

ORIGIN AND SIGNIFICANCE OF POLITICAL ARITHMETIC¹

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I

It is generally recognized among economists and statisticians that Political Arithmetic was a method of numerical analysis in the field of social science created by J. Graunt (1620-74) and W. Petty (1623-87) in the middle of the 17th century. In the following 15 decades up to the days of A. Young (1741-1820), it brought about such far-reaching influence not only in England but on the Continent that it came to be regarded as a 'mother science, both of statistics and of political economy in England'.² The ultimate aim of this paper is to make an inquiry into the theoretical growth and social basis of Political Arithmetic and to clarify its scientific significance for us.

As was properly stated by Prof. G. N. Clark, 'it is quite wrong to think that it [Political Arithmetic] arose from the sudden application of mathematics to the investigation of society. ...it built higher a long-standing structure'.³ It is however beyond the ability of the present author to inquire from all angles into the 'long-standing structure' of Political Arithmetic. He will therefore try an approach to the afore-mentioned aim mostly confining himself to the works and activities of these two pioneers. In this connection, he does not believe that the traditional method of separating the economic and statistical aspects of Political Arithmetic, though thus far adopted by many scholars, will be fruitful for his purpose. As will be shown in the sequel, Political Arithmetic had these two aspects as an

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² S. Bauer, *History of Political Arithmetic*. (*Palgrave's Dictionary of Political Economy*. London, 1901. Vol. I.) p. 56.

³ G. N. Clark, *Science and social welfare in the age of Newton*. 2nd ed. Oxford, 1949. p. 120.

inseparable entity already at its earliest stage, and herein lay the very significance of this method of social investigation. The reproduction as one entity of the intentions, arguments and activities of the co-founders, who were life-long friends to each other, and their studies in the light of their social environments constitutes therefore the very method the author wishes to adopt in this paper. For he believes that such a method of approaching will certainly contribute to the clarification of one of the key problems of us, *i.e.* the quantitative observation and qualitative understanding of socio-economic phenomena or the concrete grasping of the correlations between statistics and economics.

It was Petty himself that called this kind of approach 'Political Arithmetick' and first gave it a definite methodological outline. So far as various publications in those days indicate, Graunt was the first man who actually "observed" social phenomena by this method and took the initiative toward this direction. The activities of the co-founders during the decade or so from Graunt's *Observations* (published in 1662) to Petty's *Political Arithmetick* (written in 1671-76) therefore provide important data for the clarification of the real content and theoretical setup of Political Arithmetic.

In making a comprehensive study of the social background of Political Arithmetic which constitutes the very subject of this paper, the author believes, this sort of approach alone will lead to the complete understanding of the nature and structure of Political Arithmetic as well as the activities of the co-founders before the publication of Graunt's *Observations*, namely in the days of the Puritan Revolution and the Commonwealth, particularly the latter being more important.⁴ With this in view, their works during about three decades from 1640 to the formulation of Political Arithmetic are chronologically listed below (after Graunt's *Observations*, only main works are mentioned):⁵

⁴ As for the life and achievements of Graunt, to our great regret, little is known to us.

⁵ All these works except 13) written by Graunt are Petty's. 1)-4), 6) and 9)-12) are included in *The Petty Papers, ed. by the Marquis of Lansdowne*. London, 1927. 2 vols. And 13)-17) are contained in Dr. C. H. Hull's *The Economic Writings of Sir William Petty*. Cambridge, 1899. 2 vols. (It must be noted here that the heading of 6) is added by the editor, and as for 9), only its heading is left on the list of writings written by Petty himself.) Figures in brackets denote the approximate years of writing estimated by the editors, and the numbers at the end indicate the Literature Numbers in *The Petty Papers*. With the exception of 5), 7) and 8), the author always refers in this paper to the works contained in the publications edited by the Marquis of Lansdowne and by Dr. Hull.

It is said that except the *Observations*, Graunt wrote something on excise and on religion, but none of them are left intact. But the *Account of the multiplication and growth of carps and salmons* he submitted to the Royal Society is included in Dr. Hull's reprinted edition. In order to make a more thorough-going inquiry into the problems, which constitute the subject of this paper, we have to take up Petty's essays in his late years, for which we have to our regret no space to spare any more.

- 1) *Holland*. (1644) (No. 132)
- 2) *History of Trades*. (1647) (No. 60)
- 3) *Observations of England*. (1647) (No. 61)
- 4) *An Explication of Trade and its Increase*. (1647) (No. 62)
- 5) *The Advice of W. P. to Mr. Samuel Hartlib for the Advancement of some Particular Parts of Learning*. (1647) London, 1648.
- 6) (*Natural Observations*.) (1652) (No. 147)
- 7) *Reflections upon some Persons and Things in Ireland*. (1659) London, 1660.
- 8) *History of the Down Survey*, ed. by T. A. Larcom. (1659) Dublin, 1851.
- 9) *Observations on the Bills of Mortality*. (1660) (No. 158)
- 10) *The Registry of Lands, Commodities, and Inhabitants*. (1660-61) (No. 25)
- 11) *Of Interest*. (1661) (No. 68)
- 12) *Interest*. (1661) (No. 69)
- 13) *Natural and Political Observations made upon the Bills of Mortality*. (1660-61) London, 1662.
- 14) *A Treatise of Taxes & Contributions*. (1661-62) London, 1662.
- 15) *Verbum Sapienti*. (1665) London, 1691.
- 16) *The Political Anatomy of Ireland*. (1671-76) London, 1691.
- 17) *Political Arithmetick*. (1671-76) London, 1690.

II

A chronological study of these works might perhaps be the best way for presenting the main subject of this paper. But space is so limited that we shall start from Graunt's *Observations* where Political Arithmetic was first expounded, so to speak, in original form.

It goes without saying that Graunt's 'long and serious perusal of all the Bills of Mortality, which this great city [London] hath afforded for almost fourscore years'⁶, originated from the then prevailing social environments, *i.e.* the population and labour problems, with which English capitalism was confronted in its infancy—the steady concentration of urban population in line with the growth of domestic commerce and international trade, the reproduction of labour forces, the prevalence of epidemics, especially plague, which had the effect of decreasing the population, and so forth. Whatever the case might be, his long and serious study was apparently motivated by his personal interest rather than by his intention to solve these social problems. It is said that, brought up in the Puritan atmosphere, Graunt was

⁶ *Observations*. p. 398.

a self-taught man and that he 'served with distinction' as captain of the Trained Band on the occasion of the Puritan Revolution. If we want to understand the significance of his *Observations* based upon 'a long and serious perusal of all the Bills of Mortality', the most important fact in his career we must not lose sight of is that he was a merchant, born and bred in London, who found 'in Trade the want of an universal measure'.⁷ Little wonder that, when he seriously studied 'all the Bills of Mortality', Graunt came to believe in 'the Mathematicks of my [his] Shop-Arithmetick'.⁸ It must be recalled here that, along with the development of the international trade of England from the latter half of the 16th to the first decades of the 17th century, commercial arithmetic made remarkable progress in England, its subjects centering around "the rule of three" and "the chain-rule (conjoined proportion)". In fact, with this as a social background, R. Record's *The Grounde of Artes* (1540) and W. Oughtred's *Clavis Mathematica* (1631) were published, while J. Napier's *Logarithms* (of which the English edition was published in 1616, dedicated to 'the commercial classes') was so welcome to them.⁹ These achievements in the field of mathematics are said to have come from one and the same social conditions, which were also responsible for Graunt's reliance upon his "Shop-Arithmetick". Characterizing mathematics in those days, J. Wallis (1616-1703), who paved the way for Newton's discovery of binominal theorem, wrote as follows: 'Mathematicks at that time, with us, were scarce looked upon as Academical Studies, but rather Mechanical; as the business of Traders, Merchants, Seamen, Carpenters, Surveyors of Lands, or the like, and perhaps some Almanack Makers in London... For the Study of Mathematicks was at that time more cultivated in London than in the Universities'.¹⁰ In such social environments in the days of *manufacture*, Graunt and Petty came into acquaintance with each other, which later developed into a life-long friendship between them, and the latter completed his above-mentioned works in 1640's as will be shown in what follows. From the foregoing, it may be concluded that Graunt's belief in his 'Shop-Arithmetick' was inseparably connected with the rapid progress of commercial arithmetic in those days, which greatly contributed to the development of mathematics in general.

In his *Observations* which consist of 12 chapters, Graunt deals with various matters concerning the movement of population—namely its composition and change by sex, marriage, fertility or the number of 'teeming

⁷ *ibid.*, The epistle dedicatory to Sir R. Moray.

⁸ 'seine Krämer-rechnung in der Mathematik'. V. John, *Geschichte der Statistik*. Stuttgart, 1884. s. 171.

⁹ F. Cajori, *A history of elementary mathematics, with hints on methods of teaching*. Rev. and enl. ed., New York, 1924. See *Modern Times (Arithmetic)*.

