

Population density and wealth

SIR — Since the first edition of Malthus's *Essay on Population*, conventional wisdom has stated that more people mean less goods for each person, and that, as population grows, poverty inevitably increases. Although this may certainly be the case for bacteria or donkeys, for human beings the situation may be quite different. Since the time of Malthus, the world's human population has increased 6.6-fold, but ordinary people certainly seem more wealthy now than in the early nineteenth century. It may be argued, however, that this may be due only to the great increase in wealth in the industrially developed countries which, through averaging, blurs the situation in most other countries, where the negative relationship of population to wealth may be valid. To have a sharper picture of this problem, a country-to-country correlation between these factors is needed.

Until recently, this has been difficult to achieve, as prices of the same goods and services vary greatly, and currency exchange rates are frequently distorted by 'official' rates that may lag behind market rates by more than one order of magnitude. Recently, the United Nations has introduced the International Comparisons Program (ICP), which makes useful inter-country comparisons of per caput gross domestic product (GDP).

We have compared per caput GDPs with population density for the 108 countries for which ICP data are available¹. These countries represent 90.4 per cent of the world's population¹. When comparison is done on a per country basis (figure, upper panel), there is a small positive

correlation ($r = 0.192$) that has a $P < 0.05$. When the correlation is done weighing the points according to each country's total population (lower panel), the correlation is very slightly negative ($r = -0.048$), and not significantly different from zero ($P < 0.7$).

This study, therefore, does not support the commonly held belief that more densely populated countries are poorer than those that are more sparsely inhabited.

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1. *World Development Report 1992*, Table 30 (World Bank/Oxford University Press, 1992).
2. *World Resources 1990-1991*, Table 17.1 (World Resources Institute, Spanish Edition, Instituto Panamericano de Geografía e Historia, México, 1991)

Science and anti-science

SIR — The leading article "Defending science against anti-science" (*Nature* 368, 185; 1994) contained misleading statements that flowed into over-extended and potentially offensive conclusions. The arguments fall apart where they hinge on the scientific method. In other words, if experimentation or controlled observations are not the bases of the conclusions reached in the leading article, then the subject of the attack has as much validity as do the baseless arguments.

It is possible that "astrology is a pack of lies". However, it has never been established that this is the case using the tools of astronomy, statistics and psychology. If applications of our scientific techniques have not invalidated astrology, then dismissing it is similar to the Catholic Church's historic treatment of Galileo. According to the article, "truth is not absolute, but rather a series of working hypotheses. . . ." If this is so, then how can it be a "plain fact" that non-mainstream practices, such as astrology, "cannot be correct"?

My understanding of the content of much of the article was that 'non-science' is actually the subject of this vituperative attack. Although the "forces of anti-science" no doubt exist, "other mumbo-jumbo such as faith-healing, water divin-

ing and spiritualism" hardly qualify as actively threatening the practice of modern science. There have been many distasteful attempts in European history to denounce non-mainstream ways of thinking, as well as campaigns to eradicate the practitioners of such unthinkable objectionable arts as astrology.

As a scientist, I find it quite chilling that you would describe any scientist-critic as an "insidious" threat to the theory and practice of modern science. The greatest advances in science have come about through criticism and proposals that are radical, not conforming to the accepted standards of the day. To reject alternative explanations at any point in our cultural evolution is tantamount to saying: 'at this point we know absolutely the true nature of the universe'. This is unlikely to ever be true. Please stop encouraging limitations on "the enhancement of the general enlightenment".

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SIR — John Maddox is concerned about the forces of anti-science, and he asks for a polemicist to take up the fight against them. His outrage, although I do not share it, deserves a response.

Certain philosophies are inherently paradoxical. Advocates of democracy, for instance, are surely frustrated that they must occasionally tolerate speeches for tyranny and bigotry. Such frustration is a side-effect of democracy, and may be an essential aspect of democracy. The paradox is that stifling undemocratic speeches puts one in the undemocratic camp.

Advocates of science must also invite criticism, as criticism of the basic tenets of science is the only way in which science can progress. Must this criticism come only from the true believers? That would produce an ultimately sterile philosophy. Science, in the mirror of anti-science, has its blemishes magnified, and that is good for science. Maddox asks for someone to take up the cudgel against anti-science, but that cudgel would strike against science itself, in breaking the mirror. I believe that the restraint that Maddox criticizes in Holton's anti-anti-science stance is an essential aspect of science.

If anyone is unconvinced that Maddox's argument stands more on the side of anti-science than science, one has only to ask what, if anything, the approaching end of the millennium has to do with the need for science to describe itself. That sounds like an astrological casting to me.

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