Introduction to Quantification and Its Concerns

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1. Introduction

It took scientists centuries to figure out how the use of quantities could facilitate the development of science. Nowadays, advertisers, politicians and scholars always use quantities to convince the public that their claims really rest on something. Yet, it would be doubtful whether the numbers they use are solid enough to be that "something". The answer lies on the process that turns concepts into quantities—quantification. In this essay, on top of introducing its history and purpose, I will raise some concerns about this powerful tool.

1.1 The definition of quantity

A quantity is a property that exists as a multitude or magnitude. It could be discrete (the number of people could only be integers) or continuous (the intensity of a light bulb could vary in infinitely small steps).[1]

1.2 The idea of quantification

Quantification is the mapping of a concept to numbers. These numbers would represent the quantity of the property associated with the concept.

Take length as an example. At first, length was a subjective concept.

1 See "Quantity" in *Wikipedia* (Retrieved 07:30, April 27, 2011).

"Longer" things possess higher magnitudes of length. Although the concept (which may be expressed as a statement) "length" ("Longer" things possess higher magnitudes of length.) cannot be represented by a number, the property "length" of an object can be. Then the ruler was invented to provide a linear scale which quantifies the concept of length. Length thus became objective.

After an international agreement on the definition of a standard ruler was reached, a standard unit (metre) of length became available.[2] Since then, that "ruler" has been a definition of length that is internationally accepted.

1.3. The purpose of quantification

Quantification favors further calculations. It also makes accurate predictions of future situations using existing data possible. For example, if the quantity A is defined and so are B and C, after collecting a finite number of data points of A, B and C, it is discovered that they all fit the relation $A = BC$, then it would be convincing to claim that we can predict A when B and C are known. The original data points are discrete and finite, but upon fitting, necessarily subsequent to quantification, the points are generalized into a continuous relation which, with the other two provided, predicts any one of A, B or C. In short, it allows the prediction of infinitely many results from finite observations.

2. Brief history of quantification

2.1. Natural science—from pre-Renaissance to the 20th century

The Greek physicists proposed many relations such as $V \propto F/R$ ("Velocity" is proportional to "Force" divided by "Resistance"), yet the

2 1 meter = the distant in vacuum that light travels in 1/299 792 458 second.

definitions of these variables were not clear.

From then to Galileo, the same problem persisted, especially for the discussion on quantification. It was not until the 14th century that a group of British scholars came up with the definition of constant velocity, which gave a foundation for the definition of constant acceleration. Theses definitions were based on measurable quantities.[3]

Before Galileo, most physicists were fond of studying the relations between concepts and trying to construct mathematical relations, yet the definition of such properties were not clear. Quantification of properties is necessary for the development of mathematical relations, yet little attention was paid on it. Consequently, even with the aid of mathematics no one could relate different relations to deduce a new one or further generalize pre-existing relations.

Galileo, known as the father of modern science, was able to realize the importance of quantification.[4] On top of that, he was able to operate the well defined quantities with mathematics. With both combined, kinematics was born. His successor Isaac Newton went a step further. He quantified intuitive concepts like "Force" ($F=ma$).[5] Also he applied calculus on quantities to study continuous variations. The rate of variation between two properties (which are quantitative) was discovered to be another quantitative property. The contributions made by Newton enabled scientists to deduce further and the quantification of properties together with mathematics allowed proofs and deductions to be verified step by step.

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3 The scholars are Heytesbury, Bumbleton and Seineshead. See Edward Grant, *Physical Science in the Middle Ages*, Chapter 4, Paragraph 34, Reprinted in from *In Dialogue with Nature* (Hong Kong: Office of University General Education, CUHK, 2011).

4 Galileo Galilei (1564–1642), Renaissance physicist, astronomer.

5 Sir Isaac Newton (1643–1727), scientist. For the definitions, see Isaac Newton, *The Mathematical Principles of Natural Philosophy* (Running Press, 2003).

2.2. Social science and quantification—a recent trend

Recently (around the last century), social scientists have been attempting to make social science more natural-science like. In short, that is to make theories that could predict, thus, falsifiable. A theory that is not falsifiable gains less and less attention. (For example, psychoanalysis, proposed by Sigmund Freud (1856–1939). It describes the human mind as a combination of id, ego and superego. Yet the three were not observable in his theory. As psychoanalysis focused on the interaction between the three, with the three not observable, one can hardly verify or disprove what he claimed.) Also, studies on quantitative relations between concepts are more common. However, as each person is unique, to study the general trend, statistics are used.

Statistical variables such as mean and standard deviation are not naturally occurring variables. They are however well quantified. Internationally, there are agreements on the definition of these statistical variables, so their quantification is objective. But statistical results could not cover all concepts. Some concepts, such as the "overall life satisfaction" of the population, are not naturally occurring and need to be defined. And that makes quantification in social science more troublesome than in natural science.

3. Concerns about Quantification

3.1 The question of objectivity

In natural science, as mentioned above, the definitions of quantities are objective in the sense that they are mapped by devices (either mathematical or physical), that can operate without the presence of humans. The interest of natural science is to understand nature. Quantification is basically providing a standard of measurement, so that analysis of measurements could be carried out.