¹⁰ E. G. R. Taylor, *The mathematical practitioners of Tudor & Stuart England*. Cambridge, 1954. p. 4.

women', age, the number of males or 'fighting men', religion, profession, parish or location. In so doing, he reduced the 'Bills of Mortality' into 'Tables so as to have a view of the whole together, in order to the more ready comparing of one Year, Season, Parish, or other Division of the City, with another', and discovered 'some Truths, and not commonly believed Opinions' arising from his 'Meditations upon these neglected Papers' (the Bills of Mortality).¹¹ Among the 'Truths' Graunt finally succeeded in discovering through his extraordinarily persistent observations, the most valuable from the statistical point of view is that concerning numerical regularities in population phenomena. According to Dr. C. H. Hull, these regularities are summarized in the following four points:¹² 1) The constant proportion between some of 'the several casualties' (for instance, 'chronical diseases') and the 'whole number of burials' (Chap. II), 2) the excess of male over female births and the approximate numerical equality of the sexes (Chap. VIII), 3) the high rate of mortality during the earlier years of life (Chap. II), and 4) the excess of the urban over rural death rate (Chap. XII). (The idea of proportion or ratio played the most important role in Graunt's 'Shop-Arithmetick' for the derivation of these regularities. This clearly indicates that Graunt's method was abreast with the progress of commercial arithmetic in his days.) He attributed these regularities to the 'climate and air' or 'the Law of Nature, that is, Law of God', and imagined that the healthfulness of the people was under their control (Chap. II and XII). He concluded that the 'Increase of Mankind' was in conformity with the Law of Nature, because 'Hands being [labour is] the Father, as Lands are the Mother and Womb of Wealth' (Chap. VIII). In connection with these issues, he further discussed such delicate problems as the air contamination and smoke (the increased consumption of 'Sea-Coal'), the relations between professions and deaths, death from hunger and beggary, and asked for the relief of the poor. He also stated that the number of 'christenings' had been decreasing 'disproportionally' since 1642 as a result of the 'Confusion and Changes' in the government, which took place in turn as a result of 'differences in Religion' (Chap. III, XII).

Thus, there is no doubt that the regularity in population phenomena is 'one of the leading ideas in his book', but Graunt failed to realize that 'the regularity must naturally be less prominent where the number of observations is small',¹³ though he might have anticipated the Law of Large Numbers. He was however well aware that his 'Observations which I [he] happened to make upon the bills of Mortality, have fallen out to be both Political and Natural'.¹⁴ The author dedicated his book to President Sir

¹¹ *Observations*. The Preface.

¹² C. H. Hull, *Introduction to The Economic Writings of Sir William Petty*. Vol. I. p. lxxvi.

¹³ H. Westergaard, *Contributions to the history of statistics*. London, 1932. pp. 18, 19.

¹⁴ *Observations*. The epistle dedicatory to Sir R. Moray.

R. Moray of the Royal Society which was founded in the year when the book was published. The dedication was made on the ground that his 'Natural, and Political Observations' concerned 'the Air, Countries, Seasons', etc. On the other hand, he dedicated his work to Lord J. Roberts, eminent minister of state under King Charles II, the patron of new science, on the ground that his book was related to political matters, *i.e.* 'Government and Trade'. Moreover, Graunt regarded his *Observations* as 'Natural History'. This was simply because he thought that Bacon reckoned *The History of Life and Death, being the third part of the Instauration Magna* as 'Natural History', and that the Royal Society, the incarnation of Bacon's ideal, was provided with 'the three Estates, viz. the Mathematical, Mechanical, and Physical.'¹⁵

It is undeniable that Graunt's study, motivated by his personal interest, was too crude in construction to inquire into the true nature of the subject observed and too obscure in basic thinking to clarify the socio-economic relationship. This notwithstanding, his discovery of regularities in social phenomena was of such significance at that time, especially because the regularities were numerically demonstrated with indisputable evidence, that Graunt, shop-keeper as he was, was given the membership of the Royal Society with the King himself as recommender.

But the question presents itself: How did his observations, 'both Political, and Natural' (underlined by the author) come to get unified theoretically by Petty?

III

In the author's opinion, an important clue for the answer to this question is found in Graunt's writing, *i.e.* in the 'Conclusion' of the *Observations*. The significance of the 'Conclusion', written in very compact style, lies not so much in the fact that it summarizes what has been observed in the preceding 12 chapters as in the fact that it raises new questions, *i.e.* 'To what purpose tends all this laborious bustling and groping? To know, The Number of the People? How many Males and Females?...' These questions in further analysis are reduced to whether or not, and how, the aforementioned knowledge of the numerical regularities in population phenomena can be used as 'the Art of Governing, and the true Politicks' or 'the Foundation or Elements of this honest harmless Policy...to preserve the Subject in Peace and Plenty.' It is apparent that Graunt considered, 'a clear knowledge of all these particulars,...is necessary, in order to good, certain, and easie Government, and even to balance Parties and Factions both in

¹⁵ *ibid.*; cf. V. John, *op. cit.*, s. 171.

Church and State'. In other words, he intended to obtain scientific knowledge necessary for providing foundations upon which the rational policy for industry and employment of a modern state at its earliest stage could be laid down.

How then can such knowledge be obtained? Graunt proposed for this purpose a survey of 'the Land, and the hands of the Territory', *i.e.* a survey of the 'intrinsic value' and that of the 'accidental, or extrinsic' value of the land. The former means an investigation of a) the topographical features and b) the productivity of land which can be measured in terms of soil fertility and crops available; and the latter concerns the prices of the land and products and their fluctuations. Graunt further urged that these surveys should be combined with a population census by 'Sex, State, Age, Religion, Trade, Rank, or Degree, etc.'¹⁶ Thus, what is proposed in the 'Conclusion' is not only to make a numerical observation of the natural conditions of population, irrespective of the social environments, but to observe the relations between the inhabitants and the land which had the greatest capital value in civil society at that time, and thereby to clarify the socio-economic significance of the population (and its movement).

It must be recalled here that almost the same proposal is made by Petty in the latter half of Chapter V of his *Taxes* ('Of Usury'), namely a survey of the intrinsic and extrinsic or accidental values of lands.¹⁷ In fact, the necessity of the population census is emphasized almost everywhere in Petty's work together with the need of the 'computation' of national wealth. It is needless to repeat details of Petty's arguments on the land survey, for what is said in his work is almost a word by word repetition of *Observations*. But brief mention must be made of the following points:

(1) Proposing a land survey, Petty criticized the Monthly Assessment—a direct tax, which was imposed together with the Excise during the Puritan Revolution. Succeeding the Tudor Subsidies, the Monthly Assessment was created as property tax as a result of the gradual establishment of modern landownership (or in the course of the transformation of rent in kind to money rent) and 'contributed to the break-up of the medieval financial system'.¹⁸ A national tax as it was, it was however not completely deprived of its medieval and local characteristics as might be noted from the fact that its rates widely varied according to localities and its assessment standards were rather obscure. With a view to realizing a fair taxation, the land survey was proposed by Petty as a means to minimize local differences and set up a rational standard for assessment.

(2) Petty's arguments on the land survey are based upon and inseparably connected with his fundamental theories. The 'Ratio formalis' of

¹⁶ All quoted from the 'Conclusion' of the *Observations*. cf. V. John, *op. cit.*, ss. 167-170.

¹⁷ *Taxes*. p. 49, *et seq.*

¹⁸ M. P. Ashley, *Financial and commercial policy under the Cromwellian Protectorate*.

wealth constitutes a keynote of his persistent advocacy of the fairness in taxation, which was so emphatically stressed in the *Taxes*. In fact, it was found by him that, even if taxation should be made at one and the same rate all throughout the country, the effects upon the capitalized value (price) of lands to be brought about by Monthly Assessment would not be the same, dislocating the 'Ratio formalis' of wealth in accordance with the status of the land in question, *i.e.* with the origin of its possession or lease.¹⁹ Inquiring into the 'mysterious nature' of wealth (rents) as a tax source, he further developed the theory of rent (surplus value), land prices and interest and proceeded with the discussion of how to establish a standard for assessment and how to compute the money value of land rent. He finally proposed a survey of lands.

(3) Petty's arguments on land survey, rent, etc. are characterized by some salient methodological features. His usual methodology is as follows: First to observe the subject intrinsically, then to look for the factors which may influence it accidentally or extrinsically, thereby finding its true nature. Take for instance his view on land rent, which constitutes one of the most important parts of his theories: He begins with the study on the intrinsic nature of rent in kind which is followed by the observation of it in the form of money rent. Then, inquiries are made into the factors responsible for the accidental fluctuations of the silver price in order to determine the 'natural Par between Land and Labour'. This is perhaps one of the most typical patterns of the arguments which was employed by Petty. Such an approach is not confined to his discussion on land survey and rent, but common to all his theories.²⁰ It was through this kind of reasoning that the numerical observations gradually gave rise to more qualitative considerations. It was also through it that social relationships were abstracted from a complex of social phenomena for the formulation of some fundamental ideas and theories of economics.

