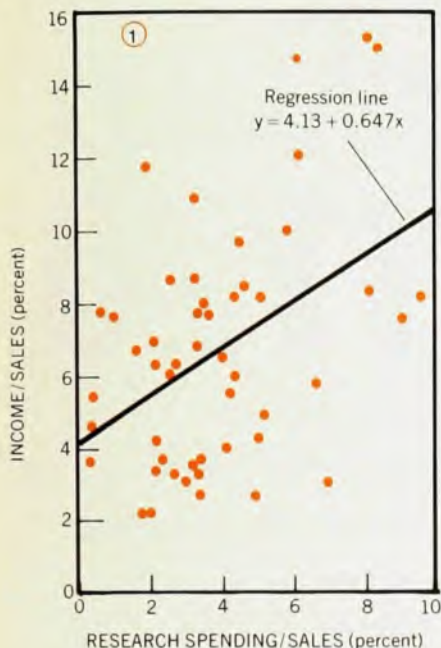
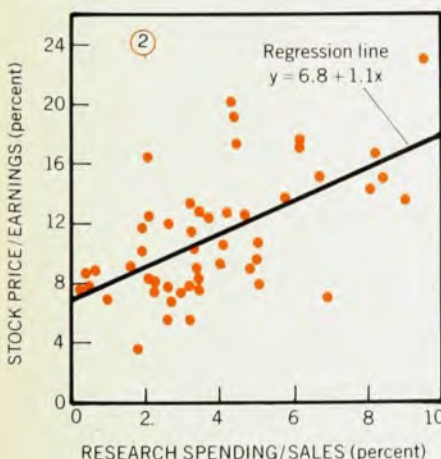


letters

Packard, Upjohn, Polaroid) have reputations as innovators, so their expenditures have indeed influenced their situations. The 10% with the smallest relative expenditures (Exxon, Shell, Standard of California, Mobil, Standard of Indiana) are uniformly the oil companies and have corresponding reputations as non-innovators. Thus, the data appear to have internal consistency.



The square of the correlation coefficient is a measure of the effect of research spending on the variations in income among the companies of the data set. In this case, the value 0.20 indicates that 20% of the variations can be attributed to research (or lack thereof) while other factors cause the remaining variations. These other factors are such things as: marketing, financial strength, manufacturing efficiency, overhead accounts, and so on.



As mentioned above, there is no good reason to expect a strong correlation between research spending and income because one relates to the present while the

other relates to the future. A performance measure that has more future-related content is the price/earnings ratio. It reflects the opinions of analysts (both amateur and professional) regarding the future prospects of corporations. The P/E ratio is determined by other factors as well, but the stature of a corporation's research program is one important factor. This is confirmed by the correlation plot of figure 2, which displays the P/E ratios of the 50 corporations of figure 1 plotted as a function of their relative research expenditures. The correlation is improved in comparison with figure 1. This may be seen by visual inspection and by the increase in the correlation coefficient from 0.45 to 0.59 (a 31% increase).

In figure 2, the regression line indicates that a one percent increase in relative research spending is connected with a 1.1 point increase in the P/E ratio. Also, $r^2 = 0.35$, which may be interpreted to mean that 35% of the variations in P/E ratios among the various corporations is determined by the strengths of their research programs. This is a strong influence indeed!

J. J. GILMAN
R. H. MILLER

Allied Chemical Corporation
Morristown, N.J.

8/26/77

Longest airlift

The recent airlift of a superconducting magnet to Moscow from Chicago (September, page 20) was notable from a standpoint other than that of international scientific cooperation. The flight of a Lockheed C-5 of the United States Air Force included 45 tons of related equipment. Lockheed claims that the 5900-mile flight, which included two refuelings, was the longest in aviation history with a payload that heavy.

MICHAEL D. LUBIN

McClellan Air Force Base
North Highlands, California

10/3/77

Oil reserves

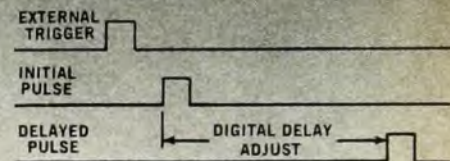
In a letter on commodity reserves (October, page 82) Richard Vook points out reassuringly that the known reserves of many minerals (he did not list fossil fuels) have increased dramatically in the years 1950-70 and he says that predicting the life expectancy of any commodity "is probably very difficult, to say the least. Perhaps it isn't even worth the effort."