In social science, even with the presence of statistics, one still has to consider how statistics can help map the phenomena of interest to various

quantities. Some quantitative studies are interested in the correlation between naturally occurring variables. These variables can be measured directly and hence the problem of quantification is reduced to the method of measurement. However, for those which cannot be directly measured, how the relations between measurable properties and the concept to be quantified are constructed is always a subject of debate. Some of such properties have their own meanings and definitions which, upon quantification, such meanings would be distorted or lost at worst. On top of that, such definitions could vary across cultures, schools of thoughts or even people. Any quantitative model for quantification is operationally objective in the sense that whoever plugs the same measurable quantities into the model would yield the same quantity. Different people would however come up with different models even if they were asked to study the same set of measurable quantities. In short, the operation of the model is objective, but not its construction.

3.2 The example of poverty—distortion of meaning due to quantification

There are many definitions of poverty. One is to see whether certain measurable property(s) of a person exceeds a certain value. For example, the World Bank defines absolute poverty for a person as earning less than the purchasing power of 1.25 USD per capita per day. In that case, that indicator would serve as the quantity of poverty. This standard is world wide and absolute. Some uses various operational standards which are also absolute to define poverty.[6]

6 For example, David Gordon, Professor of Social Justice, University of Bristol. See David Gordon, *Indicators of Poverty and Hunger* (http://www.un.org/esa/socdev/unyin/documents/ydiDavidGordon_poverty.pdf), p.7.

However some suggest that poverty is a culture.[7] There is a general trend in the characters of slump living people. They are more likely to possess certain characters, such as the mistrust against authorities. This gives rise to particular social problems such as crimes, which, ironically, are believed to be associated with poverty. More diversified is the society (in terms of income/purchasing power), more prominent is this trend. The above studies imply that the commonly known problems of poverty could be attributed to social inequality, which is about the relative position of the person in his society; and there is no worldwide standard.

The aim of quantifying poverty is to allow the quantitative study of poverty, which would hopefully give more accurate and precise results, providing more reliable and solid foundation for the proceeding studies for ANNIHILATING poverty. So correctly mapping the numbers to the concept of poverty is vital. However, as mentioned above, different people hold different views about poverty. The fundamental question — whether relative or absolute wealth deficiency is responsible for the "social crisis" "poverty", does not have a definite answer, so there would not be a definitely "correct way" to quantify poverty.

The example illustrates the problems associated with quantification in social science. It is a question of how far quantification should go. It is sure that statistics have contributed a lot to the development of the data collection for social scientists, providing solid and objective DATA or measurements as the foundation for further study. But how data are put into suitable context, and then are explained or elaborated is indeed a subjective process. In social science, this process however is the key to give meanings which everyone looks for. Not until there is a unified definition of a social phenomenon,

7 許寶強著，《限富扶貧 — 富裕中的貧乏》（香港：香港中文大學亞太研究所，2010），pp. 9–12.

which is not possible, that quantifying the measurements with formula would give the correct "meaning".

3.3 Quantification as a tool of disguise

Another concern is that quantification makes a concept operational, but not making subsequent arguments more valid. The general public superstitiously believes that claims and arguments are more creditable due to the mere PRESENCE of quantities, without understanding the nature of that quantity. As mentioned above, the objectivity of quantification is limited to the operation of the quantifying model, yet there are real cases that some attempts to mislead the public to believe that quantification provides an objective standard of operationallising that concept. In the last Copenhagen conference, India promised to cut off 20~25% of their "emission".[8] The devil is hidden in the definition of "emission". India used emission per unit GDP. For India, due to rapid economic development, both GDP and emission would drastically rise. By dividing the latter with the former, this quantity would hide the magnitude of the actual emission growth. The reason for employing this definition of emission is to mislead the rest of the world about the true increase of carbon emission. If this problem persists, quantification would bring crisis instead of progress.

4. Conclusion

Quantification has demonstrated its power and versatility in the field of natural science in the last few centuries. On one hand, its contribution is undeniable, yet on the other, one should never superstitiously believe that it is necessarily objective. Proven by history, it is a powerful tool for scientific

8 See Krittivas Mukherjee, 'India to Slow Greenhouse Growth in Step to U.N. Deal' (Retrieved from Reuters, Thu Dec 3, 2009 16:12).

research; one should however remember that it has to be used in the right place and more importantly with the right intention.

References

References in English

1. *In Dialogue with Nature* (Hong Kong: Office of University General Education, The Chinese University of Hong Kong, 2011).
2. "Quantity" in *Wikipedia* (Retrieved 07:30, April 27, 2011).
3. "Quantification" in *Wikipedia* (Retrieved 07:30, April 27, 2011).
4. Edward Grant, *Physical Science in the Middle Ages*, Chapter 4, Paragraph 34, extracted from *In Dialogue with Nature* (Hong Kong: Office of University General Education, The Chinese University of Hong Kong, 2011).
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6. David Gordon, *Indicators of Poverty and Hunge*r (http://www.un.org/esa/socdev/unyin/documents/ydiDavidGordon_poverty.pdf).
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1. 許寶強著，《限富扶貧 ── 富裕中的貧乏》（香港：香港中文大學亞太研究所，2010）。

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Teacher's comments:

This is a thoughtful and original writing, which reveals the limitation of the applicability of the method of science from a special perspective — quantification. The ideas are clearly explicated and the arguments are easy to follow. The author firstly explains the idea of quantification and then introduces its use in the human history. It makes mathematical formulations of science possible and hence leads to deeper understanding of the universe. Lastly, the author argues that while quantification is an obvious step in the method of natural science, it is not always straight-forward in social science. (Chan Chi Wang, Ng Wai Yin, Szeto Wai Man and Wong Wing Hung)