Petty's proposal for land survey cleared the way for liquidation of the local differences in the feudal rent in kind and nation-wide introduction of the modern land tax system after the Glorious Revolution in England. Some countries on the Continent soon followed suit. Herein lies the practical significance of his theories in human history.²¹ Such an achievement

London, 1934, p. 83.

¹⁹ *Taxes*. Chap. IV.

²⁰ This method of approaching, as aptly mentioned by Dr. Bevan, is shown in the most clear-cut form in Petty's *The Dialogue of Diamonds* (in C. H. Hull's ed. pp. 624-630). *cf.* W. L. Bevan, *Sir William Petty, a study in English economic literature*. (*Publications of the American Economic Association*. Vol. IX. No. 4. 1894.) p. 63.

²¹ As referred to by Dr. H. Ouchi in his article entitled "Significance of Petty's *Taxes* in the history of economic doctrines" in Japanese *C. Maide Kyoju Kanreki Kinen Ronbunshu* (Papers in Commemoration of Professor C. Maide's 60th Birthday). Tokyo, 1953, pp. 62-63. At the second Protectorate Parliament (1656-57) Major-General E. Whalley, one of the Regi-

of his was made possible, it is to be remembered, only by his laborious efforts to tackle the very central problem put forth by Graunt in the 'Conclusion' of the *Observations*—a comprehensive survey of population in connection with the lands which were then considered to have the greatest capital value in civil society as well as a unitary understanding of 'the Land, and the hands of the Territory'. This being the case, it is necessary for us to clarify what enabled Petty to do so.

Before taking up this problem, the author wishes to make a cursory review on the so-called "Disputed Authorship" of Graunt's *Observations*. He does not however intend to go into details in this respect, but to summarize the controversies about the similarity or rather identity between the 'Conclusion' of the *Observations* and Petty's arguments on land survey in the *Taxes*. In other words, we shall be concerned with the similarity or identity of the so-called "Parallel Passages" with a view to elucidating their social background, for such an elucidation is closely connected with the main subject of this paper.

IV

Although Graunt's name is printed on its title-page, which was the actual author of the *Observations*, Graunt or Petty? This question was raised soon after the death of Graunt and has since remained unsolved in the past three centuries or so. We do not want to go into details, much less to get involved in this long-pending controversy, but wish to make a brief survey of the controversial discussions referring to the publications,²²

cides, criticized the Monthly Assessment and proposed 'a national rate of 6 *d.* in the pound'. But the proposal was rejected on the ground that it was 'plausible but not practicable', because there had not been 'an elaborate survey of the entire property of the kingdom.' (cf. Ashley, *op. cit.*, pp. 74-75.) It can be said that Petty's arguments on land survey and the theory of rent provided a theoretical basis for such a proposal.

²² In preparing this bibliography, the author owes much to the literatures (27), (43), (44) and (45). Comments contained in some works on the history of statistics and some dictionaries are omitted. As for the literatures marked with asterisks, information is only indirect.

- (1) * Aubrey, J. (1626-97), *Brief lives*, ed. by A. Clark. Oxford, 1898. 2 vols.
- (2) do, *Brief lives*, ed. by O. L. Dick. London, 1950.
- (3) * Bell, J. (?-?), *London's remembrancer*. London, 1665.
- (4) * Burnet, G. (1643-1715), *History of his own time*. 2nd ed. Oxford, 1833. 6 vols.
- (5) Child, Sir J. (1630-99), *A new discourse of trade*. 2nd ed. London, 1694.
- (6) Evelyn, J. (1620-1706), *The diary of John Evelyn*, ed. by W. Bray. London, 1950. 2 vols.
- (7) Hale, Sir M. (1609-76), *The primitive origination of mankind*. London, 1677.
- (8) Halley, E. (1656-1742), *An estimate of the degrees of the mortality of mankind*, ed. by L. J. Reed. Baltimore, 1942.
- (9) * Houghton, J. (d. 1705), *A collection of letters for the improvement of husbandry and*

the author happened to gain access to directly or indirectly.

It was probably in the middle of the 19th century, when J. R. McCulloch formally recognized Graunt's authorship of the *Observations*,²²⁻¹⁴ starting this protracted controversy. Concerning the authorship of this work, the contemporaries of Graunt differed from one another in opinion,

- trade*. London, 1681-83. 2 vols.
- (10) * Oldenburg, H. (1615?-77), *Oldenburg to Boyle, 18th September, 1665*. (R. Boyle's Works, ed. by T. Birch. London, 1772. 6 vols.)
- (11) * Pett, Sir P. (1630-99), *The happy future state of England*. London, 1688.
- (12) Süßmilch, J. P. (1707-57), *Die göttliche Ordnung*. Berlin, 1741. Jap. Übers. von I. Takano & T. Morito. Tokyo, 1949.
- (13) do, *Die göttliche Ordnung*. 2. Aufl. Berlin, 1761-62. 2 Bde.
- (14) 1845 McCulloch, J. R., *The literature of political economy*. London, 1845.
- (15) 1851 Roscher, W., *Zur Geschichte des englischen Volkswirtschaftslehre im 16. und 17. Jahrhundert*. Leipzig, 1851. Jap. Übers. von E. Sugimoto. Tokyo, 1929.
- (16) 1855- Mohl, R. von, *Die Geschichte und Literatur der Staatswissenschaften*. Erlangen, 58 1855-58. 3 Bde.
- (17) 1859 Hodge, W. B., *On the rate of interest for the use of money in ancient and modern times*. (*Assurance Magazine, and Journal of the Institute of Actuaries*. Vol. VIII. 1859.)
- (18) 1859 De Morgan, A., *On a statement revived in Mr. Hodge's paper on interest, with reference to the authorship of Graunt's Observations*. (*ibid.*)
- (19) 1865 Todhunter, I., *A history of the mathematical theory of probability from the time of Pascal to that of Laplace*. Cambridge and London, 1865.
- (20) 1867 Wagner, A., *Statistik*. (*Deutsches Staats-Wörterbuch, hrsg. von J. C. Bluntschli und K. Brater*. 11. Bde. Stuttgart und Leipzig, 1857-70. 10. Bd. Jap. Übers. von H. Ouchi. Tokyo, 1942.)
- (21) 1872 * De Morgan, A., *A budget of paradoxes*. London, 1872.
- (22) 1892 Cunningham, W., *The growth of English industry and commerce in modern times*. Cambridge, 1890-92. 2 vols. Vol. II.
- (23) 1894 Bevan, W. L., *Sir William Petty, a study in English economic literature*. (*Publications of the American Economic Association*. Vol. IX. No. 4. 1894.)
- (24) 1895 Higgs, H., *Review of Bevan's Petty*. (*Economic Journal*. Vol. V. 1895.)
- (25) 1895 Fitzmaurice, E., *The life of Sir William Petty 1623-1687*. London, 1895.
- (26) 1896 Hull, C. H., *Graunt or Petty? The authorship of the Natural and Political Observations upon the Bills of Mortality*. (*Political Science Quarterly*. Vol. XI. 1895.)
- (27) 1899 do, *The authorship of the Natural and Political Observations upon the Bills of Mortality*. (*The Economic Writings of Sir William Petty, ed. by C. H. Hull*. Cambridge, 1899. 2 vols. Vol. I.)
- (28) 1903 Pasquier, M., *Sir William Petty, ses idées économiques*. Paris, 1903.
- (29) 1927 Lansdowne, Marquis of, *On the disputed authorship of the London Bills of Mortality. Parallel passages in the London Observations and Petty's unpublished writings*. (*The Petty Papers, ed. by the Marquis of Lansdowne*. London, 1927. 2 vols. Vol. II.)
- (30) 1928 Westergaard, H. and Nymbole, H. C., *Grundzüge der Theorie der Statistik*. 2. Aufl. Jena, 1928.
- (31) 1928 Lansdowne, Marquis of, *The disputed authorship*. (*The Petty-Southwell Correspondence, 1676-1687, ed. by the Marquis of Lansdowne*. London, 1928.)
- (32) 1928 Greenwood, M., *Graunt and Petty*. (*Journal of the Royal Statistical Society*. Vol. 91. 1928.)
- (33) 1931 Bonar, J., *Theories of population from Raleigh to Arthur Young*. London, 1931.

because they recognized facts differently. Most of them were however interested in standing neither for Graunt nor for Petty. It was the commentators of later generations that tried to utilize the unbiased testimonies of these contemporaries for determining the authorship. There can be no doubt that almost all the contemporaries hailed with joy the brilliant "discovery" on the numerical regularities reported in the *Observations* and tried to develop various achievements in it for their own use.^{22-5,7,8} J. P. Süssmilch (1706-67), who endeavoured to develop the Political Arithmetic thus founded in England as 'die politische Rechen-kunst', evaluated Graunt's work so highly that he compared his achievements with the discovery of the New Continent by Columbus.^{22-12,13} But he regarded the regularities discovered by Graunt as 'die göttliche Ordnung' and Petty's computation of national wealth simply as a technical method of statistical estimation. He probably failed to recognize the significance of "political" (social) way of thinking initiated by these two pioneers,²³ so far as the 1741 edition of his work was concerned.

