Cost of science: An early career researcher's perspective

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In his original essay, the renowned Vietnamese economist Vuong Quan Hoang discussed an often-overlooked aspect of science, the cost [1]. Is science low-cost? Are most scientific contributions wasteful? Does science have a real practical contribution? Does science, especially social sciences, justify their funding?

These are essential questions that every scientist needs to understand.

Most researchers have linear career paths. We all begin with being a Ph.D. candidate, then postdoc positions, slowly moving on to various university positions until you can get a tenured position. The ultimate goal is a professorship in a good university, which often equals more opportunities to get research funding, consultant works, and so on. There are variations, like people who work in the private sector or geniuses who achieved early success. Nonetheless, for an average person who pursues a career in science, he/she spends a longer time in school, and the career only starts when he/she is in the early 30s.

I went to Japan for my undergraduate degree. Then, I obtained my Master's in Vietnam. The costs for study overseas and domestically are starkly different. My parents (it is common for Asians to provide their kids until undergraduate study) spent around VND 250 million (~US\$10,800), and it

included an 80% tuition reduction already. Meanwhile, it cost me only VND 95 million (~US\$4126) for two years of a Master's degree. Until you can officially start working, it will cost you quite a fortune to get a start.

Despite the official cost for learning officially, the relationship between a student and a mentor is not straightforward. For instance, my mentor is well-established in academia and the business sector, so he does not rely on the conventional academic system. In this way, his mentorship is the kind that you cannot, and should not, put a price tag on it. I believe the moment someone tries to quantify it, it will lose the magic. In a way, I am forever in his debt, just like how I owe my parents. Hopefully, I can pay him back with my works and my dedication to his intellectual legacy [2-7].

So, the cost of learning is relatively high, but it does not guarantee that you can do science. That is why after Ph.D., researchers will spend years as postdocs, lecturers, and other untenured positions. Of course, they may have certain achievements during this period, but stability only comes when they get tenures. Here, the cost does not translate into a straightforward transaction: you pay A amount to get the B result. It is more like the following situation. You pay A, then you might have an opportunity to do several things, like C, D, Z, and then you have to pay F to get another shot at achieving B. It is similar to the semiconducting principle that was proposed by Vuong Quan Hoang: the scientific values can be accounted for as a monetary one, but not vice versa [10].

Every research understands that you need many flawed ideas to come up with a good one [8,9] finally. Moreover, only a few scientists can have meaningful and impactful research. Others will have to contend with their contribution, hoping they can come up with something great one day. That is why there are heartbreaking stories in academia [11,12]. Thus, it is understandable that the 'publish or perish' culture exists in academia. It is a reasonable way to measure scientific progress and contribution, to provide early career researchers with clear goals for their future [13]. However, it turns out to be ugly, and scientists start to lose sight of the beauty and only focus on grinding the numbers [14].

That is why the cost of science has become higher. We have to weed through too many shoddy papers to find a good one. That is why I feel fortunate to work for a mentor whose idea centers around an objective, systematic, fast, and low-cost basis.

"Playing football is very simple, but playing simple football is the hardest thing there is." – Johan Cruyff

Just like Johan Cruyff talked about football, it is applicable to research with low cost. When you look at big problems like climate change, sustainable energy or materials, or astrophysics, it is easy to feel overwhelmed and start to imagine that it can cost billion dollars. However, to a certain extent, Elon Musk has proved that things can be cheaper than they seem [15-17]. Macroeconomics models have failed to predict and prevent many crises in human history [18]; thus, economists have explored different methods and approaches to revitalize the disciplines [19-23]. As behavioural economists suggested, humans are not as rational as we think we are [24,25]. Thus, there is no way to think that the cost of science is a rational issue.

Money is an integral part of the equation. Actually, it is so essential that there would be no science without it. That is why the cost of science needs to be understood and discussed carefully. I already spent a fortune just to be an early career researcher. I am fortunate that I do not have an enormous debt as a result. Thus, every pursuit of scientific exploration needs a careful reflection: am I improving the quality of life?

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