I feel that it is worth the effort to bring to our students, our teachers and our national leaders an understanding of the easily calculated results of exponential growth in the rate of consumption of a finite resource. The most dramatic example I know follows from the assertion that it is possible to calculate, with considerable accuracy, an absolute upper

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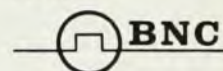
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letters

limit for the amount of petroleum in the earth. One simply asserts that the volume of petroleum in the earth can not be greater than the volume of the earth 6.8×10^{21} barrels. At the 1970 rate of production of 1.67×10^{10} barrels per year held constant with no growth this amount of oil would last 4.1×10^{11} years.

In the eighty years from 1890 to 1970 world production of petroleum grew 7 percent per year. If this historic rate of growth of consumption were to continue, all of the oil in a tank the size of the earth would be used in 344 years!

ALBERT A. BARTLETT
University of Colorado
Boulder, Colorado

11/21/77

The final frame— eppur si muove

An Elegy Written In A Non-Inertial
Frame of Reference

(With Apologies to Thomas Gray, Author Of
"Elegy Written In A Country Church Yard"
1751)

The Theory tolls the knell of parting
rays,

Light bending in the influence of G ;
The Old One homeward plots his world-
like ways,

and leaves our frame in constancy of
c.

Now fade fictitious forces on the light,

And every frame equivalency holds,
Nor gravitation wheels the planets' flight,

Space curvature inertial pathways
mold.

Beneath Newtonian trees still apples
fall,

Provided we the proper axes keep;
But other choices will their motion stall,
Consigning them to relatively sleep.

Let 'Humanists' not mock the Physicists' toil,

Their abstract joys in animate devo-
tion;

Nor 'Jet-Set' hear with a disdainful
smile,

The convoluted annalen of motion.

The force of gravity, inertia's power,

And mass responding, particle and
wave,

They fall alike from Galileo's tower,

Paths of Newton—can appearances be
saved?

Full many a gem of purest ray serene,

The dark unfathomed caves of space-
time bend;

Full many a λ blue-born have we seen,

Red-shifted at their journey's end.

Far from the gravitating mass's pull,
Their Doppler-shifted courses do they
stay;

Along a field line stretched taut full,

They keep the constant fastness of their
way.

Though at rest with the distant stars,

Fixed in ertial frames we prove,

Gravity's strength defies all bars;

Eppur si muove! And still it moves!

For who to dumb forgetfulness a prey,

To the old philosophers' demise re-
signed,

Embraces new philosophy today,

Nor casts one longing, lingering look
behind?

Here rest their heads upon the lap of
earth;

Giants to both the cultures not un-
known;

Fair Science frowned not on their humble
birth,

Let Humanists regard them as their
own.

While still we seek their merits to dis-
close,

Their final frame is in that dread
abode,

Where all alike in trembling h repose,

Perchance engaged in games of dice
with God.

ROBERT A. DICURCIO

Loomis Chaffee School
Windsor, Conn.

10/5/77

Cosmology in the dark

The article about cosmology by Beatrice Tinsley (June, page 32) is a delightful exercise of the intellect. I have a simpler, down-to-earth explanation based on the Hubble variable.

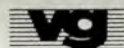
According to modern mysticism,¹ the radius of universe is 10.4×10^{22} kilometers, corresponding to a symbolic time of 1.1×10^{10} years. The radius of Earth is 6.38×10^3 kilometers. The ratio of former to latter is 1.63×10^{19} .

When the Hubble variable was discovered² in 1926 it had a value of 500 kilometers per second per megaparsec. During a past half century this variable has gradually declined³ to 50.3 kilometers per second per megaparsec. The radius of universe is inversely proportional to the magnitude of this variable. Accordingly, the universe is expanding by a factor of 100 per century. Dividing this factor into above ratio discloses that the expansion began here on Earth 961 years ago; or 1015 AD during the Dark Ages. Obviously, western cosmology was born in the dark and has been there ever since.

References

1. H. Arp, "Extragalactic Astronomy," Science

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