Dr. C. H. Hull presents a comprehensive and detailed survey on all the "Disputed Authorship" controversies in the latter half of the 19th century.^{22-26,27} Two salient features of the controversies in this period deserve special attention: namely, 1) it was almost agreed that the *Observations* were a joint work of Graunt and Petty in some sense or other, and 2) controversies were gradually concentrated on the character of their collaboration, i.e. which played a more essential role, Graunt or Petty. In

(34) 1932 Müller, W., *Sir William Petty als politischer Arithmetiker. Eine soziologisch-statistische Studie.* Gelnhausen, 1932.

(35) 1932 Lansdowne, Marquis of, *Petty and Graunt.* (*Times Literary Supplement*, 8th September 1932. No. 1597.)

(36) 1932 Brett-James, N. G., *Petty and Graunt.* (*ibid.*, 15th September 1932. No. 1598.)

(37) 1932 Greenwood, M., *Graunt and Petty.* (*ibid.*, 22nd September 1932. No. 1599.)

(38) 1932 Lansdowne, Marquis of, *Petty and Graunt.* (*ibid.*, 13th October 1932. No. 1602.)

(39) 1932 Powell, L. F., *Petty and Graunt* (*ibid.*, 20th October 1932. No. 1603.)

(40) 1933 Greenwood, M., *Graunt and Petty—A re-statement.* (*Journal of the Royal Statistical Society.* Vol. 96. 1933.)

(41) 1937 Clark, G. N., *Science and social welfare in the age of Newton.* Oxford, 1937.

(42) 1937 Willcox W. F., *The founder of statistics.* (*Revue de l'Institut International de Statistique.* 5 ann. livr. 4. 1937.)

(43) 1939 Willcox, W. F., *Introduction to the reprint of J. Graunt's Observations.* Baltimore, 1939.

(44) 1941 Kuruma, S., *On the disputed authorship of J. Graunt's Observations.* (Jap. transl. of J. Graunt's *Observations.* Tokyo, 1941.)

(45) 1948 Greenwood, M., *Medical statistics from Graunt to Farr.* Cambridge, 1948.

(46) 1954 Strauss, E., *Sir William Petty, portrait of a genius.* London, 1954.

²² In this sense, Süssmilch was in the history of statistics the first man who systematized Political Arithmetic. cf. V. John, *Johann Peter Süssmilch.* (*Allgemeine Deutsche Biographie.* Leipzig, 1894. 37. Bd. s.195.) D. Diderot had no doubt about authorship of Graunt. cf. Article "Arithmétique Politique" in *L'Encyclopédie.* Tome I. Paris, 1751. J. G. Meusel, of the *Staatenkunde*, also believes that the *Observations* were Graunt's work. cf. *Literatur der Statistik.* Leipzig, 1790. s. 22.

defence of their own stands, all the controversialists resorted to "direct testimony" and/or "inward evidence" as Dr. Hull put it. Arguments based on the latter can further be classified into the following: a) Picking up and analyzing the "Parallel Passages" in the works of the two pioneers, b) comparing the statistical methods expounded in their works, and c) comparing their character, styles of writing, etc. After having studied in detail all the controversies along these lines, Dr. Hull concludes, 'in short, the "Observations upon the Bills of Mortality of London" are essentially Graunt's work, and he deserves the credit for them'.²²⁻²⁷ By using the adverb "essentially", Dr. Hull undoubtedly refers to the numerical regularities discovered by Graunt.

In the 20th century, Dr. Hull's conclusion had been regarded, as before, as an established fact until the twenties when the Marquis of Lansdowne, a descendant of Petty, edited and published *The Petty Papers* and *The Petty-Southwell Correspondence* and concluded, 'there can, I think, be no reasonable doubt that the Observations on the London Bills were in all essential respects his [Petty's] own work'.²²⁻²⁹ The "essential respects" as said by the Marquis of Lansdowne may be summarized as follows: 'Graunt's hand may perhaps have held the pen, but it was surely Petty who supplied the ideas which have caused this book to be regarded as "One of the Classics of Statistical Science"'.²²⁻³¹ A renewed and hotter controversy thus took place between the descendant of Petty and Prof. M. Greenwood.²⁴ Other commentators took part in the controversies, which proceeded in this century along the same line as that a few decades ago. It however deserves special mention that the academic discussions became concentrated increasingly upon which should be regarded as more "essential", Graunt's or Petty's ideas in the *Observations* (a line of demarcation had gradually be drawn between their ideas). Prof. W. F. Willcox fundamentally agrees with Dr. Hull and offers a very persuasive conclusion.²²⁻⁴³ According to him, a) The Epistle Dedicatory to Sir R. Moray, b) the 'Conclusion,' and c) the Life Table (Chap. XI) may have been written by Petty, but the whole of the *Observations* except a) and b) is 'a more coherent and sinewy piece of writing'.²⁵

This is a very cursory review of the "Disputed Authorship" controversies up to the Second World War. Since the end of the War, there has not been repeated any such argument so far as the author is concerned. In his recent work on Petty,²²⁻⁴⁶ Mr. E. Strauss however made an excellent

²⁴ Prof. G. N. Clark wholly agrees with Prof. Greenwood who asserts that the statistical achievements in the *Observations* were attained entirely by Graunt, but he says that Prof. Greenwood is 'unnecessarily emotional' in his argument. 22-41.

²⁵ Prof. Greenwood, who attributes the authorship of the Life Table to Graunt, considers as 'cogent' what is contended by Prof. Willcox, but he says, 'although Prof. Willcox has certainly shaken my previous conviction, I still feel reluctant to surrender Graunt's table to Petty.' 22-45.

review on this issue. Saying 'the posthumous reputation of the *Observations*' lies in 'its painstaking statistical method', he carefully traces Petty's substantial contributions in this respect in a lot of contemporary literature. He concludes that 'the co-operation between Petty and Graunt, which resulted in the *Observations*, was an epoch-making event for the history of statistics', and that the 'Conclusion' of the *Observations* [which, in his opinion, was 'almost certainly Petty's work'] sums up the 'aims of Petty's pioneer work in the social sciences, which consisted in the proclamation of quantitative measurement as the key to adequate knowledge of social facts, and in the principle of inductive reasoning from statistical data'.

The prolonged controversies extended over more than a century from the perfection of classical economics and modern statistics, respectively, by D. Ricardo and L. A. J. Quetelet in the first decades of the 19th century to the Second World War—during this period both sciences underwent a series of remarkable developments and transformations. These discussions, in the author's opinion, are not without the following shortcomings: namely, 1) too much emphasis has been placed on the numerical regularities in social happenings, which has been derived by Graunt from the 'natural and political' observations, 2) the explanation of the social and economic facts, measured and perceived numerically, have often been ignored as originating from Petty, and 3) the issue of the "Parallel Passages", including the similarity between the 'Conclusion' of the *Observations* and Petty's arguments on a land survey,²⁶ has been discussed merely as a problem of parallelism in their published works. Such discussions are liable to distort the real value of the *Observations*. As properly said by Prof. S. Kuruma, the final solution of the authorship dispute may depend upon the difference of opinions about wherein the true value of the *Observations* lies.²²⁻⁴⁴ The essential point here is not the clarification of the sole or co-authorship of the *Observations*, but the analysis on the social basis of the "Parallel Passages", which induced the dispute, while the land survey and the distribution of confiscated lands carried out by Petty himself in Ireland under the Commonwealth prior to the publication of the *Observations* and the *Taxes*, were among the most important constituents of the said social basis.

²⁶ In Dr. Hull's opinion, the parallels here are the 'longest and closest' among the Parallel Passages and 'are doubtless important.' He further writes that the 'Conclusion' is not 'a sober summary in the style of the book itself' but 'a not altogether unsuccessful attempt to write wittily about these matters'. 22-27. The author wishes to note that the words 'to write wittily about these matters' are cynically quoted by Dr. Hull from the 'Conclusion' probably in the sense that Petty himself is making witty remarks in the 'Conclusion' instead of 'truly' studying 'Nature and Things' (1st ed. of the *Observations*). But the author does not agree with Dr. Hull in this respect.

