a manifestation of the law of diminishing returns.

Without drawing out a full, multiperiod numerical example, the above reasoning makes clear that, even if Crusoe's level of savings grows, resulting in the accumulation of an increasing stock of ideas, the marginal contribution of each successive idea to larger catches of fish would fall; the growth rate of poor Crusoe's economy would dwindle, eventually to zero.

Of course, realistically Crusoe is not forced to innovate under what was the state of knowledge; at the very least he now *knows* what the rod & reel is. He has experienced the trials and errors needed to achieve its present design; he has fished using it and recognizes its strengths and weaknesses. Crusoe, for example, can use his new savings to come up with a *better* rod & reel because of the *nonrivalrous nature* of ideas. Old Crusoe can use Young Crusoe's idea for a rod & reel to come up with the idea for a better rod & reel without Young Crusoe sacrificing any use of the original rod & reel. Even though Old Crusoe only spends 3 fish himself, a total of 6 fish are spent on the new idea. *There are benefits to young Crusoe's savings that are external to Young Crusoe and can be captured by Old Crusoe*.

Contrast the above with an example of capital that is nondepreciating *but rivalrous*. Assume that, with the current state of knowledge, Crusoe can create a net that never wears out by spending his initial savings of 3 fish. Having caught 48 fish using the net, Crusoe now saves 6 of them yielding 2 additional nets. Crusoe is now constrained by those annoying *fixed factors* that are intimately associated with diminishing returns. (E.g., there is only one Crusoe to cast the nets making fishing with 3 nets more time-consuming; there is also only one best fishing hole in which to cast so Crusoe must cast his second and third nets in lower-yielding waters.) Clearly, on the margin, Crusoe's third net will be less productive than the second; the second less productive than the first. The absence of depreciation is not sufficient to overcome diminishing returns.

Is nondepreciating capital at least a *necessary* condition for secular growth? Not necessarily. Instead of a Crusoean economy, consider an economy with many individuals and positive population growth. If over any relatively short period of time (e.g., a generation) nonrivalry leads to the type of external effects described above, then population growth will lead to magnification of the external effects. (These are the well-known "scale effects" present in many endogenous growth models.)[2]

Engelhardt should be credited with calling attention to the fact that intangible capital is largely nondepreciating.[3] When dealing with an intertemporal phenomenon such as secular growth, undoubtedly the potential for knowledge to endure, largely intact and indefinitely, facilitates the capture of external effects over successive generations. However, it is the nonrivalrous nature of that knowledge that is fundamental.

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[2]I do not claim that such an "intratemporal" engine of economic growth is plausible or empirically relevant. Jones (1995) notes, in fact, that the scale effects of theory are contradicted by available international data for economies over long periods of time.

[3]Ideas/intangible capital is, more precisely, relatively slow to depreciate and/or depreciates incompletely.

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