
Discussion

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The paper provides a thoughtful analysis of the long-run economic implications of cloning. Obviously, at the current stage, there is a substantial amount of uncertainty about the future of cloning and the potential relevance of the analysis. However, in my opinion, it is precisely this uncertainty that makes the contribution most valuable and the debate most interesting, at least from a theoretical point of view.

Gilles Saint-Paul discusses three different motives for cloning (assisted reproduction, child enhancement and financial investment), and offers a model that studies the long-run evolution of ability in the population when cloning occurs for one of the last two reasons. In both cases, the main conclusion is that cloning tilts the distribution of abilities in the population towards high types. Moreover, under certain assumptions, every individual ends up being of highest type in the long run. So, even though the author does not directly advocate cloning, his paper presents arguments that are undoubtedly in its favour.

This is a highly enjoyable piece of research. It combines precise facts with rigorous analysis and formal modelling. Also, some provocative yet thoughtful speculations add interest to the debate. I will refrain from commenting on the ethical aspects of the problem (even though they are certainly of first order importance). Instead, I will ask the following question: ‘Suppose that we take the model seriously, how plausible are the assumptions, how realistic is the model and how convincing are the results?’ Following the author’s methodology, I will discuss separately the cases of ‘cloning for child enhancement’ and ‘cloning as an investment’.

Child enhancement

Although the idea that cloning will increase the ability of the population seems quite natural, I am a bit more sceptical about the conclusion according to which all individuals will be of highest ability in the long run. I understand the mechanics, but I think that the assumptions about the distribution of abilities in the population that are needed in order to obtain this result are very strong. In fact, I do not refer only to ability invariance (a point discussed in the paper). I am also concerned with other assumptions like bounded ability in the population, identical birth rate for all couples, etc. (see below for a further discussion of these two assumptions).

I also have some problems with the random matching hypothesis. In the model, parents choose the reproduction technique with the objective of maximizing the ability of the child. This means that this criterion is a very important factor in the parents’ utility function. Therefore, it seems natural that parents will also look for a

mate with this same objective in mind. As a result, in a frictionless world, we should observe only pure homogeneous matching, that is, matching between individuals of exactly the same ability, and therefore no incentives at all for cloning. In a more realistic world, we can expect heterogeneous matching but a limited spread in the intra-marital distribution of ability. In that case, every individual should, in the long run, be at the top level but only within his subset of ability. This looks very much like the system of castes existing in some primitive tribes.

The inclusion of risk in the model could deliver a number of interesting insights. First, one could think that parents are risk averse. For example, it seems that they are usually more frightened by the possibility that their child presents a congenital disease than enchanted by the likelihood of the child being a genius. Obviously, such risk-aversion increases the incentives for cloning (a relatively safe alternative) relative to natural birth (a relatively risky one). More interestingly, the assumption of bounded ability and the existence of a positive mass of individuals with the highest ability seem quite unrealistic. In fact, the current model does not capture what I think is one of the main evolutionary advantages of natural birth relative to cloning – the possibility of always improving the ability of the highest type in the population. If everyone in the 19th century had used cloning technology, a large number of bright scientists would have been cloned, but Einstein would have never existed. The final draft of the paper touches on this, but the tension between risk-averse individuals and a potentially risk-loving society is an interesting direction for further research.

Economic investment

One interesting issue is to determine whether the model or the clone gets the highest benefits from cloning. Under cloning as a private investment, the model must reap part of the rents of the clone. Otherwise, he would not have incentives to clone himself. However, from the ‘information retention’ mechanism developed in the paper, we note that there is an important advantage of being a clone. Clones can save on search costs since they do not need to invest in learning their ability. How valuable is this information? Consider the simplest possible model. The utility of a risk-neutral clone is $U = \theta e - e^2/2$ where θ is his ability and e is the effort selected. A clone who exerts effort before knowing his ability optimally sets $e^* = E[\theta]$ in which case, and from an *ex ante* perspective, his expected utility is $U^* = (E[\theta])^2/2$. By contrast, when he knows his ability prior to his effort decision, he chooses $e^{**} = \theta$ and his expected utility from an *ex ante* perspective becomes $E[\theta^2]/2$. The value of information is then $\text{Var}[\theta]/2$, which may be non-negligible if the support of abilities is sufficiently wide. Naturally, under the assumptions of the model, knowing that one is a clone is enough since all clones have the highest possible ability in equilibrium. More realistically, in a world of multiple occupations, clones will still need to know in which dimension they are of top ability (as basketball players, violinists or surgeons). Now, assuming that the value of information is high, then it seems reasonable to suppose that each clone will capture the biggest fraction of

this value. On the other hand, given the infinite supply of clones, the model captures a small fraction but for each of many replications. Overall, it seems difficult to determine *a priori* who is going to benefit more from cloning. This is an important issue. Indeed, one of the main arguments against cloning as an investment is based on ethical and fairness considerations: a clone should not be worse off by the mere fact of not having been born naturally. The model shows that this does not need to be the case.

The assumption that fertility and ability can be negatively correlated seems quite implausible. The fact that birth rates are inversely related to family income can be explained in a number of more convincing ways – education about contraception, (rational or irrational) economic choices, etc., all of them pointing to the idea that birth rates vary between couples of different abilities but that this is an equilibrium choice.

Last, I would like to raise some broader questions. Can we expect clones to receive equal treatment? Or will they, in the short run, suffer from some sort of implicit or explicit discrimination? How costly can this be for society? How about the long run? Can we expect a reverse effect with discrimination against inferior, naturally born children as in the recent science-fiction movie *Gattaca*?

Carol Propper

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This paper uses economic analysis to examine the consequences of human cloning. I think this is a topic very worthy of economic analysis. As the author points out, technological developments are proceeding rapidly while policy analysis lags behind due to the huge ethical issues involved. All the more reason, I think, for economic analysis.

The paper discusses both parental cloning and financially motivated cloning, but I will focus my comments on the latter, more controversial kind. For financially motivated cloning to operate, there must be property rights to the clone. The author argues that this is probably possible and may develop in countries in which human rights are less valued. The author's model predicts that a market will develop such that high ability persons will be cloned, with the child being brought up by low-ability women, and society will have three classes: a reproductive class of women at the bottom of the ability distribution; a productive class at the middle; and a replicated class at top.

As support for his argument, the author amasses various pieces of evidence showing that there is a market in marriage and having children, and that there seems to be a premium in the assisted reproduction market for education (which he equates with ability).

It is, however, difficult to know quite what to read from the evidence cited, as it is somewhat of a mixed bag. Some is from the developed world, some from developing countries. Some examine long-term trends, for example, shifts of fertility/divorce as labour market conditions for women change, others are cross-sectional. This mixing of long-term trend evidence and cross-country evidence is not very helpful. Due to long-term changes in relative prices, we would expect to see changes in fertility/