V

The land survey and the distribution of confiscated lands were directly connected with the conquest of Ireland by Cromwell, better known as the Cromwellian Settlement of Ireland. The conquest and confiscation were an event in a series of England's invasions of Ireland, which was started in the 12th century and strengthened by the absolutist policy to Ireland by Henry VII, Queen Mary and Queen Elizabeth I, as well as by later attempts to completely subdue her. It was called 'the most sweeping, perhaps, [confiscation] that modern ages have seen'²⁷ and 'the climax of a century of English policy'.²⁸ And its epochal significance lies not so much in the thoroughness with which it was enforced mercilessly as in its ultimate objective, *i.e.* the establishment of civil order in Ireland.²⁹

It took more than a decade after 1641 for the English Commonwealth to suppress a series of rebellions by the Irish, especially by the Roman Catholic landlords against the colonial domination by England. The main aim of this English policy was none other than to create, according to a predetermined plan, a modern land system through the distribution of confiscated lands among the English Protestants—Protestant yeomanry in Ireland.³⁰ It must be remarked here that the lands thus confiscated were distributed as redemption, in the form of land, of government debts to the creditors, namely the English Protestants— a) the London Adventurers who supplied war funds to the Government for 'the speedy and effectual reducing of the rebels in Ireland'³¹ and b) the officers and soldiers of the Cromwellian army whose remunerations in arrears were to be covered by the distribution of rebels' lands. A study of the debentures issued by the Government for the army officers and men reveals that the money debts were redeemed not only in the form of 'Rebels Lands' but also (rebels') 'Houses, Tenements and Hereditaments, in Ireland; or other Lands, Houses, Tenements, and Hereditaments there'. It means that the material wealth of Ireland was offered entirely as a security for the monetary loans of the Commonwealth Government of England. 'Ireland,' said E. Hyde, the Earl of Clarendon (1609-74), 'was the great capital out of which all debts were paid, all services rewarded, and all acts of bounty performed'.³²

For good or bad, what the Commonwealth had to enforce by all

²⁷ W. F. T. Butler, *Confiscation in Irish history*. London, 1917. p. 115.

²⁸ E. Strauss, *Sir William Petty, portrait of a genius*. London, 1954. p. 66.

²⁹ C. Hill and E. Dell (Editors), *The good old cause*. London, 1949. p. 429.

³⁰ C. H. Firth, *Cromwell's army*. 2nd ed. London, 1912. p. 205.

³¹ E. Curtis and R. B. McDowell (Editors), *Irish historical documents 1172-1922*. London, 1943. pp. 177-179. This act is generally called the Act of Subscription (1641).

³² A Cromwellian Debenture, reproduced in J. P. Prendergast, *The Cromwellian settlement of Ireland*. 2nd ed. Dublin, 1875. Frontispiece. R. Bagwell, *Ireland under the Stuarts and during the Interregnum*. London, 1909-16. 3 vols. Vol. II. p. 338.

means was: 1) To calculate the total amounts of debts due to a large number of various creditors, 2) to make a survey of the confiscated lands which constituted the most important means to redeem these debts, and 3) to carry out the redemption of debts, *i.e.* the distribution of lands among the creditors.³³ It was the second and third items that Petty was ordered by the Government to take charge of. Petty, being originally in charge of the land survey, was naturally entrusted with the distribution of the surveyed lands.³⁴

It was in September, 1652, or immediately after the suppression of the Irish rebels that Petty left the post of professor of anatomy at Oxford University and came to the 'wasted, desolate country'³⁵ as a physician to Cromwell's army. Not long after his arrival in Ireland, he took over the task of surveying and distributing the confiscated lands, though it had little connection with his profession. We know many reasons for his taking over such a duty, but two of them deserve special consideration: 1) He thought 'the whole work would have been over...in about two years time, so as to have proved rather an unbending than a breaking of that bow, wherein I [Petty] aimed at natural knowledges', and 2) he wanted to enlarge his 'trade of experiments from bodies to minds, from the motions of the one, to the manners of the other, thereby to have understood passions as well as fermentations...'³⁶

Petty's land survey was called the Down Survey in the sense that the lands surveyed were laid down on maps. Working under his direction were about 1,000 surveyors, mostly soldiers. It is more significant that he adopted the principle of division of labour not only for field work but for the making of surveying instruments as well.³⁷ Thus, the Down Survey, covering the 22 counties of the country, was finished in 13 months.³⁸ The methods employed and the survey itself are described in detail in his *History of the Down Survey*. So far as the topographical features covered in the

³³ M. J. Bonn, *Die englische Kolonisation in Ireland*. Stuttgart und Berlin, 1906. 2 Bde. II. Bd. s.74.

³⁴ *ibid.*, s.83.

³⁵ R. Dunlop (Editor), *Ireland under the Commonwealth*. Manchester, 1913. 2 vols. Vol. II. p. 477. It is written that due to a series of rebellions, about 'five-sixths of her people had perished' in Ireland. *cf.* J. P. Prendergast, *op. cit.*, p. 307.

³⁶ *Reflections upon some persons and things in Ireland*. 2nd ed. Dublin, 1790. pp. 3, 7. In his address delivered on November 24, 1658, at the Grocers' Hall, Petty declared that 'the chief end of my going to Ireland was to make way for distinguishing the so'diers' from the adventurers' interest in the eleven counties'. These remarks indicate that, even before his departure for Ireland, he had been determined to take over the task of land surveying and distribution there. *cf.* *Calendar of the State Papers, Ireland, Adventurers for land, 1642-1659*. p. 362.

³⁷ Sir T. A. Larcom writes that Petty 'had discovered the great principle of division of labour' in the course of the Down Survey. *The history of the Down Survey*. p. 314.; *cf. ibid.*, pp. xiv-xv, 17-18.

³⁸ *ibid.*, p. 295.

survey are concerned, the 'Instructions'³⁹ Petty gave to his subordinate surveyors are said to have been summarized almost literally in a 'survey of intrinsic values of land' in the *Taxes* (Chap. V). In fact, the Down Survey was originally intended for the following two-fold purposes, *i. e.* cadastral as well as topographical surveying, for the survey was planned as a prerequisite for the proposed distribution of the confiscated lands and, moreover, quit-rent and other taxes were to be imposed upon the lands which would be distributed among the creditors. The essential point of technical difficulties of the Down Survey therefore lay in the classification of the distributed lands in accordance with the degree of their profitability. A surveyor, called Lewis Smith, being engaged in the land survey in the county of Kerry, complained, 'as to what wee have done in Kerrey, wee can very well justifie quantities, but as for the quality of land wee had noe rule to walke by,... but did according to the best of our judgements, and the best information wee could get'.⁴⁰ This should not be taken as a testimony by a single incompetent surveyor but interpreted as indicating the general situation about 'the almost impossibility of distinguishing the classes of land in the state they then were'.⁴¹

This difficult problem was "solved" by the methods employed 'ordinarily and usually' in accordance with 'the advice of the chief inhabitants'⁴² in each county. In Petty's arguments on land survey as expounded in the *Taxes* (Chap. V) however the issue is rationally solved by an investigation of each denomination of land which is measured intrinsically by fertility and available crops. This will become clearer if we read his essay⁴³ on (Irish) land registry written just before the publication of the *Taxes*. In that essay, Petty proposes a survey of 'the intrinsic fertility' as a means to measure the value of land. It is highly significant that this sort of approaching corresponds to the typical method of observing the subject "intrinsically", which was also employed in his studies on rent (and other fundamental theories).

VI

It was during 1656-58 that the distribution of the forfeited lands was enforced under Petty's supervision, and this under ever-worsening conditions, such as the increasing disbandment of the army forces, the impoverishment of the disbanded soldiers and the subsequent negotiation of debentures, the

³⁹ *ibid.*, pp. 46-53.

⁴⁰ *ibid.*, p. 97.

⁴¹ *ibid.*, p. 330.

⁴² *ibid.*, p. 96.

⁴³ Refer to the 10th literature listed on page 55.

increasing concentration of such debentures in the hands of high-ranking officers and politicians, the friction between the army and the London Adventurers, and so forth. These conditions are summarized by Sir T. A. Larcom as follows: 'In truth it is difficult to imagine a work more full of perplexity and uncertainty than to locate 32,000 officers, and soldiers, and followers, with adventurers, settlers, and creditors of every kind and class, having different and uncertain claims on lands of different and uncertain value, in detached parcels sprinkled over two-thirds of the surface of Ireland'.⁴⁴ Land prices in Ireland were roughly fixed province by province under the Act of Subscription of 1641, and they were called 'Act Rates'. For surveying and distributing the confiscated lands, it was however necessary to estimate the prices lot by lot in full consideration of the natural, economic and social conditions of each lot—a very complicated and difficult task in an extremely backward country like Ireland under the afore-mentioned conditions.

It 'would require a treatise by it self', as Petty wrote, to describe perfectly the distribution of the forfeited lands. In carrying out this laborious project, Petty regarded 'the whole party [of the creditors (soldiers)] as one man...as if one uniform distribution had been made, and then considered each as having received or being about to receive such or such a "quota pars", in order to make up the deficient, and pare down the redundant, to the same rate in the pound on their respective claims.' 'In this there were of course many practical difficulties',⁴⁵ and this distribution was carried out forcibly 'as Parties interested could prevail upon and against one another by their Attendance, Friends, Eloquence, and Vehemence; for what other Foundation of Truth it had in nature, I [Petty] know not'.⁴⁶

All these things came from the very fact that, in such a backward country as Ireland where money was regarded as "useless" for most of the inhabitants,⁴⁷ it was highly difficult to compute the money rent or land

⁴⁴ *The history of the Down Survey.* p. 338.

⁴⁵ *ibid.*, pp. 184, 336.

According to Mr. A. T. Lucas' private communication Petty's description about land-distribution (cf. *ibid.*, p. 184, 2nd paragraph) is interpreted as follows:

'In order to give an account of the distribution of the forfeited lands, it has first to be noted that when some of the soldiers were disbanded in 1653 they were given lands at a more advantageous valuation than that set out in the Act: the valuation adopted was apparently the same for all of them. In order therefore to determine how much they actually received, as compared with what they were entitled to, the amount of land to be distributed to all the soldiers must be computed at the rates set out in the Act; then a calculation must be made of the proportion which the amount of land that the disbanded men received (whether this was supposed to be $\frac{5}{8}$ or $\frac{2}{3}$ or any other fraction of their whole share) bore to the amount that they should have received. The reckoning must not be on the basis that those who got lands in Louth have received half of what is due to them, and that those in Longford have got the whole, etc.'

⁴⁶ *The Political Anatomy of Ireland.* p. 179.

⁴⁷ *ibid.*, Chap. XI; *Political Arithmetick.* Chap. II.

price in full consideration of all the "extrinsic or accidental" factors. In other words, the greatest difficulty involved in the Down Survey lay in distinguishing the profitability from the unprofitability of lands. In the case of land distribution, nothing was more difficult than to express in terms of money the distinguished, if not perfectly, profitability or unprofitability. This was the reason why Petty interpreted his "survey of extrinsic or accidental values of lands" as a method of computing the money rent through a survey of prices (and price fluctuations) of land products. Not only that, this method of computation, as already mentioned, corresponds to the method with which Petty studied the land rent in kind in the form of money rent. In the course of such analysis, Petty lay 'the foundation of equalizing and balancing of values' of commodities, upon which 'the superstructures' (*i.e.* extrinsic or accidental price fluctuations) are built (*Taxes*. Chap. IV). Furthermore, starting from this foundation thus laid down, he came to consider all the commodities as 'the creatures of Lands and mens Labour thereupon', and tried to find out the 'natural Par between land and labour' in order to 'express the value by either of them [land and labour] alone'. He further determined, though in very simple form, the 'Natural Price' (value of commodities) underlying the price fluctuations.

Probably comparable in scale to the Domesday Survey, the Down Survey (including the distribution of the confiscated lands) could not have been carried out without the strong state power of the Commonwealth which completely suppressed the Irish rebellion. However, its ultimate aim, *i.e.* the establishment of the English Protestant yeomanry in Ireland, was not attained in its perfect form. In reality, it induced the mushrooming of the 'Cromwellian newcomers' or 'upstart gentry'⁴⁸ and helped to promote the colonial pauperization of Ireland, in particular, after the Glorious Revolution, thereby laying the foundation upon which English absenteeism was gradually built.⁴⁹ This notwithstanding, it is notable that this survey paved the way for the establishment of a modern land system in Ireland which was little more than 'a new State' ('as a white paper'), and this 'before men had even the possession of any land at all'⁵⁰ there. In this sense, the survey substantially succeeded in attaining its objective. The reason why Petty's arguments on land survey played an epochal role for the creation of

⁴⁸ E. MacLysaght, *Irish Life in the seventeenth century*. 2nd ed. Oxford, 1950, Chap. IV. Petty was himself one of these get-rich-quick upstarts, for he made speculative purchases of the debentures and got possession of a wide expanse of lands in Ireland. On the occasion of the Restoration however these lands were granted to him due to the favour of King Charles II. *cf.* C. S. P. *Ireland*, 1660-62. pp. 180, 280, 502-3. In this respect, his complicated personality is shown in relief. *cf.* E. Strauss, *op. cit.*, Part II.

⁴⁹ 'As a transfer of property from Irish to English hands the Cromwellian settlement had some measure of success, but as a scheme of colonisation it totally failed.' R. Bagwell, *op. cit.*, Vol. II. p. 337.

⁵⁰ *Taxes*. pp. 9, 39.

a modern land tax should be looked for in the very fact that his Down Survey was itself a monumental project for introducing this system.⁵¹

In England, the art of surveying, cartography and map-making made remarkable progress in and after the latter half of the 16th century as a result of 'a convergence of economic needs and intellectual progress', as well as of the gradual decline of feudal landownership, for 'there was a need [for] the defining of rights'.⁵² Indeed, field-surveying was 'very much needed during a period of forfeited estates', inducing W. Leybourne to write his *Compleat Surveyor* (1653).⁵³ Petty's Down Survey is said to have been 'the most comprehensive and scientific survey of a large area made by any Englishman before 1755'.⁵⁴ Its accuracy was such that it only 'understated the area of forfeited land by 10-15 percent',⁵⁵ and his *Hiberniac Delineatio* (1685?), or 'the first atlas of Ireland', was 'the most important event in the 17th century'⁵⁶ in that 'Ireland has for the first time found her true shape, if not real size'.⁵⁷

Modern cartography was 'in all its aspects closely allied to statistics... [for] a map is an abstract statement based on measurement; statistics are abstract statements based on measurement, counting, and calculation'.⁵⁸ As mentioned elsewhere, Petty's Down Survey was itself at the same time a land survey, a project for map-making and a statistical investigation of the 'Lands, Houses, Tenements and Hereditaments in Ireland' which constituted the whole national wealth of that country. In this sense, historical progress of surveying, cartography and statistics is clearly reflected in the Down Survey.

It is almost certain that, in addition to the Down Survey, Petty took charge of a population census in Ireland in the latter period of the Commonwealth.⁵⁹ The returns of this census are very comprehensive, being 'arranged geographically in counties, baronies, parishes, and townlands; and in cities, parishes and streets. In addition to mere numbers, the returns supply the names of the principal or distinguished occupiers of townlands and streets...In setting down the numbers on each inhabited townland and

⁵¹ England at that time, though urgently needed, had no Land Registry. cf. D. Ogg, *England in the reign of Charles II*. Oxford, 1934. 2 vols. Vol. II, p. 441, and M. P. Ashley, *op. cit.*, p. 75. When one reads the 10th literature on page 55 with this in view, he could understand all the more vividly Petty's far-sighted arguments.

⁵² G. N. Clark, *op. cit.*, p. 125.

⁵³ E.G.R. Taylor, *op. cit.*, pp. 86, 230-231, 360.

⁵⁴ E. Lynam, *British maps and map-makers*. Rev. ed. London, 1947. p. 33.

⁵⁵ Y. M. Goblet's work cited by E. Strauss, *op. cit.*, p. 71.

⁵⁶ R. V. Tooley, *Maps and map-makers*. 2nd ed. London, 1952. p. 93.

⁵⁷ Y. M. Goblet's work referred to in E. Strauss, *op. cit.*, p. 73.

⁵⁸ G. N. Clark, *op. cit.*, p. 126.

⁵⁹ S. Pender (Editor), *A census of Ireland, circa 1659*. Dublin, 1938. Introduction. This voluminous book is undoubtedly one of the best works which provides us with valuable information about the history of modern population censuses.

in each street, the proportions of English, Irish, and Scotch, are expressed ...The returns also supply important and interesting baronial and city lists of the names and numbers of principal Irish.⁶⁰ The most significant fact was that this census was conducted along the lines of the Commonwealth Government's fundamental policy toward Ireland.

The Down Survey, together with this census, can be said to have been the first statistical surveys of 'the Land, and the hands of the Territory' in modern history. It is none the less noteworthy that these projects gave important stimulus to the theoretical development from Graunt to Petty.

VII

In the latter part of his boyhood Petty received an education of medieval style, probably based on the Seven Liberal Arts, at a Jesuit college at Caen, France.⁶¹ In the early years of his adolescence, he experienced the Puritan Revolution and 'vigorously followed' his studies of medicine (anatomy) and mathematics at then most advanced universities in Holland. It was at Dutch universities and at the informal gathering at Paris with M. Mersenne as a central figure that he was influenced directly or indirectly by then leading scholars and thinkers, such as J. Pell, T. Hobbes, S. Hartlib, J. A. Comenius, R. Descartes, B. Pascal, and P. Gassendi. At Paris, he, together with Hobbes, was absorbed in reading A. Vesalius' *Fabrica* (1543). It was after the latter half of his adolescence that his command of strikingly comprehensive knowledge thus obtained, partially in response to the practical needs characteristic of the science and technique in the days of *manufacture*, was further developed mainly through his intimate association with the "virtuosi", who were the followers of Bacon and his experimental philosophy. And it was in those days that he became a good friend of Graunt (as we have already seen in the 2nd section of this paper).

Generally speaking, it can be said that, when he took charge of the Down Survey, Petty was one of the learned men with the widest knowledge and highest education known at his time. In fact he was one of the 'practitioners'⁶² under the direct influence of Bacon. Not only that, he was a mathematician and anatomist, who knows the secret of success in life. Though limited space prohibits a detailed explanation in this respect, his papers written in 1640's (see the first five works listed on page 55) clearly indicate that already at that time he knew the importance of numerical

⁶⁰ W. H. Hardinge's statements cited by Mr. S. Pender. *ibid.*, pp. v-vi.

⁶¹ cf. *Palinodia* and *A Collection of W. Petty's Severall Works and Writings since the Year 1636* in *The Petty Papers*. No. 149, 158.

⁶² It is necessary for us to recall here the remarks of J. Wallis shown on page 55 (see Footnote 10). Also refer to E. Strauss, *op. cit.*, p. 184.

observation of socio-economic phenomena and practised them.

As already mentioned, he took care of the laborious task of the Down Survey in order to extend his 'trade of experiments' from natural history to sociology. It is not an exaggeration to say that in this connection he closely followed Bacon's 'striking recommendation'⁶³ as shown in the following sentence of his: 'It may also be asked (in the way of doubt rather than objection) whether I speak of natural history only, or whether I mean that the other sciences, logic, ethics, and politics, should be carried on by this method. Now I certainly mean what I have said to be understood of them all'.⁶⁴ After all, the Down Survey was historically a great social experiment not only for the Commonwealth of England but also for Petty himself. So far as the fundamentals of his theory and methodology are concerned, it was mainly through this experiment that Petty initiated the labour theory of value, analyzed the social setup centering around the creation of wealth, and estimate national wealth from the unitary point of view in the *Taxes* and the *Verbum Sapienti*, which were written after the Restoration and thereby greatly contributed to the solution of the problem as set forth in the 'Conclusion' of Graunt's *Observations*. In other words, it was basically through the Down Survey that Petty's anatomy and arithmetic, combined with Graunt's commercial arithmetic and guided by Bacon's experimental philosophy, crystallized into a "political" (social in the modern sense of the term) entity.

In the foregoing six sections, we have seen how Political Arithmetic and Political Anatomy, which Petty 'long aimed at' and 'attempted',⁶⁵ were born and grown up to a quantitative method of social science. It was in the Preface to his work entitled 'Political Arithmetick' written during 1671-76 that he first formulated this method with confidence. But the author wishes to emphasize that Political Arithmetic and Political Anatomy constituted the integral parts with each other in his theory under the influence of Baconian philosophy.⁶⁶ Salient features of these methods, if regarded as one entity, may be summarized in the following three points:

1) Petty's method is based upon the parallelism between the 'Body Natural' and the 'Body Politick'.

2) It measures and anatomizes the 'Symmetry, Fabrick, and Proportion', namely the structure of civil society by means of 'Number, Weight, or Measure', which are probably originating from *The Wisdom of Solomon*.⁶⁷

⁶³ B. Farrington, *Francis Bacon, philosopher of industrial science*. London, 1951. p. 113.

⁶⁴ F. Bacon, *The new organon. (The works of Francis Bacon. Vol. IV. London, 1883.)* p. 112.

⁶⁵ *Political Arithmetick*. p. 244. *The Political Anatomy of Ireland*. p. 129.

⁶⁶ Petty himself believed in the integrity of his Arithmetic and Anatomy. cf. E. Fitzmaurice, *The Life of Sir William Petty 1623-1687*. London, 1895. p. 158.

⁶⁷ G. N. Clark, *op. cit.*, pp. 72-73. G. N. Clark, *The seventeenth century*. 2nd ed. Oxford, 1950. p. 257. E. Strauss, *op. cit.*, p. 185.

3) It severely criticizes the traditional scholastic method of, medieval learning and considers 'only such Causes, as have visible Foundations in Nature', *i.e.* factors founded upon the objective facts independent from human consciousness.

What then was the ultimate aim of such a scientific method? It was, as Petty himself clearly writes, 'to shew the uses of knowing the true State of the People, Land, Stock, Trade, etc'.⁶⁸ In Petty's theory, 'People' are the bearer of labour power or a source of wealth (value), while 'Land', etc. are the forms of material wealth or the means to acquire it. Accordingly, Petty's method, though closely connected with the demands on the part of the mercantile policy in those days, was intended for grasping of the true nature of wealth in civil society, although he did not make an inquiry into the "Wealth of Nations" so clearly as A. Smith consciously did. It was this theoretical standpoint that enabled Petty to properly evaluate the quantitative regularities, which Graunt derived from the movements of 'People' (population) without referring to 'Land, Stock, Trade, etc.', leading him to the discovery of the qualitative regularities underlying socio-economic phenomena.

In this light, the author wishes to review in the next section the quantitative observations of socio-economic phenomena, which is the most important feature of Political Arithmetic and Political Anatomy, as well as its interconnection with the qualitative side of socio-economic relationships.

VIII

It is essential that the process of Petty's concept formation was much dependent upon his numerical observations and reasoning based upon them. Their close mutual interconnection is well seen in this dependence. In order to clarify such interconnection, it is necessary to explain what the 'Number, Weight, or Measure', or figures, really were and how they were used by Petty.

In the author's opinion, the figures used by Petty are classified into the following: 1) Figures empirically obtained through statistical surveys or personal observations, 2) figures estimated in some way or other, and 3) illustrative figures used 'as Suppositions to shew the way to that knowledge I [Petty] aim at'. These three kinds of figures, needless to say, are mutually interwoven with one another. It must be noted here that among the first named figures, those obtained through statistical surveys are very few, while those obtained through practical observations are extremely numerous.

⁶⁸ *Political Arithmetick.* p. 313.

As for the estimated figures of the second class, the following question arises: How are they estimated? Roughly speaking, they are estimated by three methods: *i.e.* a) estimation which is obtained from known figures or quantities taking into consideration other relevant and concrete facts (by way of the Rule of Three), b) estimation through the application of figures to theoretical reasoning, and c) estimation on the basis of mean values of known figures. Space does not allow us to go into details of these estimations, but as is clear from the ultimate aim of Political Arithmetic, it must be remembered, Petty was primarily concerned with the estimation of national wealth and income, and in making these estimates, he regarded the price (value) of land (and other property as well) as the rent capitalized through 'years purchase', which was equal in function to the general rate of interest.

The typical use of the illustrative figures is seen in Petty's basic theories on rent, interest, etc. As Dr. W. L. Bevan aptly writes, 'when he [Petty] asserts that the price of silver in Russia and in Peru is determined simply by the quantity of labor, it is almost certain that he confidently uses this illustration, without investigating its truth'. He goes on to say that 'his employment of deductive method is concerned in reducing complex facts to simplicity.'⁶⁹ It deserves special attention that the figures used as illustrations in such a case play a very important role.

It may be no exaggeration to say that Petty's arguments are all based upon the free use of these three kinds of figures. Theoretically speaking, it is particularly significant that these figures are used simply as a tool of reasoning. These figures now function not only as recorders but also as calculators. But it was only in the early years of the modern age that the medieval practice of using the Roman figures for recording and using the abacus for calculation was replaced by the new method of using the Indo-Arabian figures for both purposes. Prof. F. Cajori calls the former the abacistic school, and the latter the algoristic school.⁷⁰ In his later years, Petty himself said that his Political Arithmetic was the 'Algorithm of Algebra', or an algebra applied to 'policy'. Therefore, his Political Arithmetic is 'a kind of Logick' and 'a more refined way' of reasoning, and figures are nothing other than a tool for 'Ratiotination' (reasoning).⁷¹ Petty's basic ideas are therefore said to have been built up through 'reasoning by figures' as put by C. Davenant.⁷²

⁶⁹ W. L. Bevan, *op. cit.*, p. 89.

⁷⁰ F. Cajori, *op. cit.*, p. 188.

⁷¹ *The Petty-Southwell Correspondence 1676-1687*, ed. by the Marquis of Lansdowne. London, 1928. pp. 318-322. Mr. E. Strauss writes that Petty's 'conception of mathematics was, therefore, that of a tool of mental analysis.' E. Strauss, *op. cit.*, p. 184. The author believes this is a very proper opinion.

⁷² C. Davenant, *Works*. London, 1771. 5 vols. Vol. I. p. 128.

Petty's computation of the 'Superlucration' is a typical example of his proper use of the afore-mentioned figures. In order to demonstrate the reason why England's 'Wealth and Strength' should increase more and more, he computed the 'Superlucration' in the *Political Arithmetick* (Chap. VIII). This 'Superlucration' is a conception, which means the surplus to be accumulated out of the value newly created through the employment of 'spare hands' in the country. The surplus also makes possible the enlarged reproduction of civil society.⁷³ But Petty does not give us any clear information about who get such surplus as income. He appears to have been interested not so much in who earn the surplus as wage, rent or profit, as in the enlargement of social production as a whole. According to him, wealth is created by labour of people, accumulated in some form or other, and enables people to enjoy more plentiful living. 'What we call the Wealth, Stock, or Provision of the Nation, being [is] the effect of the former or past labour'.⁷⁴ But all the classes of society, namely capitalists, landowners and workers, are regarded as a complex whole. He therefore fails to explain the mechanism of the distribution of wealth. Such ambiguity is also well recognized in his theories on rent, interest, etc. in the *Taxes*, but all this must be interpreted not as the shortcoming on the part of Petty, but as something inevitable historically. In his opinion, 'Husbandmen, Seamen, Soldiers, Artizans and Merchants' were 'the very Pillars of any Common-Wealth',⁷⁵ and people's earnings constituted "national" income in the proper sense of the term. It should be remarked that such an observation was made possible only by a man with a rare ability of being extremely far-sighted. In spite of some theoretical inconsistencies on his part, Petty observed socio-economic phenomena by means of the above-mentioned three kinds of figures, made a generalization of what had been observed, and finally succeeded in building up his basic conceptions.

In his essay written in 1640's,⁷⁶ Petty considered the 'Superlucration' simply as 'gold, silver, precious stones, etc.' which were saved and stored. It is interesting to note in this respect that in the same essay he defined labour as 'the simple motions of men in order to commodities, (for) so many houres as hee is naturally able to endure the same'. It was through

⁷³ Thus considered, it can be said that Petty's essays written in his later years, generally regarded as his works on vital statistics, are in final analysis his arguments for 'the increase of the 'Superlucration'. In Dr. Hull's opinion however these essays, except on money, 'added practically nothing of economic interest to these earlier books'. But the author believes Dr. Hull is going too far in this respect. cf. C. H. Hull, *Petty's place in the history of economic theory*. (*The Quarterly Journal of Economics*. Vol. XIV. 1900.) p. 322 and also E. Strauss, *op. cit.*, p. 201.

⁷⁴ *Verbum Sapienti*. p. 110.

⁷⁵ *Political Arithmetick*. p. 259.

⁷⁶ Refer to the 4th literature on page 55. Such a definition of labour is not so much economic as anatomic (physiological) in nature. It is to be recalled here that, a few years after this essay was written, Petty became a professor of anatomy at Oxford University.

his numerical observations and reasonings, based upon his social activities in and after 1650's, that his ideas formed in his younger days took more definite shape, becoming clearer from the viewpoint of the labour theory of value. Generally speaking, the numerical observation of socio-economic phenomena, *i.e.* 'die Quantifizierung der sozialen Tatsachen',⁷⁷ is some sort of abstraction. And such observation could be made possible only after almost all the social products were expressed in terms of money and social relations were reduced to a common denominator called money. Such 'reasoning by figures', though conditioned by the social development, was not peculiar to Petty, but common to almost all the mercantilists in those days.

It is to be noted however that, though under the historical restrictions common to the mercantilists, he had a far wider and deeper insight into social phenomena and created a series of basic theories which later became the main current of classical economics. According to Marx, Petty's Political Arithmetic is 'die erste Form, worin die politische Ökonomie sich als selbständige Wissenschaft abscheidet'.⁷⁸ This assertion of his was probably originating from this fact.

IX

As for the social basis of Petty's pioneering theories, there are many facts to be considered, but the most important is, in the author's opinion, the establishment of modern landownership in Ireland under the Commonwealth as well as the execution of the Down Survey, which acted as the groundwork for the successful introduction of such a land system there. In other words, Petty created the theories of his own and succeeded in clarifying some most important social relationships, which came into existence through a series of social and political changes culminating in the Puritan Revolution. With Bacon's experimental philosophy as a guiding principle, he numerically observed these social relationships and extended theoretical reasonings to such observations. As a result he succeeded in deriving his key ideas on the determination of these relationships and thereby built up his own theoretical system. It is to be remarked that these key ideas were his own creation which was only materialized after his painstaking efforts. For 'Dissections' of society, he had 'only a common Knife and a Clout'.⁷⁹ In his theory, the numerical observation and theoretical analysis of socio-economic phenomena therefore remain inseparable, forming an

⁷⁷ cf. P. Flaskämper, *Allgemeine Statistik, Grundriss der Statistik*. Teil I. Hamburg, 1949. s.30.

⁷⁸ K. Marx, *Zur Kritik der politischen Ökonomie*. Berlin, 1951. s.50.

⁷⁹ *The Political Anatomy of Ireland*. pp. 129-130.

organic unity.⁸⁰ Complex phenomena are simplified through numerical measurements, and the "intrinsic" relationship underlying these phenomena is grasped after such simplification, while the "extrinsic" factors, if any, are dealt with in abstraction. Thus, the way was paved, though in very simple form, for scientific abstraction.

In his *Essays or Counsels*, Bacon writes: 'The greatness of an estate in bulk and territory, doth fall under measure; and the greatness of finances and revenue doth fall under computation. The population may appear by musters; and the number and greatness of cities and towns by cards and maps. But yet there is not any thing amongst civil affairs more subject to error, than the right valuation and true judgment concerning the power and forces of an estate'.⁸¹ The author does not intend to make light of Petty's ingenious versatility, but wishes to emphasize that, if not based upon the social background described in the foregoing, Political Arithmetic could not have obtained such a far-reaching scientific significance far beyond the narrow confines of mercantilism and Petty himself could not have succeeded in making 'the right valuation and true judgment concerning the power and force' ('Wealth and Strength' in his terminology) of England in the latter half of the 17th century. In fact, he could have never made such a rosy prediction about the prosperity of England in the 18th century under the uncertain social conditions during the third Anglo-Dutch War, which was the worst ever known in the history of England.

According to Prof. P. Flaskämper, the kernel of the social facts lies in 'qualitativer Natur' and 'das eigentliche Wesen [der sozialen Tatsachen] jedenfalls sich nicht restlos in Quantitäten auflösen lässt', though figures play a great role in social as well as natural sciences. He further asserts that any figure could not be significant without due consideration on the qualitative side of socio-economic happenings and that the important problem in statistics is not 'die Art der Erkenntnisse, ob stochastisch oder nichtstochastisch', but 'die Bedeutung eines statistischen Aufschlusses im Rahmen der gesamten Erkenntnisse über einen Gegenstand, in dem... die Einsicht in qualitative, in Sinnzusammenhänge die entscheidende Rolle spielt'.⁸² Developing such arguments mainly on the conception of a 'Parallelismus von

⁸⁰ This unity or rather indivisibility of his numerical observation and theoretical analysis corresponds to the fact that in his theory prices and values of commodities are confused with each other. It was in the days of Petty's followers, such as G. King and C. Davenant, that Political Arithmetic changed into a simple art of computation and estimation, as these two aspects of his theory were separated from each other. A. Smith also considered Political Arithmetic as such and had 'no great faith' in it (prior to the classical theory of probability, the technique of estimation on Political Arithmetic was naturally crude and unreliable), but it was none other than Smith that theoretically elaborated Petty's labour theory of value or the other aspect of Political Arithmetic. cf. A. Smith, *The wealth of nations*. W. R. Scott's ed. London, 1925. 2 vols. Vol. II. p. 40.

⁸¹ F. Bacon, *op. cit.*, Vol. VI. London, 1878. p. 445.

⁸² P. Flaskämper, *op. cit.*, ss.10, 30-31.

Sach-und Zahlenlogik', he goes on to say that herein lies the key problem to be taken care of by statistics.⁸³

The author does not pretend to understand perfectly Prof. Flaskämper's suggestive conceptions on statistics. But, he believes, he has shown in the foregoing that Political Arithmetic as a numerical method of scientific study succeeded in grasping the 'qualitative Natur' of socio-economic phenomena getting a deeper insight into the 'Sinnzusammenhänge'. Its success was in the first place due to its formation during the growth of civil society in England and to its dependence upon the labour theory of value for its 'gesamter Erkenntnisse'. Secondly, it is due to its successful unification, of course standing on the labour theory of value, of the parallelism between the 'Body Natural' and 'Body Politick' from the monistic point of view (in Prof. Flaskämper's theory, the 'Parallelismus' appears to remain ununified), thereby giving 'das eigentliche Leben'⁸⁴ to the 'Number, Weight, or Measure'. In this point lies the whole significance of Political Arithmetic at its earliest stage, enabling us to make a deeper inquiry into the essential problem of statistics as well as economics.

⁸³ *ibid.*, s.244.

⁸⁴ *ibid.*, s.10.